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Agroecology as a means to achieve the Sustainable Development Goals

A discussion paper

Photo: Peter Lüthi / Biovision

Hadija Kibwana and her farmer group were trained in organic farming methods supported by Sustainable Agriculture Tanzania (SAT) and Biovision. They learned to create terraces against erosion, to increase soil fertility with compost, to combat pests with natural pesticides, and to cultivate suitable vegetable varieties with seasonal intercropping.

Swiss National FAO Committee (CNS-FAO)

Agroecology as a means to achieve the Sustainable Development Goals

This discussion paper by the Swiss National FAO Committee (CNS-FAO) serves to orient the Swiss Government and interested stakeholders on agroecology as a means to achieve the Sustainable Development Goals (SDGs). It primarily covers agricultural production and food consumption and only marginally touches on food processing and trade. The discussion paper builds on the understanding that there is no single approach or technological solution to make global agriculture and food systems (AFS) more sustainable. Instead, a combination of diverse activities is required, which are aligned with the overall objective of sustainable AFS (see CNS-FAO 2016 «Working towards Sustainable Agriculture and Food Systems»). This paper explores the specific role that agroecology can play in this process and outlines ways forward to make use of this potential.

Contents

Abbreviations

AFSA	Alliance for Food Sovereignty in Africa
CNS-FAO	Swiss National Committee for the FAO
CFS	Committee on World Food Security
COAG	FAO Committee on Agriculture
ETH	Swiss Federal Institute of Technology
FiBL	Research Institute of Organic Agriculture
FAO	Food and Agriculture Organization of the UN
HAFL	School of Agricultural, Forest and Food Sciences
IIED	International Institute for Environment and Development
IFPRI	International Food Policy Research Institute
OECD	Organization for Economic Co-operation and Development
LEISA	Low External Input Sustainable Agriculture
FOAG	Federal Office for Agriculture
SDGs	Sustainable Development Goals
SOCLA	Latin American Scientific Society of Agroecology
TWN	Third World Network
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
ZHAW	Zurich University of Applied Sciences

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Executive Summary

Due to the fundamental importance of agriculture, achieving agricultural sustainability lies at the heart of the SDG process. Agricultural sustainability is directly or indirectly necessary for reaching all of the 17 goals, but especially for reaching SDG 1 no poverty, SDG 2 zero hunger, SDG 12 responsible consumption and production and SDG 15 life on land. The FAO and the UN acknowledge the urgent need for a transformation of the agriculture and food system. More food and fiber need to be produced, while ecosystem functioning and human wellbeing needs to be restored and maintained. This tradeoff can be addressed by combining environmentally and socially sound farming practices with reductions in food waste and in concentrate fed livestock. Meeting the SDGs requires locally adapted agricultural practices that foster productivity and human health, maintain environmental sustainability and promote rural livelihoods and social stability. Solutions need to be systemic; there is no place for reductionist approaches that maximize only selected aspects.

As part of the overarching concepts of sustainable and ecological intensification, agroecology is one important path to delivering a well-functioning agricultural and food system, and hence achieving the SDGs (Figure 1). At its best, agroecology can use a multitude of suitable solutions, including new technology and traditional techniques, improved inputs and outputs and applying unique localized knowledge-based practices not only at field level but also in terms of processing and marketing of food. It aims at holistic and system-oriented farm management practice, including social, cultural and political principles. A number of farming systems can be considered as agroecological including, but not limited to, Organic Farming, Agroforestry and Permaculture. Selected techniques and practices of agroecology are also adopted by intensive farming systems (such as e.g. precision farming, integrated production) and are elements of sustainable intensification. Therefore, agroecology is synergistic and not competing with other efforts to make agriculture and food systems more sustainable.

