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Pathways to advance agroecology

Overcoming challenges and contributing to sustainable food systems transformation

Photo by: Peter Lüthi, Biovision

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Swiss National FAO Committee (CNS-FAO)

Pathways to advance agroecology – overcoming challenges and contributing to sustainable food systems transformation

This working paper by the Swiss National FAO Committee (CNS-FAO) serves to orient the Swiss Government and interested stakeholders on pathways to advance agroecology to overcome and contribute to sustainable food systems transformation, as well as on how agroecology can support the UN Food Systems Summit 2021 Action Tracks. The discussion paper builds on two previous working papers of the CNS-FAO (CNS-FAO 2016 «Working towards Sustainable Agriculture and Food Systems»; CNS-FAO 2019 "Agroecology as a means to achieve the Sustainable Development Goals").

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Cover photo description: Marketplace in Embu, Kenya. Two ladies proudly present their mangos. They use Integrated Pest Management (IPM) to protect the mangos from fruit flies.

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1. Introduction

Transforming agriculture and food systems in line with Sustainable Development Goals (SDGs) should not be treated as a policy option; it is an imperative that can no longer be ignored or deferred (CNS-FAO, 2019). In facing up to this challenge, agroecological approaches stand to play an indispensable role: connecting environmental sustainability and social justice, production and consumption, global concerns and local dynamics through the support of locally adapted solutions, participation and the mobilization of local knowledge (HLPE, 2019).

In our paper of 2019 (CNS-FAO, 2019), we the Comité National Suisse-FAO, a non-parliamentary advisory group of the Federal Government, set out the most salient obstacles to mainstreaming agroecology. These included that it is currently unknown to the public; the time lag between implementing agroecological practices and observing positive results; weak knowledge and advisory systems; transaction costs; policy incoherence; crucial deficits of landscape-level coordination, incentive systems in research, and compensation for yield reductions; and the need to strengthen the aspect of sufficiency in a sustainability context.

This paper sets out from a definition of agroecology, highlighting its promise for a sustainable transformation of food systems. Since there is no consensus in defining and implementing agroecology, neither in public discourse nor among the authors of this paper, our intention here is to make transparent current areas of consensus and difference.

In a second step, we address the main challenges for agroecology identified in our former paper (CNS-FAO, 2019) and systematically outline solution pathways. These centre on the transformation of agricultural knowledge networks (farmers and other food producers, farm advisors and scientists), the role of markets (food producers, handlers and traders), encouraging cooperation and policy consistency, and changes in consumer behaviour and nutrition. As a third step, we address the five Action Tracks of the UN Food Systems Summit 2021[1] (UNFSS). In doing so, we strongly emphasise cross-cutting issues and views between action tracks, as the agroecological approach is classically holistic and system-oriented and tries always to break out of disciplinary "silos".

Finally, we present promising examples of agroecological transformations in relation to each of the above-mentioned challenges. The projects and initiatives presented as promising examples in this paper show what is already being done at different levels, in different areas and by different actors engaged to advance agroecology. We have selected them according to the definition of agroecology in chapter 3. While all of them

[1] https://www.un.org/en/food-systems-summit/action-tracks

deliver important contributions, the examples listed in this paper are at different stages of progress in achieving agroecology. The list gives just a glimpse of the multitude of ongoing initiatives at local, regional and international level.

The overarching aim of this paper is to demonstrate viable solution pathways with reference to explicit practical examples, supporting and strengthening the concept of agroecological systems for the UN Food Systems Summit 2021.

2. Overview

Agroecology is both a means and an end-in-itself for achieving the SDGs. The first main goal is food security, encompassing the human right to adequate food for rural and urban populations. To date, however, much of the world's population remains inadequately nourished, with more than 820 million people having insufficient food and suffering from hunger. Many more consume low-quality diets, contributing to a substantial rise in the incidence of diet-related illness and obesity (Willet et al., 2019). The second main goal is a significant reduction in the exploitation of the natural resources of soil, water and air, and a reversal of biodiversity loss (Leclerc et al., 2020); with a net negative carbon emission agriculture (Smith et al., 2012) constituting the third main goal.

Not least due to the current Covid-19 pandemic, it is clearer than ever how fragile global food systems can be. Food insecurity and acute hunger have increased along with more people living in extreme poverty (HLPE, 2020). The degradation and fragmentation of natural and semi-natural ecosystems seem to be highly correlated with the incidence of zoonoses - which some authors argue might also be the case for Sars-CoV-2 (Shaw et al., 2020), as the habitats of numerous wild animals become smaller and the contact possibilities with livestock populations greater, facilitating zoonotic transmissions (Hodson et al., 2021).

The challenges involved in providing food for 10 billion people in 2050 are great. It will take a 56 per cent increase in plant-based calories compared to the base year 2010, in case unsustainable consumption, food loss and waste and the use of food crops for biofuels are not addressed. A significant resulting expansion of agricultural land, coming up to 593 million hectares, must be curbed wherever possible. Existing agriculture should mitigate 11 gigatons of greenhouse gases, in order to meet the Paris climate target of less than 2 degrees Celsius warming. Future solutions must also take into account that by 2050, it is forecasted that 68 per cent of the world's population will live in cities, increasing the importance of urban food production. We therefore need to transform the way we produce, process, consume and manage across the entire food system. At the same time and with the same priority, the livelihood of farmers and other food

producers[2] and their families must be improved. Agroecology offers a powerful means of effecting both transformations. Bringing these together, it involves as many actors as possible and uses their specific knowledge and experience. It is characterized by cooperation, participation and knowledge sharing (FAO, 2018a; CNS-FAO, 2019). Resultantly, agroecology promises to significantly reduce the numerous trade-offs between productivity and sustainability.

3. Definition of what we mean with agroecology

Agroecology contains three dimensions: it is a transdisciplinary science, a set of practices and a social movement (Wezel et al., 2009). Agroecological approaches have thus broadened their focus, from on-farm practices to entire agrifood systems. And, by embracing a transdisciplinary outlook, they avoid separating scientific and technical questions from their attendant social and political context (HLPE, 2019).

Agroecology as we understand it, has a common framework grounded in the FAO's 10 elements (FAO, 2018b). The 10 Elements of Agroecology are interlinked and interdependent. They encompass ecological characteristics of agroecological systems (diversity, synergies, efficiency, resilience and recycling), social characteristics (co-creation and sharing of knowledge, human and social values, culture and food traditions), and enabling political and economic environments (responsible governance, circular and solidarity economy) (FAO, 2018b).

These elements come together in a model that relies centrally on the non-exhaustive and non-destructive use of biodiversity and ecosystem services, with off-farm inputs playing a diminished role in production. Agroecological farms apply sustainable practices, such as diverse crop rotations, mixed crop-livestock systems, polycultures, inter-, cover- and mixed cropping, natural or semi-natural habitats and corridors for flora and fauna. In general, diversity of the landscape and habitats, of farm activities, of crops grown, of livestock kept and of above and below ground flora and fauna is a defining feature of this approach.

Another consensus here is that agroecological approaches elevate the role of farmers and other food producers in associated knowledge and value chains. This is especially the case for the knowledge and experience of women, with their day-to-day practice in food production, processing and preparation in almost all regions around the world, encompassing their deep knowledge on biodiversity, including seeds, on food preservation and recipes for not only culturally adapted but also nutritious meals. Agroecology can create better opportunities for women by integrating diverse work tasks and specific forms of knowledge, providing a more significant role for women in

[2] Primary food producers in the context of this paper explicitly include farmers, fishers, hunters, pastoralists, etc.

the household economy. As agroecology, through low initial investment costs and knowledge intensive technologies, is better accessible to women, it also fosters their economic opportunities and autonomy. In its political dimension, agroecology seeks to achieve a more just system. It is not enough to simply include women in the implementation of actions: if the process is to be truly inclusive, women need to be there from the outset, designing them (Seibert et al., 2019).

