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Systemic Challenges, Systemic Responses

Innovating Adaptation to Climate Change through Agroecology

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Adaptation through Agroecology

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Systemic Challenges, Systemic Responses:

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Cover image: Nagamani, a farmer from the Visakhapatnam district of Andhra Pradesh. © Andhra Pradesh Community Managed Natural Farming

Executive Summary

There is an inextricable link between our food systems and accelerated climate change.

A growing body of evidence reveals that accelerated climate change has far-reaching impacts on our food systems, while at the same time, our food systems are adversely affecting climate change trends.

The Intergovernmental Panel on Climate Change (IPCC, 2019) found that unsustainable agricultural production processes accelerate biodiversity loss, and are responsible for the bulk of greenhouse gas emissions from land use change, land degradation, and the unsustainable use of freshwater resources. According to the Food and Agriculture Organization of the United Nations, if current rates of greenhouse gases emissions are maintained, there will be a 17% decline in the production of four major cereal crops that provide the staple food for billions of people (coarse grains, oil seeds, wheat and rice) by 2050.

These findings underscore that the agricultural sector is both a contributor to, and casualty of, accelerated climate change. To date, however, the global response has remained sectoral, and disconnected in nature. The complexity of local adaptation needs, coupled with the need to address the resilience of food systems as a whole, means that no single initiative can address all challenges in a comprehensive way.

There is emerging evidence that agroecology – which links food production at farm level to the broader social-ecological systems that support resilience to climate change – can contribute towards more systemic solutions. Adding to concrete results documented by agroecological initiatives, such as MASIPAG in the Philippines or Andhra Pradesh Community Managed Natural Farming in India, recent reports from High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, and the Global Commission on Adaptation, have acknowledged this contribution.

Over the course of several months, a broad range of experts, policy makers and practitioners held a series of consultations to explore the contribution of agroecology to innovative and transformative climate change adaptation responses. This paper is the culmination of this process, which not only sought to develop a common understanding of the role of agroecology to climate change adaptation, but to craft a common language that can help bring together the agriculture and climate change communities.

The consultative process identified the following five key messages:

1 To be innovative, adaptation efforts must respond to the systemic challenges posed by climate change to our food systems.

2 Diverse agricultural systems are less vulnerable to extreme climatic events, climate variability, and cumulative agro-climatic changes.

3 To strengthen the adaptive capacity of rural livelihoods, it is necessary to pair technological innovations, and improvements in agricultural practices, with investments in social capital, the co-creation of knowledge with farmers, new marketing networks, and the responsible governance of land and natural resources.

4 Integrated measurement approaches, such as true cost accounting, are necessary to capture all the factors that contribute to climate-resilient food systems.

5 Innovating adaptation to climate change calls for nothing less than transforming our food systems.

Through its call for a large-scale, international mobilisation to strengthen the resilience of small-scale farmers to climate change, the Global Commission for Adaptation Action Track on Food Security and Rural Livelihoods offers a timely opportunity to "road test" these messa ges.

However, these messages are just a first step. In order to start to transform our unsustainable food production, and consumption systems, the required systemic response must span the entire trajectory of the need for systemic responses (in terms of research focus, investments and, ultimately, measures) to meet climate change challenges. This paper underscores that we need to take a number of measures, moving forward. These include:

- Allocating more resources to research exploring systemic adaptation for food security and rural livelihoods, and the contribution of diverse food systems, including agroecological approaches.
- Targeting investments in climate change adaptation for food security and rural livelihoods towards agroecological programmes.
- Enhancing the enabling environment for scaling up diversified and climate-resilient agricultural systems at scale, through a focus on, among others, responsible land governance, inclusive access to markets, extension services, agricultural finance, and promoting local processing and value addition.
- Strengthening alliances for change for food system transformation from the local to global levels. This includes ensuring that international policy processes provide sufficient space for multiple voices and perspectives to explore diverse pathways towards climate change adaptation and resilience. There is also a need to enhance policy and institutional synergies, such as between the three UN Rio Conventions (Biodiversity, Climate Change, and Desertification), and agricultural communities.