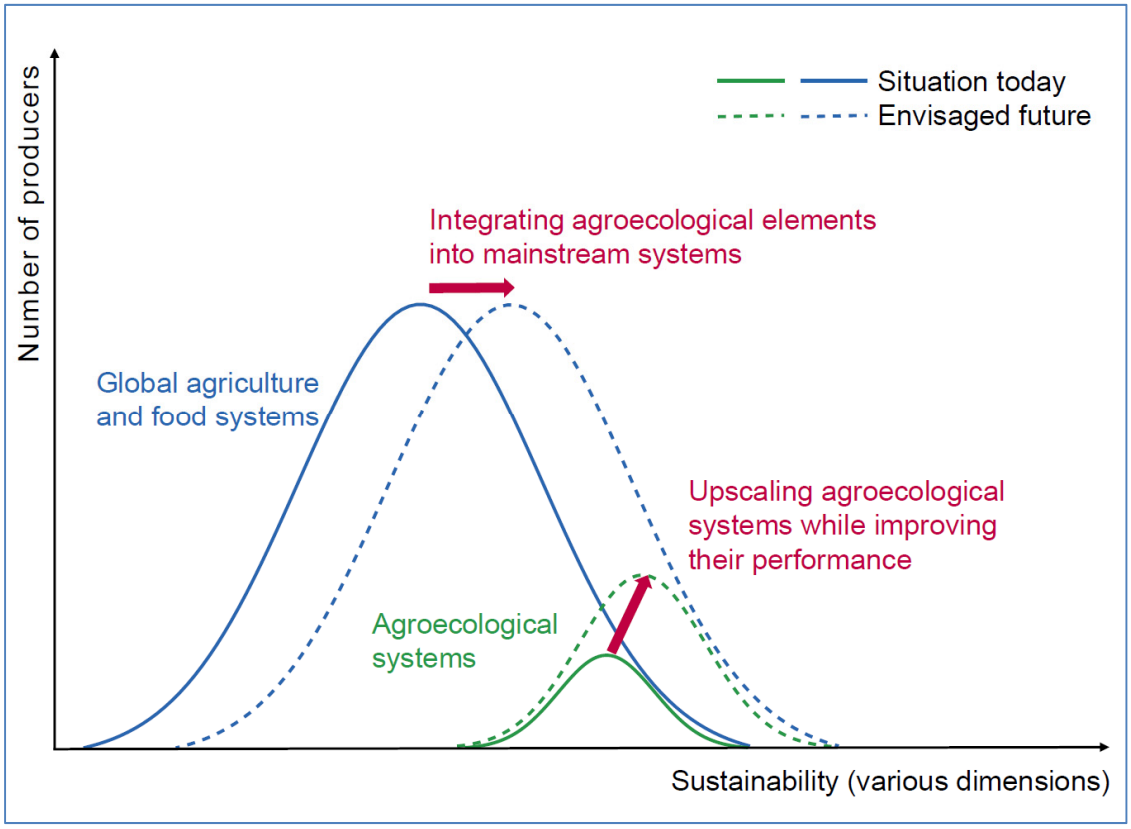

Figure 1: The role of agroecology in transforming agriculture and food systems

The success of agroecology is demonstrated by a multitude of case studies across the world: crop and livestock diversification, external input reduction, and alternative marketing channels can improve farmers' income. Conservation tillage can reduce herbicide application while raising yields. Organic farms can achieve similar yields and profitability to conventional farms, while fostering a higher level of biodiversity and increasing the available food per household (especially in smallholdings in tropical regions). Agroforestry systems can have a higher return on labor compared to monocultures. In fact, agroecological approaches can lead to remarkable increases in yield and food production, especially in marginalized conditions. In addition, it can foster biodiversity, soil fertility and human health.

Agroecology of course also has its challenges that may be overcome with targeted action and investments. Key challenges relate to: a pronounced time lag between the implementation and benefits of the measures; insufficient system research; increased labor demand (which can also be an opportunity for creating jobs); transaction costs; a negative image by some stakeholders; policy incoherence and, in an industrialized temperate setting, yield reductions.

In order to fully utilize the potential of agroecology some steps can be taken to move forward: (1) Putting Agroecological production systems in the focus of national and international policy interventions and using agroecology as a guiding scientific and practical concept. (2) Strengthening knowledge on agroecological systems, the application of novel technologies like digitalization, and co-operation between scientific disciplines as well as the private sector. (3) Strengthening and developing new local marketing structures and marketing support measures for agroecological products. (4) Considering external costs and ethical values in international and national agriculture and trade policies. (5) Supporting the self-organization of farmers, including women farmers and food producers, and ensure that they participate in decision-making and the shaping of policies. (6) Strengthening agri-environmental policy measures, assure policy coherence to allow a conducive policy context and strive for policy convergence informed by science. (7) Taking measures to reduce food waste and concentrate-fed livestock, influencing eating patterns and reducing the competition between food, feed, and fuel on arable crop land.