When farmers and other food producers are reduced to mere suppliers of raw materials, they are not in the position to address the much-needed transformation of food systems towards comprehensive and integral sustainability. Therefore, strengthening learning networks, farmers and women's organisations and thus building social capital and attractive business models as well as new modes for the co-creation of knowledge are vital prerequisites for the successful implementation and scaling of agroecological practices. In this way, intuition and tacit knowledge, practical know-how and scientific R&D can be harnessed together to yield solutions that are better suited to their particular context and are more quickly implemented. Along with a greater emphasis on traditional knowledge, there is also a return to authentic quality in food processing and a healthy and wholesome diet. The regionality of food is once again in the spotlight, and high-quality products increase the joint responsibility of producers and consumers for sustainable nutrition.

In summary, there is no definitive set of agricultural practices that could be flagged as agroecological, nor a clear, consensual definition of what is agroecological and what is not. Agricultural practices can be classified along a spectrum, expressed by the extent to which: (i) they rely on ecological processes as opposed to purchased inputs; (ii) they are equitable, environmentally friendly, locally adapted and controlled; and (iii) they adopt a systems approach rather than focusing mainly on specific technologies (HLPE, 2019).

Social movements associated with agroecology have often arisen in response to agrarian crises and have joined forces to initiate transformation of agriculture and food systems. Agroecology has become the overarching political framework under which many social movements and peasant organizations around the world assert their collective rights and advocate for a diversity of locally adapted agriculture and food systems mainly practiced by small-scale food producers. These social movements highlight the need for a strong connection between agroecology, the right to food and food sovereignty. They position agroecology as a political struggle, requiring people to challenge and transform existing power structures (HLPE, 2019).

While there is broad consensus that transformation is needed in agriculture and food systems, there is no agreement on which innovative approaches should be promoted to foster the transformation. Besides agroecological approaches, other innovative approaches can be identified and clustered within two main categories: (i) sustainable intensification and related approaches (such as climate-smart agriculture, use of

precision technology, nutrition-sensitive agriculture and sustainable food value chains); and (ii) agroecological and related approaches (including organic agriculture, agroforestry and permaculture). While the former emphasizes availability and stability of food production and resource efficiency, the latter embraces the access and utilization dimensions of food security, along with a strong focus on social equity and responsibility (HLPE, 2019).

Making rational choices among innovative approaches surveyed above requires appropriate performance metrics and monitoring frameworks for agricultural and food systems. One recent example is TAPE (Tool for Agroecology Performance Evaluation), a global analytical framework for assessing the multi-dimensional performance of agroecology (FAO, 2019). As such, TAPE builds on existing sustainability assessment tools. The assessment process starts with a description of the system, then characterizes the level of agroecological transition based on the 10 elements of agroecology (FAO, 2018b). Performance is assessed along key dimensions for achieving the SDGs, with the final analysis comprised of a participatory interpretation of the system´s results (FAO, 2019).

4. Pathways to advance agroecology

The pathways for advancing the development of agroecological systems recommended in our former paper (CNS-FAO, 2019) are the following (Figure 1):

- Strengthening knowledge on agroecology
- Working with markets
- Enhancing collaboration
- Ensuring policy coherence to create a conducive policy context for agroecology

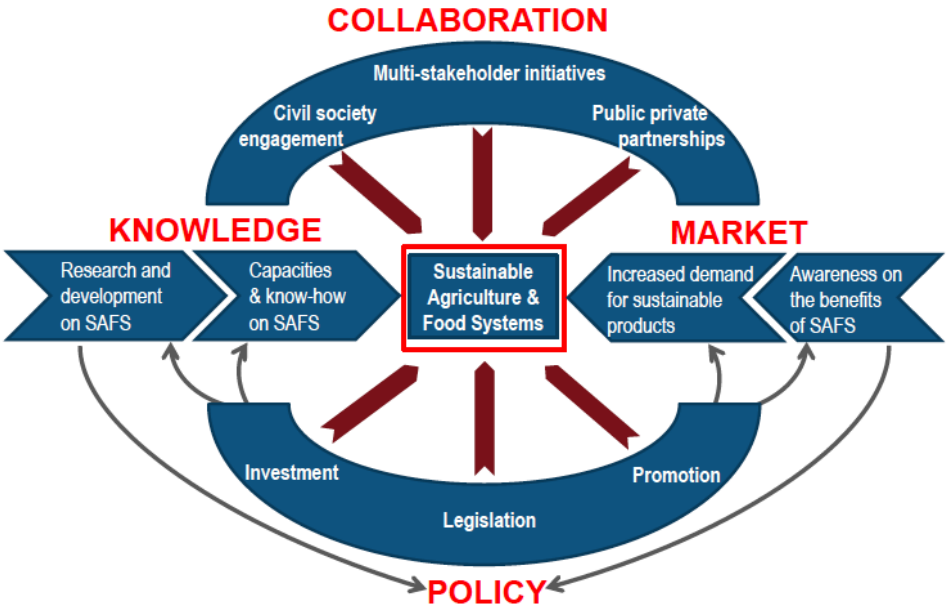

Figure 1: Theory of change: Four key factors (in red) need to work together to achieve a change towards sustainable agriculture and food systems (CNS-FAO, 2016).

In each of the subsequent sections we outline the main challenges to these, going on to present a series of concrete measures and promising examples for mainstreaming agroecological systems. We also refer to the five action tracks suggested by the UNFSS and point out how these tracks are interwoven.

4.1 Strengthening knowledge (research, education and innovation) on agroecology

Current agricultural knowledge systems still focus on maximizing short term output rather than long-term viability and productivity, as well as improving environmental issues, human health and wellbeing. Resultantly, agroecological processes, system orientation, contextualization, site adaptation, inter- and transdisciplinarity and long-term field research suffer from a lack of attention and funding. Among some farm advisors, agroecology is perceived negatively (for example, as not 'modern' enough), while certain scientists express reservations about working with non-academic knowledge holders and making use of their experience.

Tackling these challenges calls for the following measures:

4.1.1 Increasing investments in agricultural research, shifting focus to agroecological principles, better contextualizing research activities and altering funding mechanisms

In 2011, total global public and private investment in AgR4D exceeded 70 billion US dollars (in purchasing power parity dollars) (Pardey et al., 2016). Current global R&D investments focus mainly on major staple crops. More nutrient-dense crops such as pulses, fruits and vegetables, as well as the so-called orphan crops, are often neglected (GloPan, 2016; HLPE, 2017). The Consortium of International Agricultural Research Centres (CGIAR) Research Programmes still focus largely on breeding and efficiency in production systems, rather than expanding its scope to a food system perspective (Biovision & IPES-Food, 2020). A study analyzing 728 AgR4D projects with a total budget of 2.56 billion US dollars showed that local and regional value chains, traditional knowledge and cultural aspects of food systems are underrepresented in most research programmes, while only a handful of projects take a participatory approach to research (Biovision & IPES-Food, 2020). In order to transform the current food system, it is crucial for research projects to address and include key aspects of socioeconomic and political change, such as decent working conditions, gender equality (Biovision & IPES-Food, 2020) and the important role of young and highly qualified people will play.