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List of Acronyms

BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement (French Agricultural Research Centre for International Development)
FAO	Food and Agriculture Organization of the United Nations
GCA	Global Commission on Adaptation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation)
HLPE	High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security
IPCC	Intergovernmental Panel on Climate Change
IRD	Institut de Recherche pour le Développement (French Research Institute for Development)
IUCN	International Union for Conservation of Nature
KfW	Kreditanstalt für Wiederaufbau (German Credit Institute for Reconstruction) LDN Land Degradation Neutrality
NDCs	Nationally Determined Contributions
NAPs	National Adaptation Plans
SDC	Swiss Agency for Development and Cooperation
TEEB	The Economics of Ecosystems and Biodiversity
UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wide Fund for Nature
ZUG	Zukunft-Umwelt-Gesellschaft (Future-Environment-Society)

Introduction

The climate crisis is also a food security crisis

The past five decades have seen a significant rise in food production in many parts of the world. A large factor in this success was the accelerated use of external inputs in agriculture, as has been widely attributed to the Asian Green Revolution (Hazel, 2010). Yet, producing more food has not meant that all people have increased food security, as evidenced by the rise in hunger globally over the past five years (FAO, 2018a). According to the most recent State of Food Security and Nutrition Report (FAO, 2020), both the number of undernourished people and the prevalence of undernourishment is higher in 2019 than it was in 2014. In 2019, a staggering 697.8 million people are undernourished, which translates into a prevalence of undernourishment of 8,9%. In some world regions, such as western, and eastern Africa, these trends are particularly pronounced. According to data for the 2018-2019 period, the gender gap in accessing food is also increasing (Padmaja et al., 2019; FAO, 2020).

But while agricultural modernisation has helped to raise yields, it is also recognised as a major contributor to the degradation of natural ecosystems and the diverse ecosystem services that they provide (UNEP, 2016). Unsustainable food production practices and consumption patterns not only play a major role in the loss of agrobiodiversity and other essential ecosystem services (Holt et al., 2016), they are also a major contributor to accelerated climate change. Agriculture, in particular in OECD countries, is a key source of greenhouse gas emissions that create the increasingly challenging environment within which agriculture has to perform (Tubiello et al., 2013).

Climate change impacts, such as rising temperatures, changing rainfall patterns, and extreme weather events, not only create new hazards for farmers, but are also a multiplier of existing risks within food production systems, including land degradation, drought and desertification (Thornton & Lipper, 2014; FAO, 2016). According to FAO (2015), the agricultural sector absorbs more than 20% of the total damage and losses caused by natural hazards.

These negative impacts disproportionately affect smallholder farmers and low-income groups (FAO, 2016), who are generally among the least responsible for accelerating climate change. If the current rates of greenhouse gases emissions and climate change trends continue, it is estimated that by 2050 there will be an average decline of 17% in the production of four major cereal crops that provide the staple food for billions of people (coarse grains, oil seeds, wheat and rice) (FAO, 2016).

Building sustainable and resilient food systems requires holistic adaptation approaches

If there is one certainty in agriculture today, it is that climate change will continue to bring even more uncertainty. Years of drought can be followed by abrupt flooding, or farmers may experience a sudden dry spell at the onset of the regular

planting season. The unpredictability of these impacts means that there is no magic bullet in adaptation. Successful adaptation requires addressing all the underlying factors that contribute to climate change impacts and not a focus on singular solutions for specific impacts. Moreover, since such impacts also continue to evolve, even the most comprehensive responses need to be adapted over time. A key requirement in increasing resilience to climate change impacts in agriculture, therefore, is to strengthen the adaptive capacities of farmers, and other actors. This calls not only for technological skills and adapted extension services (Khanal et al., 2018), but also political empowerment (Tanner et al., 2014), social organisation (Huitema et al., 2016), and market access (Belay et al., 2017), among other capacities.

The emerging complexity of local adaptation needs and the need to address the resilience of food systems as a whole means that no single initiative can address all challenges in a comprehensive way. Moreover, successful climate change adaptation requires addressing risks to specific elements of the food system without creating negative impacts on other elements of the system. Designing such systemic responses, and measuring their impacts, is a challenging task.

Comparing it to "aiming at a moving target," Cabell and Oloefse (2012) have called for "flexible metrics" for measuring the resilience of agroecosystems. This implies, for example, that biophysical indicators (e.g. ecological self-regulation, functional and response diversity, heterogeneity) need to be complemented by a broad set of behaviour-based indicators that define an agroecosystem's adaptive capacity. The latter group of indicators includes, for example, the ability of self-organisation, connectivity, and knowledge sharing (ibid.; O'Connel et al., 2015).

Agroecology offers a pathway to boost climate resilience at farm and ecosystem levels

Agroecology has different meanings to different actors in different parts of the world, from being a scientific discipline to an agricultural practice, or a political or social movement (Wezel et al., 2019). The 14th report of the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (2019) underlines that while agroecology means different things to different people, ultimately, its core contribution lies in its focus on the entire food system: "An agroecological approach to sustainable food systems recognizes that agri-food systems are coupled with social-ecological systems from the production of food to its consumption with all that goes on in between (HLPE, 2019, p.14)."