1. Introduction

In its current state, the global agricultural production entails perilous trade-offs between food, feed, fiber, and fuel production on the one hand, and non-commodity ecosystem services, eco-stability and human wellbeing on the other hand. The situation is exacerbated by the ongoing growth of world population and consumption, since by 2050, the world population is estimated to grow to around 10 billion. This development is combined with an income growth in low and mid-income countries, which is expected to further escalate the ongoing dietary transition towards higher overall consumption of protein (especially meat) but also of fruits and vegetables (FAO 2017a). With existing farming practices this surge in demand will lead to an increased competition for, and overexploitation of, natural resources, higher greenhouse gas emissions, further deforestation, and land degradation (FAO 2017a).

Global models show that by combining more environmentally friendly farming, reduced consumption of concentrate-fed livestock and their products and lower food wastage, the trade-offs between production and eco-stability can successfully be addressed (Schader et al. 2015, Müller et al. 2017). In line with this conclusion, the UN recognizes that in order to design sustainable farming and food systems, agricultural technology and agroecological principles need to converge further (UN 2017). Similarly, the FAO (2017a) highlights the need for a transformative process, which considers local contexts and builds upon traditional knowledge as well as innovation. Such innovative systems support a holistic approach by incorporating biological complexity and diversity, closing the nitrogen cycle, reducing waste, protecting and enhancing the natural resource base while increasing productivity. Moreover, diversified ecological agriculture can reduce poverty and contribute to healthier nutrition.

Sustainable agriculture and food systems are central for the SDG process, which supports system-thinking approaches that embrace the system's different challenges and complex interactions. In fact, sustainable agriculture and food systems have to address a whole range of SDGs by 2030 (IFPRI 2016). Meeting the SDGs requires locally adapted agricultural practices that foster productivity and human health, maintain environmental and social sustainability, and promote rural livelihoods. Agroecology is one important path to achieving the SDGs and creating a well-functioning agricultural and food system. This was highlighted by regional FAO conferences as well as by the international FAO symposia on agroecology (COAG 2018).

Agroecology involves the integrated local application of sustainable agriculture. It applies ecological principles in order to design and manage agro-ecosystems in more sustainable and productive ways. Agrobiodiversity plays a key role in this: many agroecological practices are based on (agro)biodiversity and at the same time agroecology strengthens (agro)biodiversity. As such it supports the development of best practices, integrated solutions, and techniques that allow agriculture to minimize its ecological footprint, including approaches at the landscape level while optimizing yields. At its best, agroecology can use a multiplicity of solutions including technology and traditional techniques and improved inputs and outputs. This includes local and innovative marketing models that bring producers, processors and consumers closer together. Further, it may apply unique localized and practical knowledge-based solutions, which allow for intensification and greater food production while complying with ecological, economic and social imperatives.

Case studies across the world demonstrate how agroecology can improve crop production, especially for smallholders (Oakland Institute & AFSA 2018, Adamtey et al. 2016, Altieri et al. 2012, Pretty et al., 2003, 2006 & 2011, UNCTAD/UNEP 2011). The former UN Special Rapporteur on the Right to Food, pointed out that productivity could be doubled in regions where the hungry live if agro-ecological methods are adopted (De Schutter, 2010). Recently, scientists assessed sustainable intensification initiatives worldwide and estimated that 29% of all farms are practicing some form of redesigned systems of sustainable intensification (including agro-ecological systems) on 9% of global agricultural land (Pretty et al. 2018). They concluded that adoption of sustainable systems may soon be approaching a "tipping point" to be globally transformative.

To evaluate the contribution of agroecology in the transformation to sustainable agriculture and food systems, the FAO Committee on Agriculture suggests in its action plan to strengthen normative, science- and evidence-based work by developing metrics, tools and protocols (COAG 2018). This further intends to catalyse scientific evidence and co-creation of knowledge and facilitate its dissemination. In our view, any metrics must have a clear link to the SDGs, particularly to Goal 2 of zero hunger and SDG indicator 2.4.1 (proportion of agricultural area under productive and sustainable agriculture).

In this discussion paper we would like to contribute to the debate in an inclusive and relevant manner for all types of agriculture and farms and evaluate Agroecology within the concept of Sustainable Intensification, highlighting the potential of agroecology in the SDG process. We consider agroecology as synergistic and not competing with other efforts to make agriculture and food systems more sustainable. This paper builds on the conceptual framework of the CNS-FAO's earlier paper "Working towards Sustainable Agriculture and Food Systems» (CNS-FAO, 2017). Doing this, we emphasize-that there is a strong need to provide an enabling policy environment and economic support to promote sustainable agriculture and food systems through innovative, integrative and measurable approaches.