These challenges notwithstanding, there is growing anecdotal evidence that farms based on agroecology achieved high levels of environmental performance, productivity and household's income, thus offering an impressive return on public investment (DeLonge, Miles, & Carlisle, 2016). Nonetheless "there is a need for global and harmonized evidence (….) built with a diversity of actors, operating in different scales, timeframes, and contexts and dovetailed into their existing work" (FAO, 2019). If the increasing recognition of such successes translates into greater public and private funding for research on agroecology, we should therefore expect an increase in the viability and performance of consequent farming, processing, trade, marketing and consumption patterns.

At the farm level, research has a significant potential to increase productivity (Seufert and Ramakutty, 2017) by increasing biodiversity, which is a major driver of ecosystem functioning including soil fertility. In addition, nature-based solutions or techniques, such as biocontrol, botanicals and antagonists in plant protection, improved recycling of nutrient elements or biofertilizers, remain largely unexploited and need to be evaluated both for their potentials and their risks. The digitalization of farm work, namely self-driven robots and machinery, sensors, remote sensing, GPS and real-time data processing, might also have a significant positive impact on both the resource efficiency and the diversification of landscapes, farms and fields. Hence, digitalization can support the goals of agroecological farming systems on the one hand and, on the other hand, agroecological principles should also shape and steer the further development of digitalization and the complex algorithms used to support farmer decisions. Farmers

must be informed transparently about the large amounts of data that are accumulated on farms and their property rights must not be violated.

Systemic, interdisciplinary and transdisciplinary research is held back by the fact that scientific funding schemes, proposal review processes and career promotion of young talents tend to be sector- or discipline-specific, and narrowly focused on short-term results. This paradigm is established and well-funded. Conducting multidisciplinary research, field research and including non-scientific actors, on the other hand, remains complex, time-consuming and expensive. New funding mechanisms, appropriate to agroecological system development, are urgently needed. In particular, new research structures could facilitate the ultimate form of participative research: the co-creation of knowledge, including the users of research results from the preparatory phase of projects onwards, that is ultimately grounded in dialogue between handed-down knowledge, practical ingenuity and scientific analysis and invention.

Promising Examples:

The new research and innovation programme of the EU "**EU Horizon Europe** - Cluster 6: Food, Bioeconomy, Natural resources, Agriculture and Environment" to be launched in 2021, contains a number of sub-priority topics on agroecology (https://ec.europa.eu/info/news/46-new-projects-start-their-research-agroecology-and-ocean-observation-2020-sep-28_en). The Horizon Europe Program also uses the participative methodological approach of Living Labs, which are networks of nodes across Europe, allowing farmers, researchers, citizens and industrialists to meet and jointly develop and accompany research from scratch.

Agroscope Switzerland develops its new work program 2022 to 2025 around the beacons Agroecology, Transformation Research, Co-Creation of Knowledge and Citizen Science.

The tremendous progress brought to organic farms by better funding of research by the Swiss, German and Danish Governments and the EU Research Framework in the last 20 years. A good example is the Research Institute of Organic Agriculture (**FiBL**) and the FiBL project "SysCom" in Kenya, Bolivia and India. https://systems-comparison.fibl.org/

The **YAMSYS project** led by the Swiss ETH Zurich not only investigates individual agroecological practices (e.g., composting, complex crop rotations and agroforestry) but also considers local cultural values linked to the food system and traditional ecological knowledge, as well as promoting the co-creation of knowledge through the active participation of farmers. http://yamsys.org/en/

4.1.2 Breaking down institutional silos and enhancing system thinking in education and training

It is crucial to break down institutional silos in order to embed transdisciplinarity in the DNA of research and training institutes, starting with interdisciplinary courses at the graduate and undergraduate level that include non-academic actors. Educational structures and programmes are already showing signs of evolving towards systems analysis and higher-order thinking, with several universities recently opening food system centres or units that break down the traditional structures of research. It is further relevant to provide training that includes practitioner-led learning and building a culture of accountability where research is undertaken with and for farmers as the ultimate beneficiaries. Public support should be provided to develop agroecological curricula at colleges and universities and facilitate exchange between experienced and interested stakeholders (from research, civil society, donor organisations and private sector). Establishing a network of decentralised centres of excellence in agroecology would further reinforce system thinking and enhance exchanges between different knowledge holders (Biovision & IPES-Food, 2020, HLPE, 2019). New methodologies developed at universities and research centres such as Co-Creation of Knowledge and Citizen Science using digital tools greatly enhance participation and transdisciplinarity.

Promising Example:

The **Centre for Agroecology, Water and Resilience** (CAWR) is driving innovative, transdisciplinary research on the understanding and development of resilient food and water systems internationally. Unique to this Centre is the incorporation of citizen-generated knowledge - the participation of farmers, water users and other citizens in transdisciplinary research, using holistic approaches which cross many disciplinary boundaries.

The **World Food System Center** at ETH Zurich is a good example of nearly 10 year of practical experience bringing together numerous academic chairs and training and motivating students to work in an interdisciplinary and participatory manner.

Reverte Project: The Cerrado, Brazil's vast, diverse, tropical savanna, has in recent decades been degraded by intensive agriculture, overgrazing, and deforestation. As these challenges are exacerbated by a changing climate, almost 18 million hectares of soil lie barren or have become low-productive pastureland. Reverte is an ambitious collaborative effort led by Syngenta and The Nature Conservancy (TNC) to provide tools and technical support that enable local farmers to restore the degraded lands of the Cerrado ecoregion. The project aims to 1) reduce the rate of deforestation and land use change to agriculture, 2) demonstrate the technological viability and economic potential of land regeneration, and 3) enable farmers and landowners to improve productivity of degraded soils. Reverte applies systems approaches that integrate a variety of technologies and production practices, financing, seed varieties adapted to local

conditions and soils, agronomic practices that improve soil health, and precision agriculture and other digital tools, giving growers the capacity to control and monitor improvements in their soil conditions. https://solutionsfromtheland.org/project/stories/reverte-project/

4.1.3 Improving extension and advisory systems by applying bottom-up processes, localised solutions and improved access to information through low-cost ICTs

Chronic underfunding, geographical constraints and a lack of capacity and accountability continue to impede small scale farmers' access to farming information, extension and advisory services. In many parts of the world, private extension services financed by the sales of goods and services, are predominant. When it comes to developing extension systems that align with agroecological approaches, publicly funded extension services are crucial. Tackling them requires re-configuring knowledge and extension systems in ways that place a much greater emphasis on participation and social learning, broaden access to information and integrate advocacy. Agroecological farming is highly context-specific and knowledge-intensive – often relying on techniques that have been developed on the basis of farmers' knowledge, experimentation and innovation. It is therefore best delivered through bottom-up processes such as farmer-to-farmer learning and on-farm demonstrations. This requires a rejuvenation of extension processes and infrastructure - away from top-down, uniform processes that often push a predetermined list of technologies, towards localised solutions that stem from experimentation and participatory research (Oxfam, 2014). Documentation and scientific verification of the deep reservoir of traditional and implicit knowledge within farmer communities should be better integrated into agriculture research. In doing so, accumulated farmer knowledge can be prevented from being marginalised and can be refreshed for modern agroecological farming systems.

Expanding the use of low-cost information and communication technology (ICT) such as interactive radio, as well as digital extension tools such as apps, videos, and social media is an effective means to reach large numbers of people, including youth. ICT has the added advantage of being highly customisable to suit specific contexts, while digital tools are also highly versatile. Widening access will also require innovative approaches in the delivery of information. This means leveraging the increasingly pluralistic character of extension systems so that the private sector, farmer groups volunteers, social workers and youth entrepreneurs can become partners in delivery, training and advice (Fabregas, Kremer & Schilbach, 2019).