This paper does not engage in a scientific discussion on terminology or concepts. Instead, it considers agroecology to be part of a broader definition of agricultural systems that build on ecological principles to guide the design and management of sustainable food systems (Björklund et al., 2012). The paper acknowledges both the 10 elements of agroecology developed by FAO and the consolidated set of 13 principles of agroecology (FAO 2018b; Barrios et al., 2020) as conceptual building blocks in designing agroecological approaches.[1]

1 FAO developed the following 10 elements to capture the essence of agroecology: diversity; synergies; efficiency; resilience; recycling; co-creation and sharing of knowledge; human and social values; culture and food traditions; responsible governance; circular and solidarity economy. These elements are interlinked and interdependent (FAO, 2018b).

The 13 principles of agroecology that have been derived from literature by HLPE (2019) are well aligned and complementary to the 10 Elements of Agroecology developed by FAO (FAO, 2018b and reviewed by Barrios et al. 2020) but are more explicit when articulating requirements of soil and animal health and distinguishing between biodiversity and economic diversification. They read as follow: recycling; input reduction; soil health; animal health; biodiversity; synergy; economic diversification; co-creation of knowledge; social values and diets; fairness; connectivity; land and natural resource governance; and participation. The ten elements are broad concepts open to variable interpretation useful for identifying entry points for agroecological transitions whereas the 13 principles are explicit statements useful as the basis for analysis and to guide decisions and action, which when locally applied generate a diversity of agroecological practice.

Agroecology promotes agricultural practices that support food systems based on ecological processes, while often also facilitating a more direct connection between consumers and producers based on shared principles of fairness, social justice, participation, and localness. It thereby contributes to the progressive realisation of the right to food and nutrition, and the recognition of the right to food as a human right (FIAN, 2016).

There is emerging evidence that agroecology is an innovative approach to climate change adaptation for food security and rural livelihoods. A background paper commissioned by the Global Commission on Adaptation (GCA) analysed the contribution of agroecological approaches to climate-resilient agriculture (Sinclair et al., 2019).[2] The paper underscores the contribution of agroecological agronomic practices in addressing specific climate risks, while also improving the resilience of farming systems to climate change and supporting vital ecosystem services.

Adding to this growing knowledge base is a recent report by Leippert et al. (2020), which explores the potential of agroecology to hedge against climate change in two selected African countries. The report underlines that agroecology increases resilience by strengthening ecological principles such as biodiversity and soil health, as well as social aspects such as co-creation and sharing of knowledge. FAO has also developed the Tool for Agroecology Performance Evaluation (TAPE) as an analytical framework for assessing the performance of agroecological practices. The CFS policy convergence process also calls for development of holistic metrics for agricultural performance that will allow agroecology to be judged against alternatives on a level playing field. Last but not least, several agroecological initiatives, such as MASIPAG in the Philippines, are collecting data on the impact of their work on food security and rural livelihoods. The message from these analyses is clear, agroecological practices can contribute to enhanced adaptive capacity.

Purpose of the paper

The purpose of this paper is to discuss the contribution of agroecology to climate change adaptation and develop a set of key messages that can help bring together the agriculture and climate change communities. Specifically, these key messages are intended to feed into the GCA Action Track on "Food Security and Rural Livelihoods," which calls for a large-scale, international mobilisation to strengthen the resilience of small-scale farmers to climate change.

Methodology: A consultative process

The key messages contained in this paper were developed through a participatory process. An initial desk review provided the basis for the formulation of a first set of draft key messages based on available evidence on agroecology's ability to meet climate change adaptation needs (see Methodological Note 1). This was followed by in-depth discussions with diverse agroecology practitioners to elicit further insights based on their practical experience (see Annex 1 for a list of consulted projects and initiatives). During online consultation workshops held between 27 – 29 May 2020, a range of technical experts and practitioners (see Annex 2) further refined the key messages. A subsequent written feedback loop gathered additional input for the finalisation of the paper (see Methodological Note 2 for an overview over the specific review inputs).

2 The background paper builds on extensive evidence, including the evidence collected by Debray et al. (2018) relating to field level practice in Africa, and on the contribution of specific agroecological practices to adaptation at field and livelihoods scales.

Key Messages

1 Key Message: To be innovative, adaptation efforts must respond to the systemic challenges posed by climate change to our food systems.

Background: The Economics of Ecosystems and Biodiversity (TEEB) for Agriculture and Food framework describes food systems as the combination of natural resources (land, water, soil, biodiversity), and the agricultural production systems (crops and livestock) that manage these natural resources in different agroecological zones. Food systems are embedded within social and economic systems that transform agricultural production to food. Food is distributed through delivery chains that are based on, among other factors, market infrastructure, government policies, corporate strategies, and consumer preferences. Technologies, information, and culture create additional societal dynamics that are continuously re-shaping production, distribution, and consumption, as well as the interactions among these diverse elements.