2. The concept of Agroecology

The FAO acknowledges the wide spectrum of different understandings of the term agroecology and has compiled a framework of ten elements[1] (FAO 2017b; Figure 2) as well as a database of 19 key definitions (FAO 2018a). The OECD focuses on the scientific aspect and defines agroecology as "the study of the relation of agricultural crops and environment" (OECD 2003).

As a science, agroecology emerged in the 1960s, when scientists studied the interaction between crops and the environment. Altieri (1995) defined agroecology as the application of ecological science to the study, design and management of sustainable agriculture. Agroecology has helped increase our understanding of the environmental impact of agriculture (OECD 2003). In particular, it has shed light on how the local context of different ecological zones and the agroecosystem affect productivity and agricultural practices. As a scientific discipline, agroecology is not prescriptive; it provides no recipes, standards or technical packages. Key aspects of agro-ecological research include participatory knowledge development, on-farm studies, and holistic research approaches that consider social and economic aspects (TWN & SOCLA 2015).

Figure 2: The ten elements of agroecology. http://www.fao.org/agroecology/en/

Many farmers have adopted the findings of agroecological research and changed their management practices. Therefore, today a large number of management systems can be regarded as agro-ecological practice. They all aim to apply ecological principles in order to design and manage agro-ecosystems sustainably. Agro-ecological farming supports the development of best practices, integrated solutions, and techniques that allow agriculture to minimize its ecological footprint. Common best practice approaches include wide crop rotation, mixed crop-livestock systems, polycultures, inter-, cover and mixed cropping, natural corridors, and local marketing and value creation (TWN & SOCLA 2015). Further important aspects are local breeding programs and re-using resources from local agroecosystems (Gliessmann 2006). However, agroecological farming is an aim and a process that evolves over time rather than a prescribed and static set of practices. Already well-established farming systems considered as agroecological practice are Organic Farming, Permaculture, Low External Input

[1] FAO's Committee on Agriculture (COAG) decided in its 26th meeting (1-5 October 2018) to support these elements as one of the approaches to guide the transition to sustainable agriculture as benefits each country context. It requested FAO to revise and further develop the 10 elements of agroecology.

Sustainable Agriculture (LEISA), and Agroforestry (Armengot et al. 2016). They all comprise the 10 elements of the FAO framework, albeit with different weighting and target achievement.

Organic agriculture is an agroecological farming system that has become a global reference concept (Niggli 2015). It has some specific features that go along with the marketing strategy: the production standards are strictly codified and bound to a certification scheme, which allow for global access to markets. As there is a risk that smallholder producers in low-income countries are excluded from access to markets, group certification and Participatory Guarantee Systems are applied in order to reduce the costs of third-party certification.

Compared to organic agriculture, other agroecological farming systems are more flexible, as their production norms are usually neither codified nor certified. Some of their techniques are not compatible with organic standards, like combined fertilization with organic manure and mineral fertilizers (including nitrate) or the spraying of synthetic herbicides and pesticides in exceptional cases when the harvest is vitally threatened (Parmentier 2014).

Some farmer organizations, most prominently La Via Campesina, as well as many experts and scientists strongly focus on social, cultural and political principles, which they consider inherent elements of agroecology (La Via Campesina 2018). This agrees with the consistently voiced views of participants in FAOs regional multi-stakeholder seminars on agroecology (COAG 2018). Such concepts focus on smallholder systems that incorporate social systems such as direct co-operation between producers and consumers. This understanding of agroecology is linked to the food sovereignty movement in Latin America and similar movements across the world (Wezel et al. 2009). In regions where agroecological initiatives and projects have become durable and farmers have not relapsed to unsustainable practices, it was the result of farmers and civil society organisations having become organized as a movement (Tittonell 2014, Rosset et al. 2011). In fact, building social capital and co-creation of knowledge are prerequisites for the successful scaling of agro-ecological farm management practices (Pretty et al. 2018).

Agroecology is part of the overarching concept of sustainable and ecological intensification (Figure 3). Tittonell (2014) exemplified the role of nature in the actual design of systems: *"While sustainable intensification is generally loosely defined, so that almost any model or technology can be labeled under it, ecological intensification proposes landscape approaches that make smart use of the natural functionalities that ecosystems offer. The aim is to design multifunctional agroecosystems that are both sustained by nature and sustainable in their nature".* The concept of agroecology goes one step further towards holistic and system-oriented farm management practice.