Promising Examples:

Farmer-led agroecology extension services - the female extension volunteer programme: ActionAid piloted this farmer-led, community-based extension service

programme to ensure women farmers' access to extension services, and to promote agroecology among smallholder farmers and their transition to Climate Resilient Sustainable Agriculture. http://www.fao.org/3/BU703EN/bu703en.pdf

iCow is an SMS (text message) and voice-based mobile phone application for small-scale dairy farmers in Kenya. iCow provides farmers with SMS messages loaded with useful information on relevant farming practices. The app provides this information right into farmers' hands wherever they may be.

Farmbetter is an Android-App that connects farmers with actionable and tailored agronomic advice, currently focusing on sustainable land management practices that are provided from the WOCAT-database. Farmbetter uses farmers' location and preferences, including their agroecosystem to match their situation with the peer-reviewed sustainable land management practices. It encompasses cooperation between CDE, UniBE, ICIPE and other partners on new digital advisory services.

Réseau Semences Paysanne (Peasant Seed Network): Peer-to-peer knowledge creation and innovation in plant breeding. The work in the network is based on reciprocity and the need to protect collective knowledge. www.semencespaysannes.org

Access Agriculture is a non-profit organisation that showcases agricultural training videos in local languages, promoting the transition towards organic farming and agroecology across the global South. https://www.accessagriculture.org

4.2 Working with markets

Agroecological systems are more diverse and tend to yield a greater number of crop or livestock products, but with a smaller volume of each product. This can limit market and processing opportunities and requires higher levels of knowledge and risk-taking or experimentation. Furthermore, local marketing structures have in many regions been replaced by food retail chains, with food producers finding themselves in the weakest position along the value chain.

In continuation, we present concrete measures and promising examples to tackle these challenges and advance the development of agroecological systems in the context of markets.

4.2.1 Strengthen local marketing structures

Only 10-12% of all agricultural products are traded on international markets, and most food in the world is produced, processed, distributed and consumed within local, national and/or regional food systems (CMS, 2016). The Covid-19 pandemic has shown that sustainable local food systems are crucial for maintaining stable access to food when the global system fails. Supporting short supply chains and alternative retail infrastructures such as farmers' markets, fairs, food policy councils, and local exchange

and trading systems, may enhance farmers' livelihoods and increase access to local, sustainably-produced and diverse food (Hebinck et al., 2015). More support should be given to develop local and regional markets, processing hubs and transportation infrastructures that provide greater processing and handling capacities for fresh products from small and medium-sized farmers who adopt agroecological and other innovative approaches, and to improve their access to local food markets (Wezel in Herren et al., 2020).

Strengthening such local food systems depends on enhancing local authorities' (e.g. municipalities) capacity to design favourable local policies. These in turn could work to enhance direct connection between producers and consumers, provide public facilities, support farmers´ associations in building strong local marketing networks, and entrench participatory guarantee systems (PGS) to certify organic and agroecological producers (HLPE, 2019).

Promising examples:

Promising examples in African Countries see report: "**Agroecology and markets**": https://afsafrica.org/wp-content/uploads/2020/11/afsa-market-stories-english.pdf

Premium Hortus is the first African greentech company focused on scaling-up agroecology and sustainable development in West Africa. They are specialized in the e-commerce of agroecological products, organic production and producer support in Benin. Available as a web and mobile platform, Premium Hortus offers consumers (households, restaurants and hotels) organic certified products. https://www.agroecology-pool.org/portfolio/premium_hortus/

The **Milan Urban Food Policy Pact** (MUFPP) is an international agreement among cities from all over the world, committed "to develop sustainable food systems that are inclusive, resilient, safe and diverse, that provide healthy and affordable food to all people in a human rights-based framework, that minimize waste and conserve biodiversity while adapting to and mitigating impacts of climate change". The aim is to support municipal authorities in developing more sustainable urban food systems by fostering city-to-city cooperation and best practices exchange. To date, 211 cities worldwide have signed the pact. https://www.milanurbanfoodpolicypact.org/

Lima 2035 is a public-private-people partnership, seeking to help the city to reverse current desertification trends and to create a regenerative oasis for sustainable and human-centered food systems. https://cipotato.org/lima2035/

Participatory Guarantee Systems (PGS) are locally focused quality assurance mechanisms that certify producers based on social networks, in which all stakeholders – producers, small processing industries, retailers and consumers – share responsibility and active involvement to assure the quality of products (IFOAM, 2019). Originally developed in Brazil as an alternative to third-party certification schemes for organic

products, it rapidly spread around the world, and in many countries PGS is officially recognized as a certification system (HLPE, 2019).

JOIKKO, a social enterprise in Bangladesh working with smallholder farmers and local NGOs to improve services to farmers like machinery, storage facilities, credits and aggregation of food produced, ultimately securing higher revenues for smallholder farmers. https://www.joikko.com

4.2.2 Provide access to credits and alternative investment platforms allowing transformation towards sustainable food systems

Farmers (particularly smallholders, women and young people), producer organizations, input providers and businesses transforming their operations based on agroecological principles need access to credit and investments. Investments in land, farm machinery, infrastructure, inputs and know-how are essential and require access to capital. New generations of responsible food system entrepreneurs, including farmers in developed and developing economies, need access to long-term finance with low capital costs. Not only farmers but food systems actors in general require access to secure and low-cost capital to absorb risks (e.g. momentary lower profitability) in the course of converting towards more sustainable business models. Investments into FinTech research which accelerate and facilitate the access to transformational capital (e.g. mobile microfinance, peer-to-peer lending platform and crowdfunding) must be given due priority.

Promising Examples:

Agricultural **crowdfunding platforms** support a wide variety of projects: small or medium-sized diversified farms, agricultural services and facilities, generally with an influence on local markets and food systems. In addition, support can also be provided to entrepreneurs wishing to engage in direct sales, bulk trade, recycling, sustainable development, agritourism, etc.

In practice, crowdfunding platforms act as intermediaries between farmers, who apply for funding for a project, and savers who wish to lend to the project. **MiiMOSA** is among the leaders in crowdfunding in the agricultural sector. More than 3,000 sustainable agriculture and food projects have been created through crowdfunding on MiiMOSA, raising in total nearly 30 million euros (state 2020).

https://avenuedesinvestisseurs.fr/miimosa-avis-crowdfunding-agriculture/

4.2.3 Provide information for consumers for sustainable purchasing decisions

Sustainable purchasing decisions require that consumers receive the necessary information. The branding of differentiated agroecological produce contributes to responsible governance as an element of agroecology. Examples for sustainability

standards referring to agroecological practices and principles are organic and fairtrade standards. A number of voluntary sustainability standards (VSS) have emerged over the last years. While VSS can play an important role in enabling the shift of agricultural supply chains towards more sustainable production (Meier et al., 2020), it is important to stress that VSS are not guaranteed to be compliant with agroecological principles and a number of critical issues remain (Flora et al., 2012).

Most effective private initiatives for product declaration are those taken in response to public controversy, although here there is also a risk of greenwashing. In the Swiss meat industry, or in the case of controversial feed imports, there are two successful examples: With the Soy Network (https://www.sojanetzwerk.ch/en/), the industry has committed itself to feed only certified GMO-free soy to animals. Furthermore, the Suisse Garantie brand declared not to use palm oil products in feedstuff, which has led to a considerable reduction in palm oil imports.