Climate change affects all of the above-mentioned elements of the food system. In its 2019 report, the Intergovernmental Panel on Climate Change (IPCC) notes that the sum of climate change impacts further threatens all four dimensions of food security (availability, access, utilisation, stability). Climate change can therefore be considered as a significant threat to the realisation of the human right to food and nutrition (Dumas, 2011).

These systemic challenges require systemic adaptation responses to safeguard food security and to strengthen resilient rural livelihoods.

Message 1.1: Uncertainty is the foremost defining characteristic of how climate change impacts on agriculture. Climate change multiplies existing risks in the food system and creates additional risks for rural livelihoods and for food security from local to global levels (IPCC, 2019).

Message 1.2: Climate change negatively impacts all four dimensions of food security (availability, access, utilisation, stability). It endangers the realisation of the human right to food and contributes to the further marginalisation of vulnerable groups (ibid.).

Message 1.3: Adaptation efforts need to be tailored to specific local contexts. This requires an understanding of, among other factors: climatic patterns; market dynamics; livelihood opportunities; culture; and prevailing gender, and power relations. All these factors shape a community's specific adaptation needs and opportunities (Gómez-Baggethun et al., 2013; Bee et al., 2013).

Message 1.4: Successful adaptation to climate change requires blending technological innovations with social inclusion (Berkes & Ross, 2013). Political empowerment, gender-responsive participation, and the creation of new economic opportunities – especially for those who are most vulnerable to climate change impacts – are all elements of climate change adaptation (Burnham & Ma, 2015).

Additional considerations: Adaptation for food security and rural livelihoods will not be successful if it does not address the aforementioned social, economic, and political factors, all of which magnify the vulnerability of food-insecure farmers. Designing these complex response strategies is a matter of utmost urgency.

The west African region, for example, is pro- jected to experience more hot days, even under a 1.5° scenario (IPPC, 2019). That is, a region with already high levels of food insecurity can expect even more erratic rainfall patterns and extreme events, such as floods and droughts. In order to be effective, however, the response must simultaneously address the urgency of such situations, as well as the complex underlying dynamics. This calls for adap- tation solutions that build on iterative learning processes.

An important component of such learning is that it includes the perspectives of affected farmers, and other local communities, who are in dire need of effective adaptation responses.

2 Key Message: Diverse agricultural systems are less vulnerable to extreme climatic events, climate variability, and cumulative agro-climatic changes.

Background: Increased adaptive capacity refers to our ability to respond to extreme climatic events, as well as to climate variability and gradual changes to weather patterns in the longer term. There is growing evidence that agroecological practices contribute to adaptive capacity, and resilience at the household level (see Methodological Note 1) by promoting diversified agricultural systems (Sinclair et al., 2019). This refers not only to a greater variety of crops (species and varieties) on one farm, but also to the integration of crop-livestock systems, agroforestry, and the pursuit of supplementary off-farm income. Farmers who employ such diverse practices are less vulnerable to climate-related biophysical risks (such as landslides) and have an economic buffer in case of harvest losses. Evidence further shows that agroecological approaches contribute to improved health through the availability of a more nutritionally diverse diet and lower chemical residues in crops and livestock.

Message 2.1: Agroecological practices – such as crop-livestock systems and agroforestry – help to enhance soil structure and fertility, improve water conservation, and promote biodiversity. They therefore make agricultural production more resilient to climate change impacts, such as droughts, erratic rainfall patterns, and rising temperatures (Sinclair et al., 2019; Scholle, 2015; Stroesser 2015; Seo, 2010).

Message 2.2: Diversified farming systems reduce the risk of crop failures and livestock losses in cases of extreme climatic events or pest outbreaks, while also supporting economic diversification as an effective risk-reducing strategy, especially for smallholder farmers (Pretty et al., 2018; Nicholls et al., 2016; Aune, 2011; Tumbo et al., 2010; Altieri, 2012; Rivers et al., 2016; Cook et al., 2007; Midega et al., 2018; Wyckhuys & O'Neil, 2010).

Message 2.3: By promoting minimal external inputs, and the pursuit of supplementary, off-farm livelihoods, agroecological practices reduce farmers' economic vulnerability in case of harvest losses (Bàrberi et al., 2010; Eriksen et al., 2005; D'Annolfo et al., 2017).

Message 2.4: Agroecology contributes to healthier and more balanced diets and helps households to save money that would otherwise be spent on purchasing food (Bachmann et al., 2009; Carletto et al., 2015; Ickowitz et al., 2014).

Message 2.5: Agroecology maintains and advances agrobiodiversity, and seed sovereignty, as essential elements of resilient, diverse and healthy food systems. These include local farmer-led seed systems, free exchange of seeds, community seed banks, and participatory plant breeding (Helicke, 2015; Shrestha et al., 2013).