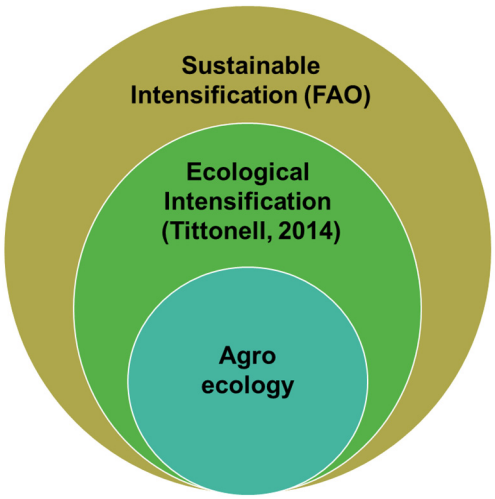

Figure 3: The concepts differ with regard to the relationship between productivity and ecological footprint (schematically).

Selected agroecological practices in the sense of the OECD definition are being applied to industrial agriculture in farming systems like Low Input Agriculture, Precision Farming, Integrated Pest Management and Integrated Production, cradle-to-cradle, systems optimized by Life Cycle Assessment, and Conservation Tillage. They are all part of the concept of sustainable intensification. Many of these management practices have been fostered by agri-environmental measures of governments. Since 2006 Switzerland, for example, has reoriented all state support schemes exclusively to farms that apply certain ecological practices, for which the requirements gradually increase over time. The European Commission established in 2013 a policy of 'greening' and required a few agroecological practices for all direct payments (European Commission 2013). However, these measures proved insufficient for achieving sustainability targets.

3. How does agroecology contribute to sustainable food systems and the SDGs?

The sustainable development goals (SDG's) set the global development agenda until 2030 – they are universal (for all in every country) and integrated (engaging all actors). The state of our food systems directly or indirectly affects all 17 of these goals. Without proper nourishment, children cannot learn, people cannot lead healthy and productive lives, and societies cannot prosper. Without nurturing our land and adopting climate-resilient agriculture, future generations will struggle to feed a growing population (FAO, 2017b). Agroecology provides one tool to help build sustainable food systems and thus contribute to the ambitious targets laid out under the SDG's (Farrelly 2016). In particular, agroecology (in all its definitions) can contribute to no poverty (SDG 1), zero hunger (SDG 2), good health and wellbeing (SDG 3), decent work and economic growth (SDG 8), responsible consumption and production (SDG 12), climate action (SDG 13) and life on land (SDG 15; Figure 4).

Figure 4: SDGs substantially addressed by agroecology.

No poverty, decent work and economic growth, SDG 1 & SDG 8

The agricultural sector is of fundamental importance for many further economic sectors and in many countries is still the largest employer. Yet, rural people – despite producing 80 percent of our food – make up four-fifths of the global poor (FAO 2017b). In addition, economic development generally starts with progress in agriculture (Sütterlin et al. 2018). Hence, achieving agricultural sustainability lies at the core of achieving SDGs 1 and 8. By contributing to local economic and resource circulation, increasing and securing yields, reducing costs and external dependencies, agroecology has the potential to contribute to economic growth and decent work, particularly for the rural poor. Strategies such as diversification, external input reduction and alternative marketing channels have, in some cases, been shown to improve farmers' income by 30% (FAO 2018b). Analyzes of agroecology and sustainable intensification show for example that Integrated Pest Management can generate remarkable improvements in production. Conservation tillage can improve soil carbon while raising yields, and integrated plant nutrient systems can achieve the same benefits with reduced fertilizer application (Bruinsma 2003, Pretty et al. 2003, Pretty et al. 2006, Uphoff 2007). Furthermore, there are indications that the economic performance of alternative and agroecological farming systems can be comparable to, and sometimes better than, conventional farming systems and that the profits from these systems may be less variable, thus providing greater predictability for farmers (Chappell & LaValle 2011). Studies have shown that with a smaller farm size organic farms can achieve the same profitability as larger conventional farms (Smolik et al. 1995, Rosset 1999) and that compared to monocultures, agroforestry systems can have a higher return on labor (Armengot et al. 2016).

Zero hunger, good health and wellbeing, SDG 2 & SDG 3

We currently suffer from a triple burden of malnutrition globally, with one in every three people malnourished in some form. In many countries, food security is still lacking, as minimum energy requirements are still not met (Sütterlin et al. 2018; Figure 5). A total of 2 billion people lack key micronutrients in their diet, 155 million children are stunted and 2 billion people overweight or obese (Development Initiatives 2017). This highlights that we are far from the SDG target 2.2 of ending all forms of malnutrition.