Positive labels are widely used in consumer products to indicate special quality. What is largely missing, however, is equivalent labelling of questionable production methods. As no company would voluntarily declare its products as questionable, a declaration obligation is needed for negative aspects of production. There are already some successful examples of this (e.g. declaration of meat with use of hormones: https://www.sff.ch/de/fleischinfos/deklaration.php). However, the WTO sets high standards, which are hard to reach in practice, especially for negative assessments that are based on ethical or cultural values. Only when it has been scientifically proven that a production method or a product could endanger the health of the end consumer is a declaration requirement permitted unequivocally. In the grey area in between, however, a declaration obligation can be justified, provided that relevant ethical concerns are judged internationally to be well-founded.

Promising examples:

Fair trade initiatives: Max Havelaar was the first Fairtrade label launched. Fairtrade International is a global network working to share the benefits of trade more equally, through standards and certification, producer support, focused programmes, advocacy and awareness-raising. Fairtrade supports and challenges businesses and governments to increase commitments to sustainable production and consumption, and connects farmers and workers with consumers. https://www.fairtrade.net/

Gebana initiative "Weltweit ab Hof": Gebana is a promising example for fair trade compatible with agroecological principles. https://www.gebana.com/de/

Organic producers´ labels such as "Knospe" (in possession of the organic farmers´ association Bio Suisse in Switzerland) or "Bio vom Berg" (in possession of the organic producers´ cooperative Bio Alpin in Austria) provide reliable brands for consumers and

also give producers a strong market position. https://www.bio-suisse.ch/en/thebudlabelstandsfor.php; https://www.biovomberg.at/

The Farm to Market Alliance helps smallholder farmers in Kenya, Rwanda, Tanzania and Zambia receive information, investment and support from seed to market, so they can produce and sell marketable surplus and increase their income. https://innovation.wfp.org/project/farm-market-alliance

4.2.4 Introduce mechanisms that internalize external costs and enhance positive externalities

The 10 elements of agroecology, as proposed by FAO, provide an important foundation for the creation of a holistic, transparent standard, against which societal costs and benefits generated from a sustainable food system can be measured. While the environmental impact of agriculture and food production systems is unarguably substantial, it is especially problematic when food products are lost or wasted along the food supply chain.

Food prices and the price for food waste should be "right". This means that both the nutritional value of a food item as well as its production- and consumption-associated costs along the entire food value chain should be taken account of (FAO, 2018c). However, an increase in food prices has a negative impact on the ability of those on low incomes to buy food of appropriate quality. Similarly, the Eat-Lancet Commission states that "food prices should fully reflect the true costs of food". However, options that support vulnerable population groups and protect them from the negative consequences of the potential increase of food prices need to be considered (Willett et al., 2019).

Besides food prices, financial and fiscal incentives of unsustainable production systems also have a significant influence on current food systems. To allow for food system transformation, the creation of a shared understanding of all the positive and negative externalities of the food system, as well as of the best approaches to defining reduction targets is crucial (Perotti, 2020).

Promising example:

Using **true cost** to measure sustainability success: **Tony's Chocolonely**, a Dutch chocolate company, has a mission to have sustainable operations and supply chains. A key question on the path to reach this goal is how to measure progress, and the true price of a product provides such a measure, as it consists of the market price of a product and all external costs ("true costs") associated with production. In short, the lower the true cost, the more sustainable the product. In 2013, Tony's Chocolonely performed a first true price assessment and formed an impact team with the objective to decrease the external costs of production and reduce the true price. The true cost of one kilogram of

cocoa has declined from €7.93 in 2013 to €4.52 in 2017. This shows that a significant reduction in external costs is possible and sets an example for the sector as a whole.

https://trueprice.org/wp-content/uploads/2018/11/The-True-Price-of-Cocoa.-Progress-Tonys-Chocolonely-2018.pdf

EOSTA is a private–sector initiative dedicated to the production and importation of sustainable, organic, and fair-trade fruits and vegetables. They provide full traceability of their products, offer extension services to farmers, promote true cost accounting, and aim at building a sustainable market with consumers. https://foodsystemstransformations.org/eosta/

4.3 Enhancing collaboration

Agroecological practices often depend on collective action across a landscape scale, involving multiple farms and a range of actors. Furthermore, agricultural innovations respond better to local challenges when they are co-created through participatory processes and endorsed by local-specific knowledge. Collaboration and coordination across local, regional and national levels is key to support the active involvement and self-organization of food system actors such as producers, private-sector investors, academia, civil society and governments. This requires higher levels of coordination and increases transaction costs.

Below, we present concrete measures and promising examples to advance the development of agroecological systems in the context of collaboration.

4.3.1 Fostering collaboration and equal partnerships among different stakeholders including rebalancing North-South power relations

In order for research to have a real-world impact, implementing agencies, civil society organisations, farmer organisations and private sector actors need to be involved at multiple stages. Multi-stakeholder dialogues built on evidence-based arguments can help to bring together different perspectives, as long as they are developed in an inclusive manner (HLPE, 2019). Too often agricultural research projects and partnerships remain focused on one-way knowledge transfer via institutes based in the Global North. It is therefore crucial not only to promote a shift towards agroecological research, but also to rebalance North-South power relations through equal research partnerships and direct access to research funding. Additionally, increased funding to build lasting bridges for South-South collaboration is needed. Supporting the emergence of long-term partnerships and coalitions with a focus on agroecology, local ownership and the meaningful involvement of social movements and farmers' organisations is equally important. In parallel, the Public-Private Partnership model that is so central to current AgR4D needs to be continually scrutinised with regard to the delivery of benefits vis-à-vis the SDGs (Biovision & IPES-Food, 2020).

Promising Example:

The **African-Brazilian cooperation** on sustainable agricultural development, particularly the Agricultural Innovation Marketplace, promotes knowledge and technology exchange among Brazilian and African researchers and has become a success story of South-South cooperation. The programme is based on the premise that research priorities need to be defined in the countries and under local conditions where the actual research will eventually be applied. Besides a focus on local or regional ownership, it also aims to align research results to famers, contexts, traditions and requests (Freitas, 2015).

4.3.2 Strengthening co-creation of knowledge and supporting agents of change for agroecology

Taking steps to achieve a greater integration of local and scientific knowledge and of knowledge along food chains requires both investment in strengthening existing capacity and, ultimately, a fundamental reconfiguration of knowledge systems (HLPE, 2019). Stronger incentives are needed to involve different stakeholders and different forms of knowledge in research design beyond traditional discipline-specific incentives. Within formal research systems, more emphasis is needed on the co-creation of knowledge, building on the work already being done by farmer groups, CSOs and indigenous peoples to promote farmer-led research and other forms of participatory research. It is very important that the farmers and other food producers not only participate in the research process, but also exercise meaningful control and have equal access to its results. Currently, these agents of change for agroecology are rarely among the recipients of research funding. It is crucial to build bridges between these different actors and to respect and value the autonomy of bottom-up approaches rather than seeking simply to extract, formalise or commodify their knowledge. A stronger link between research-oriented and support-oriented approaches, designing local set-ups that will help farmers and other stakeholders in the long-term process of redesigning farming systems is fundamental if this is to be realised. In terms of design methodologies, this means sharing project leadership with farmers and co-organizing the design of projects locally. This both bridges the gap between thinking and doing and better accounts for the singularities of farmers' situations and of the local activity system to be transformed (Lacombe et al., 2018). It is therefore recommended to take steps to facilitate learning exchanges or 'transdisciplinary labs' with different knowledge-holders based on horizontal and peer-to-peer formats to enhance collaboration between farmer groups, CSOs and researchers (Biovision & IPES-Food, 2020; Pimbert, 2018a; Pimbert, 2018b). Pursuant to this, more research is required on the lock-ins of transformation processes which are manifold, complex and highly interdependent. In order to use financial resources efficiently, we also need greater understanding of the potential driving forces of change, such as eco-schemes in policy, social, ecological and

technological innovation, markets for public goods and services, true cost accounting etc.