Additional considerations: While sustainable management of land at the farm level is an important component of adaptation, it is not sufficient in itself to achieve the desired scale and impact. Similar to water resources management, many agroecological practices therefore need to be applied at the landscape level. Recent research suggests that agroecological practices can help to strengthen adaptive capacity at ecosystem level through improved agro- and soil biodiversity (Leippert et al., 2020). This opens up an agenda for future research focused on making a deeper analysis of the necessary changes that are needed at different spatial and administrative levels to ensure that agroecological practices can be sustained and implemented more widely.

3 Key Message: To strengthen the adaptive capacity of rural livelihoods, it is necessary to pair technological innovations, and improvements in agricultural practices, with investments in social capital, the co-creation of knowledge with farmers, new marketing networks, and the responsible governance of land and natural resources.

Background: Climate change adaptation initiatives in the agricultural sector tend to focus on agricultural practices. Available evidence on successful adaptation indicates that this is a necessary, but insufficient, condition. As one moves from the farm to the food system level, additional investments in building social and political capital are needed to sustain the adaptive capacity and resilience of rural livelihoods. They include a number of elements that are enshrined in the elements and principles of agroecology, such as responsible management of land and natural resources, co-creation of knowledge, linking producers and consumers, and inclusive governance processes (FAO, 2018b; Barrios et al., 2020). Furthermore, agroecology places a strong emphasis on the role of women in agriculture and food production and, hence, contributes to gender and social inclusion.

The principles and elements of agroecology highlighted above do not only focus on necessary measures at plot level, but also address the elements of an enabling environment for sustainable agriculture at the local and higher levels (FAO, 2018b). By pointing at the interconnectedness of actions needed at various levels, these principles and elements offer a roadmap for developing systemic responses to tackle the challenges that climate change poses to food systems (Wezel et al., 2020).

Message 3.1: To increase the local relevance and effectiveness of adaptation programmes, it is necessary to facilitate the co-creation of knowledge and the genuine participation of farmers, especially women. This should cover the entire spectrum of designing, implementing, and evaluating innovations for climate change adaptation (Hudson et al., 2017; FAO, 2018a; Renaud & Murti, 2013; Mapfumo et al., 2013; Bacon, 2010; Loconto et al., 2018).

Message 3.2: Promoting equal access to and control over productive resources, such as land, water and seeds, contributes to the economic empowerment of smallholder farmers, especially women. It can also boost farmers' resilience to adverse climatic impacts and create positive incentives for investments in sustainable land management and ecosystem-based adaptation measures (Antwi-Agyei et al., 2015; Robiglio & Reyes, 2016; Helicke, 2015; Shrestha et al., 2013).

Message 3.3: Supporting the institutionalisation and strengthening of farmers' organisations and networks can enhance inclusive local governance, and promote links between consumers and producers (Pretty et al., 2020; Sperenza, 2013; Roco et al., 2014; Coordination Sud, 2013; Loconto et al., 2018).

Message 3.4: To increase resilience at the ecosystem level, there is a need to strengthen collective action by food-insecure farmers to promote the adoption of agroecological measures beyond plot level (Chaskin, 2008; Lyon & Parkins, 2013).

Additional considerations: The principles and elements of agroecology embrace a number of social principles – such as governance and equity – that are as important as biophysical aspects in fostering resilient food systems (Sinclair et al., 2019). While the messages above are expressions of these broader principles, they are not the exclusive domain of agroecology. There are many other thematic, or institutional entry points that can justifiably represent some of these elements and principles. For example, our understanding of the principles of "connectivity" and "proximity" can be compared to inclusive approaches in diverse fields, including decentralised public procurement, support for farmers' cooperatives, or urban food markets that promote products from adjacent regions. To give another example, there is a broad body of literature that addresses the importance of strengthening land tenure security to give farmers the confidence to invest in sustainable land management. This literature also includes approaches that are similar to, but do not self-identify as agroecology, nor pursue all the elements and principles of agroecology. It is for this reason that this paper casts a wide net to distil useful insights on adaptation for food security and rural livelihoods.

While we dissect the agroecological approach into its different principles and elements for methodological reasons, we would like to reiterate that agroecology adopts these principles and elements as a holistic approach. It is its holistic nature that characterises agroecology as a systemic response to the systemic challenges posed by climate change.

4 Key Message: Integrated measurement approaches, such as true cost accounting, are necessary to capture all the factors that contribute to climate-resilient food systems.

Background: While it may yield useful data, assessing climate change impacts from a narrow perspective is unlikely to yield solutions that address the root causes of climate vulnerability. This speaks to the general challenge of designing and evaluating food system interventions: For example, using the adoption of drought-tolerant plants as an indicator for climate adaptation can ignore equally important metrics, such as whether farmers have access to knowledge services, or markets to sell their produce.