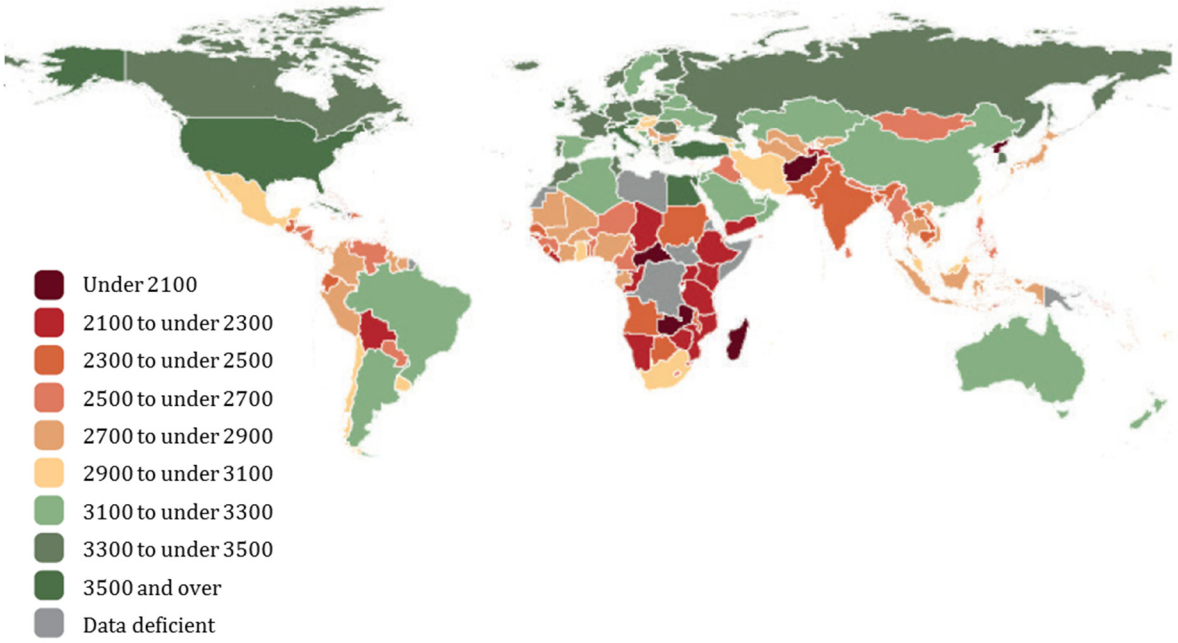

Figure 5: Average availability of food, by country, in kilocalories per capita per day. Figure adapted from Sütterlin et al. (2018), who based it on data from FAOSTAT (2018).

Extensive evidence indicates that agroecology can, on a global scale, provide a level of food-security comparable to that of conventional agriculture (Chappell & LaValle 2011). Organic agriculture increases the access to food by increasing the quantity of foods produced per household and by producing food

surpluses that can be sold at local markets (UNCTAD/UNEP 2011). In Africa, the yields of organic agriculture outperform traditional systems and match those of conventional input-intensive systems (UNCTAD/UNEP 2011). In their outstanding study Pretty et al. (2006) analyzed the impacts of 286 agroecological projects in 57 poor countries. They found that these projects led to an average yield increase of 79% on over 12 million farms, with households on average increasing their food production by 1.7 t/year (73%).

Further to this, agro-biodiversity (a key element of agroecology) is an important element of making a diverse range of food products available. Although the pathway is complex and not always positively correlated, agricultural diversity plays an important role in improving dietary diversity, which has a strong association with improved nutrition status, particularly micronutrient density of the diets (Fanzo et. al. 2013).

Applying the concept of agroecology contributes to sustainable and resilient food production systems that help maintain ecosystems and that progressively improve land and soil quality. It further helps in maintaining the genetic diversity of seeds, cultivated plants and domesticated animals. Through the promotion of reduced, alternative (non-chemical) and safe application of crop protection products, agroecology can potentially reduce risks associated with chemical exposure, thus positively influencing the health of rural workers and of consumers.

Yield increases, and increased diversity alone will not address our concomitant challenges of hunger, micronutrient deficiencies and obesity. This requires broad ranging system changes that tackle poverty, inequality and barriers to access. The systemic approach based on ethical values, often considered a part of agro-ecological methodologies, offers an opportunity to address these issues in an integrated manner. For example, in Madhya Pradesh, India a development institute provided integrated training in agroecological techniques, health and nutrition to more than 8500 women from 850 villages over 30 years. This improved livelihoods for the majority of the women and broke the cycle of poverty (FAO 2018b).