Promising Examples:

A long-running example of bottom-up innovation platforms in the context of large-scale agriculture is the **CREA farmer groups** in Argentina and Uruguay (CREA: Regional Consortia for Agricultural Experimentation). https://www.crea.org.ar/

The **Campesino a Campesino** (CAC) movements in Central America and Cuba: Using their own farms as classrooms, the peasant farmers rely on principles of popular education and peer-to-peer learning to build local capacity, autonomy, and empowerment. The CAC process has generated effective site-specific agroecological solutions and empowering forms of non-hierarchical communication for social change throughout Central America and the Caribbean (Pimbert, 2018c).

Ubinig Bangladesh: Autonomous research and learning networks with over 300.000 farming families in 19 districts of Bangladesh building on rural peoples' systemic art and science of combining and integrating all aspects of life. As a grassroots innovation movement it has developed biodiversity-rich agriculture based on ten simple rules derived from day-to-day experiences and knowledge of male and female family farmers. https://ubinig.org

4.3.3 Empower local actors to foster collaboration and coordination

Many ecosystem services, similar to public goods, require some form of coordination to manage the provision and settlement between the providers and beneficiaries of these services (Saliou et al., 2019). Even more, the natural variability of ecological processes, combined with the difficulty of predicting their behaviour, make agroecology less desirable to engage, especially when the perceived benefits require collaboration and coordination. Lucas et al. (2019) have identified different ways how local inter-farm collaboration supports agroecological transformation at the individual farm level, such as diversification, better nutrient and energy recycling and substituting external inputs with biological and mechanical means. Collaboration enables the identification and development of synergies between neighbouring farming systems, for example through integration of livestock and plant production systems. New forms of coordination among farmers and other actors along the value chain should be organized to close nutrient loops by treating human waste at point of consumption to produce fertilizers for future food production or to valorise secondary agricultural outputs or by-products by other local enterprises.

Agroecological innovation depends on changes in knowledge and on changes in the social interactions to produce and adapt knowledge. Indeed, knowledge for agroecological innovation may require front-end research, but needs also to be combined

with "know-how" and "do-how" that has been forgotten by practitioners or lost through generation (Saliou et al., 2019). Therefore, tools and platforms allowing for the transdisciplinary exchange and development of knowledge are key, especially to transmit knowledge to young people.

There is growing evidence from literature highlighting the need for collective action and coordination at the local level to create favourable sociotechnical conditions for agroecological transition (Lucas et al., 2019). Agroecological innovations to be successful and implemented at larger scale, require mobilising a growing range of stakeholders with multiple perspectives (Triboulet et al., 2019). Agroecological farmers often value community cooperation higher and as more important compared to colleagues working in non-agroecological farming systems. This is in line with the agroecology principles in which the links to the members of the community for knowledge sharing and problem solving are key to strengthen sustainability and resilience (Leippert et al., 2020). Through interactions with other stakeholders and networks farmers and other agents of change are supported to strengthen existing initiatives and further develop collective awareness, identity, and agency around agroecological management issues (Chable et al., 2020). Eidt et al. (2020) showed in a case in Kenya that collaboration and communication were facilitated in situations where mutual trust and respect was developed as a result of more engaged, appropriately trained, and supported stakeholders. In cases where a community's trust had been diminished through inadequate expectation management and poor communication, new innovation initiatives were described as being more likely to face community opposition.

Promising Examples:

The primary source of information about farming continues to be informal discussions with neighbours, friends and farmer groups (Bezner Kerr et al., 2018). Farmers are better able to tailor technical information to their local context and culture, and peer educators can become important role models for others (Pamphilon, 2017).

The EU H2020 project NEFERTITI aims to establish an EU-wide highly connected network of demonstration and pilot farms. These demonstration facilities are designed to support and strengthen knowledge exchanges, cross fertilization among actors and efficient innovation uptake in the farming sector through peer-to-peer demonstration of techniques on 10 major agricultural challenges in Europe. https://nefertiti-h2020.eu

The farmer-to-farmer adult learning manual. Agricultural extension and education are key tools to facilitate agricultural development in developing countries. Farmers learn at least as much from other farmers as they do from professional educators or extension officers. The learning manual suggests a process and provides resources to support the training of farmers as peer educators (Pamphilon, 2017).

Community supported agriculture (CSA) is a community-based organization of growers and consumers. The consumer households live independently, but agree to provide direct, up-front support for the local growers who produce their food. The growers agree to do their best to provide a sufficient quantity and quality of food to meet the needs and expectations of the consumers. In this way the farms and families form a network of mutual support. Within this general framework there is wide latitude for variation, depending on the resources and desires of the participants. https://urgenci.net/material-on-csa/

ETH Zurich-led RUNRES project: The vision of **RUNRES** is to build locally important value chains (i.e., fruit, coffee, cassava, vegetables) and rural and urban waste recycling solutions to improve the flow of resources and the resilience of rural-urban food systems in four city regions in Africa.

4.4 Ensuring policy coherence to create a conducive policy context for agroecology

To take agroecology to the next level, a solid governance structure combined with a set of coherent policy measures are essential (Eyhorn et al. 2019). Laws, regulations, publicity awareness campaigns and fiscal incentives are all part of a framework that should cut across different sectors and integrate the whole value chain. Examples of such policy approaches are the development and the implementation of public procurement policies that favour agroecological and local food production as well as intensifying South-South cooperation on agroecology (FAO, 2018b).

In his speech at the Regional Symposium on Agroecology for Europe and Central Asia in 2016, former FAO DG José Graziano da Silva highlighted that a sole reduction of the environmental footprint of agriculture is in-itself insufficient. He emphasized that in many parts of the world, the demand for agricultural products continues to grow rapidly, with new land areas being cleared for agriculture at record rates. To tackle this situation Mr. da Silva urged for better coordination of on-farm and non-farm resource management. This perspective also emphases policy coherence supporting sustainability from farm to fork is important.

Importantly, implementing the Declaration of the rights of peasants and other people working in rural areas (UNDROP) has a great potential for ensuring more policy coherence in protecting and strengthening especially poor food producers, unleashing their full potential for example as guardians of agrobiological diversity and knowledge and reducing poverty and malnutrition at the same time.

In this chapter, we focus on the role of eco-schemes, trade policies, nutrition and health policies and a continuous monitoring and optimisation of progress towards green growth.

4.4.1 Provide support through agri-environmental policy measures for the transition to agroecological systems (eco-schemes)

Agriculture benefits - at varying degrees - from government support measures all over the world. In Europe, these are mainly direct payments, which are paid out to farms to support their income. There are also other funds that support marketing, make fuel cheaper, support investments in infrastructure, guarantee the social security of farm families, promote young farmers or maintain the market organisation.

"Public money for public goods" is a claim that environmental politicians and NGOs have been making for 30 years. Fortunately, there is a growing consensus that this would be an effective greening strategy. This would bring great benefits to agroecology. Piñeiro et al. (2020) investigated which measures were most effective in promoting sustainability in agriculture. By far the most effective measures are government-supported eco-schemes in all political, economic and social contexts, worldwide. Education, extension or market incentives (demand) come second. This has to do with the fact that the market only settles private goods and services, but not public goods. The important function of state intervention (direct payments, investment subsidies, contributions to research, education and advisory services) is therefore to minimise the conflict of goals between private and public goods and functions.