Moreover, it is important to recognise that any positive outcomes of sustainable farming practices can almost always be attributed to multiple overlapping causal factors. For example, claiming that support for women's groups led to the empowerment of women within a specific agricultural chain likely overlooks other interventions and socioeconomic dynamics that contributed to such success. It is therefore necessary to design, and apply, analytical approaches that can assess multiple feedback loops within food systems. It is therefore a point of concern that so little research funding is available to analyse the contribution of systemic agricultural development approaches – such as agroecology – to climate change adaptation, and resilience (Biovision & IPES-Food, 2020).

Multi-purpose metrics, such as TEEBAgriFood, address this gap by considering a wider range of factors that affect the adaptive capacities of rural households, as well as agroecosystems. Effective measurement tools also recognise the need to involve affected communities, and other stakeholders, in designing, and monitoring adaptation initiatives. In this context, FAO has developed a set of 112 indicators for monitoring adaptation in the agricultural sector that focuses on the links between adaptation processes and their outcomes, including in the area of food security and nutrition (FAO, 2017). Through the Koronivia Joint Work of the Subsidiary Body for Implementation, and the Subsidiary Body for Scientific and Technological Advice on agriculture, the UN Framework Convention on Climate Change (UNFCCC) is currently working on enhancing methods for assessing adaptation and resilience in agriculture. This pertains to monitoring progress towards achieving adaptation goals under the Paris agreement, as defined in countries' Nationally Determined Contributions, and National Adaptations Plans. This body of work further aims to link these tools to relevant global targets, such as the Sustainable Development Goals (SDGs), and the Sendai Framework for Disaster Risk Reduction 2015 – 2030 (UNFCCC, 2019).

Message 4.1: Measurement tools that focus on the productivity of specific agricultural systems, without examining their negative externalities, ultimately undermine the sustainability and resilience of food systems (Gitz et al., 2012).

Message 4.2: To compare different adaptation options, it is important to assess how well each response addresses the systemic nature of climate change challenges. This includes taking into account the various positive and negative externalities that are associated with each adaptation option (IPCC, 2019).

Message 4.3: There are a number of established frameworks that can be used to make system- wide assessments of climate change adaptation approaches. Examples include TEEB Agriculture and Food, or the concept of a modified form of ecological footprint as suggested by the HLPE 2019 report. Such analytical frameworks can be extended to assess and compare different response options for climate change adaptation (TEEB, 2018).

Message 4.4: To respond to the magnitude of the challenge, financing adaptation needs to tap into a range of funding sources, from public to private. If externalities are not accounted for, private investments are based on incomplete information which potentially translate into higher investment risks. In order to use the leverage of capital market flows for climate change adaption of food systems, information on investment options in food systems need to encompass negative and positive externalities. True cost accounting (TCA) analyses and describes these positive and negative externalities. It therefore allows for a holistic understanding of risks and profit under the conditions

of a changing climate; and thereby to allocation efficiencies and enhanced financial stability (Unerman et al., 2018).

Additional considerations: Successful climate change adaptation for food security and rural livelihoods requires enhancing the productivity of the whole food system in the long term. This requires adopting systemic valuation frameworks. The application of these frameworks can build on long-standing experiences, both at the business level, as well as the macroeconomic level. If positive and negative externalities are not understood, this might lead to aggregated risks in financial portfolios and business models. The Initiative "True Cost – from costs to benefits in Food & Farming" is currently developing guidelines for the integration of all costs in existing standard accounting systems.[3]

5 Key Message: Innovating adaptation to climate change calls for nothing less than transforming our food systems.

Background: Climate change poses huge challenges to our food systems (Caron et al., 2018). A frequent response to the magnitude of this challenge is to call for the up-scaling of successful initiatives or programmes. In this context, up-scaling is often understood as leveraging resources to multiply successful projects or programmes, or to broaden their outreach. There is no doubt, there is value in supporting existing successful programmes that offer systemic responses to climate change. Yet, experience shows that this is unlikely to result in climate-resilient food systems at scale.

The reason is that even the most successful adaptation programme will be confronted with systemic barriers. Market niches are limited, existing extension service models may not reach the majority of farmers, or land tenure policies prohibit long-term investments in land. In order to achieve the desired scale, therefore, adaptation programmes must address these systemic boundaries (Sinclair et al., 2019).