Sustainable consumption and production, climate action and life on land, SDG 12, SDG 13 & SDG 15

Agroecological systems use natural resources more sustainably and efficiently, and reduce the release of chemicals to air, water and soil (targets 12.2, 12.4 & 12.5). Through the enhanced proximity between producers and consumers, agroecology helps raise awareness and reduce food waste (target 12.3), e.g. by redistribution of un-usable crops (Beausang et al., 2017) or by repurposing urban organic waste as fertilizer (Sonkin 2017). Agroecology puts an emphasis on maintaining soil fertility and ecosystem services, which can improve the long-term productivity of the land. As agricultural diversity is higher in organic and agroecological farming (Mäder et al., 2002), biodiversity can be conserved and potentially restored within agro-ecosystems. Studies have shown that through diverse and heterogeneous agroecological approaches it is possible to preserve and increase wild and domesticated biodiversity by up to 30% (FAO 2018b).

The connection between climate action and agroecology is two-way – agroecological systems have the potential to contribute to reduce greenhouse gas emissions and offer management practices to adapt to climate change (FAO 2018b).

4. Challenges related to agroecology

No intervention to build sustainable food systems is a silver bullet, and agroecology is no exception. The high potential of the approach is hindered by a number of limitations, many of which can be overcome with targeted action and investment. Some of them can also be turned into opportunities. Key limitations, adapted from the International Institute for Environment and Development, are outlined below (IIED 2015):

1. **A negative image** – agroecology is viewed by some actors as not being modern or scientific enough to contribute to global food challenges.
2. **A time lag** – there is often a time delay between the implementation of agroecolocial principles and the resulting benefits, such as soil fertility improvements of yield increases. There is

currently a lack of incentives to support farmers to overcome this time lag, which in many cases is more pronounced than similar time lags in conventional agriculture.

3. **Weak knowledge and advisory systems** – there is a disconnect in the knowledge and advisory systems required to support agroecology and build the capacity of actors. There is also a shortage of inter- and trans-disciplinary research on agroecology that takes into account the context specificity of the approaches.
4. **Labor demand** – many agroecological systems have a high initial demand for labor and can be more labor intense in general. This can be a serious constraint when manual labor cannot be substituted by mechanized labor. In situations where mechanization is possible, the investment required can also be a hurdle. However, provided that work conditions are decent, this can also be an opportunity for job creation.
5. **Transaction costs** – as agroecological systems are more diverse they 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 high levels of knowledge and risk taking/experimentation. Further, farmers may have to carry the financial and knowledge burden of identifying and applying alternative inputs.
6. **Policy incoherence –** agroecology requires a different type of government support that goes beyond subsidies for particular inputs. Further efforts are needed to better understand which government policies can support agroecology and multi-functionality of agriculture more generally.
7. **Lack of landscape level coordination –** a number of agroecological practices depend on collective action across a landscape scale, involving multiple farms and a range of actors. This requires higher levels of coordination and increases transaction costs.
8. **Lack of incentive systems in research –** the current global knowledge and research system promotes the maximization of short term output (Aboukhalil 2014, Edwards & Roy 2017). It is therefore not set up to support systems-oriented, transdisciplinary and long-term field research which is required by the diverse and context specific nature of agroecology. This limits research in this area and hence the evidence base that can be used to inform policy making.
9. **Lack of compensation for yield reductions –** Replacing conventional systems in marginalized conditions with diverse agroecological ones can increase the overall output of farms. However, on an average, and particularly in temperate zones with highly intensive agriculture, conversion to agroecological systems typically results in a reduction of yields that needs to be compensated by cost savings, higher product prices or other support measures in order to ensure the economic viability of the farms.
10. **Sufficiency:** 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.

5. Conclusions and ways forward

Transforming agriculture and food systems in line with the SDGs is not only an option, but a must. Agroecology is an important component of this transformation. It is an open concept for science in agriculture and nutrition as well as for practice and as a social movement. It permanently strives for best practice and is therefore dynamic. As a farm management practice, it should improve the well-being of farming households, strengthen agrobiodiversity, build fertile soils, reduce natural resource exploitation and help mitigate and adapt to climate change, through increased resilience. Through reduced production costs, better access to markets, building decentralized markets and through agri-environmental schemes, agroecology should also help build resilience to market fluctuations. As a social movement it looks at agricultural and food systems in a holistic way and, based on the Human Right to Food and Nutrition, not only ask how to produce, but also what and for whom it needs to be to produced.