Promising Examples:

One of the most advanced agricultural policies supporting sustainability and green growth is in force in Switzerland since 1992. Over the last 20 years, the catalogue of measures that are prerequisites for state support has been constantly expanded. Gradually, more government support measures have been integrated into the mechanism and well-defined agri-environmental measures have been created to protect climate, soil, animal welfare and biodiversity.

In Asia, South Korea is one of the first states to have implemented direct payments to organic producers to support their income. Starting in 1999, in agreement with the Environment-Friendly Agriculture Promotion Act, farmers certified as performing environmentally friendly agriculture are rewarded with direct payments which differ according to the certification category, type of crop, and the area cultivated (Choi, 2015).

4.4.2 Influencing Sustainable Food Supply by Trade Policies

WTO rules are strict when it comes to sustainability requirements. For example, it is not permitted to refuse to import a product because it was produced using ecologically and socially questionable production methods. Resultantly, this rule prevents states from rewarding sustainable agricultural practices through trade policy. The international community should therefore work to ensure that minimum sustainability standards can be required in addition to health requirements. WTO agreements require unanimity.

Because this is almost impossible, willing countries should agree on common minimum standards for the most important agricultural products in a plurilateral agreement. If the number of countries involved reaches a critical mass, the requirements can be legitimized at the WTO as internationally recognized standards. Sustainability agreements can also be made within the framework of bilateral trade agreements. For example, concessions can be linked to product-specific sustainability requirements or cooperative accompanying measures can be financed to improve agricultural practices.

Promising examples:

There are no examples yet of how bilateral or multilateral trade agreements have advanced agroecological concepts and cooperation. There are, however, tentative approaches to introduce minimal standards for environmental or social sustainability goals. An example is the Comprehensive Economic Partnership Agreement of the EFTA States with Indonesia that allows for tariff differentiation along the lines of process and production methods (PPMs) in the case of palm oil. https://www.efta.int/free-trade/Free-Trade-Agreement/Indonesia

Like the **United Nations Forum on Sustainability Standards** (UNFSS), a joint organization of FAO, ITC, UNCTAD, UN Environment and UNIDO coordinates standards for sustainability outside of the WTO rules, one could imagine to set-up a similar coordinated action on agroecological standards.

4.4.3 Strengthen coherence between different policy areas and adopting a sufficiency narrative

The numerous support instruments of agricultural policy must be reorganised in such a way that they serve society. As things currently stand, many agricultural policy measures have negative impacts on the goals of different national strategies such as climate, biodiversity, soil protection, animal welfare, environmental protection, nutrition and health. For example, a joint study by the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) and the Forum for Biodiversity of the Swiss Academy of Sciences (SCNAT) listed 160 subsidy measures by the Swiss federal government, cantons and municipalities amounting to billions of Swiss francs that reduce biodiversity in Switzerland. If the funds available for the various policy areas were channelled into agroecology, a huge transformative force would develop very quickly.

One major challenge is that on an average, conversion to agroecological systems typically results in a reduction of yields (Tittonell, 2014) that needs to be compensated by cost savings, higher product prices or policy support measures to ensure the economic viability of the farms. Additionally, the definition of sustainability in agriculture and food systems must be broadened beyond the efficiency narrative. Sufficiency means reducing resource consumption by adopting sustainable diets,

reducing the demand for certain goods (e.g. feedstuff and biofuels produced on arable land), and by reducing food waste. Although the efficient use of natural and human-made resources remains important, efficiency alone is often offset by rebound effects such as a higher consumption or wastage.

Promising example:

None

4.4.4 Boost public procurement of products from agroecological farming methods

Making use of existing public purchasing obligations can provide economic and political opportunities to implement policy and build new and innovative socio-economic relationships that create sustainable food systems. Public procurement of sustainably produced food, for example, can support low-income and other groups within schools, hospitals and other public institutions, setting off mutually reinforcing circuits. Interventions that focus on local procurement of sustainably-produced food for school feeding programmes, or that target groups vulnerable to food insecurity, to realize food sovereignty at local and state level, can be effective in addressing food security and nutrition while supporting sustainable food systems. These initiatives can also support safe, decent, meaningful employment for marginalized groups, including young people and low-income workers within the food system.

Promising example:

The case of **Belo Horizonte** in Brazil is an example of where public procurement of agroecologically produced food was used in school meals and in community kitchens that were available to low-income residents, with significant impacts on reducing hunger (Chappell, 2018).

In **home-grown school feeding** (HGSF) programmes, locally-sourced meals are provided daily to children attending schools. Key principles of HGSF include local food procurement, smallholder engagement, nutrient-rich and diverse foods, and regularity in meal provision (example from Ghana: Singh & Fernandes, 2018).

4.4.5 Strengthening sustainability assessment of farms, food chains, technologies or policy measures

Productivity in most economic sectors, including agriculture, is widely defined as the results of the ratio of monetary inputs versus outputs in a production process. Such a narrow definition is no longer admissible in a world of changing climate and resource scarcity. Productivity in agriculture systems should no longer focus on single factor inputs versus outputs, but at the sum of interventions and its respective outcomes and impact on the larger ecosystem.

The Green Growth policy paradigm is a meaningful reference-point, highlighting the need to transform production and consumption patterns from resource intensive processes to eco-efficient and low-carbon trajectories (Stevens, 2011).

International guidance to comprehensively measure outcomes of agroecological farming systems are TAPE (Tool for Agroecology Performance Evaluation), SAFA-Guidelines of FAO (2013) or UN System of Environmental Economic Accounting (SEAA).

Research projects in general and technology development in particular should be subjected to a holistic, multicriteria assessment measuring against the elements of agroecology: FAO's Tool for Agroecology Performance Evaluation (TAPE) (FAO, 2019), the Agroecology Criteria Tool (ACT), the growing body of work on 'true cost accounting' (see also chapter 4.2.4.) and specific metrics like the land equivalent ratio are at hand (Biovision & IPES-Food, 2020). Multi-criteria sustainability assessment tools for farms and food business are very helpful in assessing complexity and holistic sustainability and can accelerate transformation processes in agriculture and nutrition.

Promising Examples:

The Swiss Academia is a leading place with several Institutes developing Life Cycle Assessment and multi-criteria sustainability assessment tools such as ETH Zurich, Agroscope, FiBL, HAFL and ZHAW. A close cooperation with FAO on developing global standards exists (Sustainability Pathways: SAFA Tool). These tools have been tested in Europe, Africa, Asia and Latin America.

5. Conclusions: How agroecology can support the UNFSS Action Tracks

To safeguard human nutrition and the natural resources we rely upon, we urgently need a shift towards efficiently organized sustainable agriculture and food systems as well as greater sufficiency with regard to the use of agricultural resources and products as well as in the way we consume food. Agroecology has the potential to play a central role in this transformation. Given the high degree of complexity of food systems, no measure, concept or practice aiming to build sustainable food systems exists which is completely free of trade-offs. In an earlier paper, the CNS-FAO highlighted a set of ten key-challenges (CNS-FAO, 2019).