The concept of transformation goes beyond the notion of up-scaling. It encompasses the reform of policies, governance processes, funding structures, research priorities, and other structural barriers that currently constrain the emergence of climate-resilient food systems (Eguavoen et al., 2015; Urwin & Jordan, 2008; Biovision & IPES-Food, 2020; Antwi-Agyei et al., 2015). This is why institutional innovations, and other systemic responses, are critical in realising the transformation of food systems and rural livelihoods (HLPE, 2019).

Message 5.1: To adopt systemic approaches to climate change adaptation for food security and rural livelihoods, the institutional and policy landscape for rural development in most countries needs to change (World Bank, 2008; Urwin & Jordan, 2008).

Message 5.2: Funding for the food sector is dispersed across philanthropic, private, profit-oriented, and public sources. To achieve the transformation of entire food systems, it is important to not only ensure the alignment of these diverse funding streams, but also to avoid transferring most of the financing risk to the public sector (Lundsgaarde et al., 2018).

3 For further information visit the website: https://tca2f.org

Message 5.3: Consumer demand is not only critical in driving sustainable food choices, it is also important in financing climate-resilient agriculture, and food system transformation. Such consumer-driven initiatives include local markets that directly link producers and consumers, or demand for sustainably or on-farm processed products (Bachmann et al., 2009; Coordination Sud, 2013; Borsky & Spata, 2017; Roco & et al., 2014).

Message 5.4: Research plays an important role in facilitating agricultural innovation, and overall transformation of the food system. It is therefore important to ensure that research agendas, and funding, place a stronger focus on systemic responses to enhance the adaptive capacity of smallholder farmers (Sinclair & Coe, 2019; Biovision & IPES-Food, 2020). The same applies to the design of the necessary enabling environment for climate-resilient agriculture at scale. Public research is critical in this type of cutting-edge research (Janif et al., 2016; Gómez-Baggethun, 2013).

Additional considerations: Policy reform, and institutional changes geared towards food system transformation, must build on the active participation of small-scale food producers, as well as the private sector. A robust governance framework – that includes transparent accountability mechanisms – is a prerequisite in formulating transformative public policies and monitoring the performance of the private sector. In doing so, it is important to acknowledge, and constantly examine, power asymmetries among different food system actors. In particular, conscious efforts are needed to ensure the meaningful participation of food-insecure farmers, and other marginalised groups, in these reform processes.

Building alliances for change are key to achieve food system transformation. The necessary policy reforms and the design of programmes to implement them require significant changes to the status quo. There are important conceptual and programmatic overlaps among policy makers, researchers, and practitioners, working in the areas of ecosystem-based adaptation, nature-based solutions, land degradation neutrality, and agroecology. It is therefore important to encourage these different communities to explore opportunities to align their agendas and identify potential synergies to help create an enabling environment for climate-resilient agriculture, and food security.

It must be noted, however, that calling for broad alliances for change cannot be translated as a blanket call for "multi-stakeholder partnerships." While broad partnerships are a meaningful avenue for knowledge exchange, to be transformative, multi-stakeholder partnerships must be well-positioned to actually influence decision-making processes in favour of climate-resilient food systems (Zanella et al., 2018).t food systems (Zanella et al., 2018).

Way forward

Current food systems are undermining their very own resilience. To effectively respond to the systemic challenges posed by climate change, prevailing agricultural production models need to change. Agriculture is practiced in very different ways around the globe. Yet, the predominant model of agriculture undermines the ecosystem services that are pivotal for its very own survival. There is overwhelming evidence that this form of agriculture accelerates biodiversity loss and is responsible for the bulk of greenhouse gas emissions from land use change, land degradation, and unsustainable use of freshwater resources (IPCC, 2019). Climate change multiplies these existing risks in the food system further. At the same time, small-scale farmers are among the groups most affected by climate change, with the associated heightened risk of malnutrition and food insecurity. If we are to ensure food security in all its dimensions (availability, access, utilisation and stability) we need to strengthen systemic responses to climate change in the agricultural sector.

Agroecology offers an innovative systemic response to climate change adaptation for food security and rural livelihoods. The evidence reviewed above demonstrates that agroecology has the potential to meet climate change adaptation needs by providing local solutions for enhanced resilience. The consultation process further emphasised that agroecological initiatives blend cutting-edge digital approaches with community governance of natural resources and enhanced agronomic practices. These are innovations that build on different forms of knowledge, both traditional and scientific. Agroecology can thereby contribute to achieving a range of SDGs and reflects the key principles of the 2030 Agenda. Investments in climate change adaptation for food security and rural livelihoods should be targeted more systematically to agroecological programmes.