Lawrence Haddad (Haddad, 2021), Chair of the UN Food Systems Summit's Action Track 1, highlights that although everyone wants the food system to change, finding potential game changers is hard and requires creativity. Figuring out what is hindering an approach from having positive impact at scale requires a close look at the limitations and their underlying causes. In this paper we exactly did this. We lined out some central

challenges in advancing agroecology in the future and proposed concrete actions and highlighted a number of promising examples to deal successfully with these challenges, turning them into opportunities for future food systems. This set of evidence-based examples proves that agroecology has the potential to be an effective and actionable game changer as looked for in the context of the UN Food Systems Summit. Agroecology provides a powerful approach that systemically considers different elements of food systems from production to consumption and involves all stakeholders and sectors.

Despite important limitations such as for example reduced yields, high transaction costs and an incoherent policy frame, agroecology is a promising solution as it offers a huge scaling-out potential in any context among small and mid-size farmers, which constitute the backbone of food systems. If applied widely, the impact potential will have transformative character. Furthermore, agroecology has shown to be economically viable and proves a solid return on investment if the economic impact is covering both elements of profitability, such as yield, prices and productivity as well as elements such as the overall and long-term resilience of a farming system (Biovision, 2019a). Through its bottom-up approach, agroecology is very actionable and embedded in farmer communities and often requires low-cost measures. The HLPE report (2019) points out that to effectively address food and nutrition security, environmental health and social well-being and hence inducing a significant and measurable food system transformation, we need more than standalone techniques or innovations and incremental interventions. To make significant progress, the report suggests (i) inclusive and participatory forms of innovation governance; (ii) co-creation and sharing of knowledge and information amongst communities and networks; and (iii) responsible innovation that takes local conditions into account and tackles social issues. These are aspects that are well considered and addressed in the 10 elements of agroecology (FAO, 2018b), and the measures suggested as well as the promising examples shared in this paper provide valuable inspiration for locally adapted approaches.

In addition, agroecology aims at boosting food producers and consumer agency rather than treating them merely as beneficiaries. Through its holistic approach, agroecology has the potential to consider a wide range of aspects and hence to foster capacities of farmers and other food system agents related to resilience, gender equality, create opportunities for rural youth and provide health benefits for farmers and their livelihoods. Finally, agroecology is employed all over the world to various degrees and consequently there is a growing number of empirical and narrative evidence from field pilots, comprehensive programs and even national policies. There is firm evidence that because of its systemic approach and its holistic and integrative nature, agroecology

considerably contributes to the Sustainable Development Goals and fosters synergies among them (Biovision, 2019b).

The UN Food Systems Summit 2021 suggests five Action Tracks to transform food systems to reach the Sustainable Development Goals. We see strong linkages between the suggested Action Tracks and the four ways forward towards upscaling agroecology we discussed in this paper. Below, we make these connections clear and show how agroecology can contribute to the goal of building sustainable food systems.

Action Track 1 "Ensure access to safe and nutritious food for all"

Action Track 1 will aim to deliver zero hunger and improve levels of nutrition, enabling all people to be well nourished and healthy.

Agroecology aims at producing nutritious, diverse and safe food, at being productive and at ensuring that the long-term foundations of agricultural productivity - natural resources with emphasis on fertile soils and high biodiversity - are not curtailed. To develop and enhance food production in agroecological food systems, the entire knowledge system (research, advisory and extension) is critical. Our paper describes the contents, the methodologies and the financial support schemes for a transformation in chapter 4.1. Boosting local markets improve access to food and local employment. Here, agroecology can play a crucial role as described in chapter 4.2.1. Empowering local actors and collaboration helps to spread agroecological practices in rural communities (see chapter 4.3.2 and 4.3.3) and is a priority of Action Track 1 as well. An appropriate policy context will be vital to these ends and can directly strengthen access to safe and nutritious food through public procurement (see chapter 4.4.4).

Action Track 2 "Shift to sustainable consumption patterns"

Action Track 2 will work to build consumer demand for sustainably produced food, strengthen local value chains, improve nutrition, and promote the reuse and recycling of food resources.

A shift to sustainable consumption pattern is both a core feature and a prerequisite of agroecology. This includes not only consumer behaviour but also all aspects of sustainable nutrition. The organization of markets and distribution structures are key factors when it comes to implementing agroecology. Local markets (4.2.1.) enable local value chains, initiatives such as sustainability standards (4.2.2.) and true price of food (4.2.4.) inform consumers about sustainable consumption choices. Agroecological food systems rely on permanent improvements and should be accompanied by sustainability assessments (see chapter 4.4.5.). This concept of transparency outlined above might become crucial for the transformation to sustainable consumption patterns. Another core element of agroecology is cooperation among actors of the entire food chain including consumers (see chapter 4.3.3.). Agroecology aims to strengthen and improve systems of

circular economies and of local resource cycles, which strongly corresponds to Action Track 2.

Action Track 3 "Boost nature-positive production"

Action Track 3 will work to optimize environmental resource use in food production, processing and distribution, thereby reducing biodiversity loss, pollution, water use, soil degradation and greenhouse gas emissions.

There is ample evidence that agroecological systems have a better environmental performance than conventional systems (Reganold & Wachter 2016, Seufert & Ramankutty 2017). Their up-scaling therefore contributes to enhancing nature-positive production. In addition, specific agroecological practices can be integrated in mainstream systems to improve their environmental performance.

To maintain and increase productivity of agroecological systems, systemic research (see 4.1.1.), knowledge exchange (see 4.1.2 and 4.1.3.) and co-creation of knowledge (see 4.3.2.) are crucial. Here, there is a perfect match with Action Track 3. Innovative and affordable methods, practices and technologies as applied on agroecological farms are perfect solutions to boost nature-positive and productive food systems. Policy measures aiming at the transition towards sustainable production (see 4.4.1.) and trade (see 4.4.2.), and coherency between policy areas (see 4.4.3.) build the frame for nature-positive production like they do for agroecological systems. Comprehensive sustainability assessments (see 4.4.5.) as we proposed for guiding and improving agroecological farms, food systems and political framing, are useful for achieving the objects of Action Track 3 as well.

Action Track 4 "Advance equitable livelihoods"

Action Track 4 will work to contribute to the elimination of poverty by promoting full and productive employment and decent work for all actors along the food value chain, reducing risks for the world's poorest, enabling entrepreneurship and addressing the inequitable access to resources and distribution of value.

Collaboration and empowerment of local actors (4.3.3.) as well as co-creation of knowledge (4.3.2.) strengthen the base for equitable livelihoods in agriculture and food production. Strong local markets (4.2.1.) enable local employment, and access to credits and alternative funding opportunities (4.2.2.) help producers and small local food entrepreneurs to develop their businesses. As shown above, we are convinced that the measures we proposed for the advancement and mainstreaming of agroecology will contribute to improve rural livelihoods, will create new job opportunities and will make rural areas more attractive for living, especially for young farmers.

Action Track 5 "Build resilience to vulnerabilities, shocks and stress"

Action Track 5 will propose solutions to ensure that food systems - which are affected by conflict, and environmental, health and economic shocks and stresses - can maintain functionality, recover from adverse effects, and improve to a better-off state.

Agroecological systems rely on ecological processes and aim at building diverse, regenerative and resilient systems. Agroecology therefore builds an excellent base for resilient food systems. Agroecological systems are highly persistent, have both an incremental adaptive capacity and a transformative capacity. To further improve agroecological practices and integrate learning from shocks (such as the current pandemic), research (see 4.1.1.) and co-creation of knowledge (see 4.3.2.) are crucial. Through strong and participative knowledge systems beyond disciplinary silos in education (see 4.1.2.), and vivid exchange in training and advisory (4.1.3 and 4.3.3.), agroecological practices can extend their impact and make a significant contribution to sustainable food systems.

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