Research on adaptation for food security and rural livelihoods needs to correspond to the complexities at hand and acknowledge the importance of different knowledge systems. Traditional investments in agricultural research tend to favour technological research in terms of specific inputs, crop varieties or pest management. The social aspects of agricultural systems, as well as their impacts on sustainable food systems, are less understood. At the same time, there is widespread agreement that these social aspects, including knowledge co-creation and sharing, responsible governance and participation, are what transformative processes are built upon (Cerdan et al., 2012). It is therefore important to design and fund research programmes that further analyse the impact of agroecological approaches, and to strengthen initiatives that work towards the systemic transformation of our current food systems.

To achieve climate-resilient agriculture at scale, it is essential to create an enabling environment. Enabling conditions at the local level need to be strengthened to foster the adoption of agroecological practices. These include investments in

responsible land governance, marketing, extension services, and access to rural finance. It also includes creating the necessary processing infrastructure that supports more diversified agricultural systems. Many local agroecological initiatives rely on civil society organisations as process facilitators, and knowledge providers. However, these organisations require support to fulfil this role. Furthermore, local-level efforts to create an enabling environment rely on an appropriate institutional and policy framework at national level. Without this nationa l framework, local initiatives will have limited impact, or are vulnerable to external influences. Investments in the enabling environment are therefore a key determinant in the success or failure of climate change adaptation for food security and rural livelihoods.

The 2021 World Food System Summit would benefit from a better understanding of what is meant by food system transformation and how to achieve it. Ahead of the World Food System Summit, talk of food system transformation is ubiquitous. Yet, these discussions are seldom accompanied by an analysis of how transformations look like and how they are going to be achieved. It is not possible to understand food system transformations without assessing the entire range of impacts on food systems, from food security, to their environmental and social externalities. It is therefore imperative to further invest in systemic metrics, such as True Cost Accounting. International policy processes, too, need to account for the interdependencies and complexities of challenges within food systems, as outlined throughout the paper. Given the complexity of food systems, there will naturally be several pathways to achieve food system transformation. It is therefore important to encourage open, and inclusive debates on potential pathways for food system transformation, to allow for meaningful participation of all interest groups, and to eschew the premature close of such consultative processes. Diversity breeds resilience. This holds true for climate-resilient food systems, as it does for the debates on food system transformations.

We cannot afford to continue the silo thinking that still dominates too many policy circles. Alliances for change are key. Looking for solutions within existing political, social, or economic silos will not bring about the necessary change – neither at national nor international level. There is an urgent need to find a common language and define joint goals between agricultural and climate communities. Strengthening strategic alliances at the policy and institutional level – for instance between the three UN Rio Conventions (Biodiversity, Climate Change, and Desertification), and the agricultural sector – is pivotal to further programmes and activities towards climate change adaptation, ecosystem restoration, and food security. Without embarking on these new pathways towards sustainable food systems, we will neither be able to meet current and future climate change adaptation needs, nor maintain the natural resource base upon which we all depend on.

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Annex 1: List of agroecological initiatives

The initiatives listed below were cornerstones of the "Adaptation to Climate Change through Agroecology" process – by sharing their experience, they allowed to include practical evidence of agroecological impacts. Despite not all the initiatives self-ascribing as agroecological approaches, they all relate to several of the agroecological principles described by FAO (2018a). The selection was conducted in order to obtain geographical diversity, but also to represent different aspects and scales of agroecology.

Andhra Pradesh Community-Managed Natural Farming – India

Action Aid International Kenya - Kenya

Centro Sabià – Brazil

Biovallée – France

HiPP – Germany/Costa Rica

Chololo Ecovillage – Tanzania

SEKEM – Egypt

MASIPAG – Philippines

Watershed Organization Trust – India

Vida Cafe AC – Mexico

Annex 2: List of consulted technical experts and practitioners

In addition to the co-authors, the technical experts and practitioners listed below provided their inputs on the key messages at the digital workshop series held on the 27th - 29th of May 2020, or in a written response after the workshop series.

NAME	ORGANISATION
Jennifer Bansard	IISD
Lena Bassermann	INKOTA-netzwerk
Lucia Benavides	TMG Research
Martial Bernoux	FAO
Rachel Bezner Kerr	Cornell University
Abram Bicksler	FAO
Samuel Bonvoisin	Oasis de Serendip/Biovallée
Ronnie Brathwaite	FAO
Bruce Campbell	GCA
Devaraj De Condappa	TMG Research
Felix Diesner	ZUG
Angeles Estrada Vigil	IISD
Madhav Gholkar	WOTR
Beate Huber	FiBL
Johannes Kotschi	Agrecol
Anne Maréchal	IEEP
Ariel Andrade Molina	URGENCI
Barnabas Mongo	Chololo Ecovillage
Louise Postema	GCA
Manja Reuter	ZUG
Cristina Rumbaitis del Rio	GCA
Sarah Schneider	MISEREOR
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Kitasi Swaleh	Action Aid International Kenya
Stig Tanzmann	Brot für die Welt
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