In order to fully utilize this potential of agroecology, we suggest the following steps to move forward:

Strengthening knowledge on agroecology:

- Innovations and novel technologies like digitalisation are expected to increase the efficient use of resources, labour and farm inputs. Their potential for reducing food waste, relieving natural resources and increasing landscape, farm, field, market and consumption diversity should become a special focus of publicly as well as privately funded research. The usefulness of selected technologies for agroecological practices and supporting agrobiodiversity should be a priority in research, training and advice.
- Agroecology challenges the scientific community as it encompasses strong interactions in systems, requires close co-operation between disciplines and involves all actors along the food and nutrition value chain and of context specific food systems. While continuing the work on improving eco-efficiency, research needs to focus on system redesign based on the principles of agroecology. In this, the interaction with farmers, farmworkers, food producers, and consumers has to be given special attention in order to also integrate traditional and tacit knowledge as well as innovation and technology. We need a co-learning of research and practice, geared to solve problems that farmers are facing.
- Agroecology should be strengthened in the curricula of Universities of both basic and applied sciences. State and private research institutes should offer on-the-job training in agroecology. Applying the concept of agroecology can help to understand the impact of different farm management practices on productivity and the local environment and thus enabling farmers to choose the best options for their unique situation, recognising the diversity of agricultural production systems globally.
- In order to support a dynamic progress towards best practice, consulting and evaluation of food system actors should be carried out according to holistic guidelines. The leading position of Swiss research in sustainability assessments (ETH, Universities, Agroscope, FiBL, HAFL, ZHAW, private sector players) should therefore be further developed and used as a matter of principle in national and international research. Evidence based private sector measures should be included if the data is fully disclosed and audited.
- An impact assessment of the adoption of agroecology on global food security and on agricultural incomes would clarify the effects of agroecology and provide much needed evidence.

Working with markets:

- Farmers' markets and local marketing structures should be strengthened that in many places have been replaced by food retail chains. The promotion of new marketing concepts, based on proximity, sustainability, traceability and the involvement of farmers and their organizations become crucial and are providing employment and income opportunities. Among other measures like urban- and peri-urban agriculture, digitalization could be used to bridge geographical scales.
- In addition to, or instead of, agri-environmental measures (see under “policy”), many governments help farmers with marketing support measures. By orienting this support towards agroecological systems, consumption of their products can be considerably increased, and people become aware of sustainable food production and consumption.
- International and national trade policies can contribute to foster agroecological practices, if the monetaristic model of the comparative advantage is shifted towards a paradigm which includes external costs and ethical values. This could, for example, be reflected in different tariffs for agroecological products.
- The CFS Principles for Responsible Investment in Agriculture and Food Systems (RAI) as well as the Voluntary Guidelines on Responsible Governance of Tenure (VGGT) should be promoted in collaboration with the financial sector at local, national and regional levels as a crucial prerequisite for agroecological farm, food and nutrition practice. Farmers (particularly smallholders and women), producer organizations, input providers and businesses transforming their operations based on agroecological principles need to get access to credit and investments.
- A transition to Agroecology will require adequate funding mechanisms on various levels, in combination with the right incentives. While the uptake of sustainable agricultural practices at scale is in the interest of land managers, communities, companies and governments, it will be challenging to channel the needed funds. New and alternative funding sources and instruments, such as blended finance impact products or environmental/social impact bonds, should therefore be explored for funding transition initiatives.

Enhancing collaboration:

- As a social movement, agroecology strengthens family farmers and food producers around the world in their capacity to organize themselves for knowledge sharing and the continuous development of locally adapted, diverse and intelligent agroecological practices. It also increases involvement in decision making on policies around agricultural and food systems to defend their rights and access to resources (UN Declaration of Peasant Rights 2018). This work of self-organization, exchange and co-creation at national, regional and international level needs to be supported, also financially, in order to build a transformative movement.
- Up-scaling agroecological systems from farm to fork requires the involvement of producers, private sector including investors, academia, civil society and governments who all agree to measure results based on clear indicators aligned with the SDGs. Specific emphasis needs to be given to young people and to the rural-urban nexus (e.g. through food councils).
- Agroecological production systems must be therefore in the focus of national and international policy interventions. This is particularly important because it allows public money to be used effectively for the sustainable use, maintenance and production of public goods. All activities of empowerment of farming communities as well as knowledge sharing between practitioners, farm advisors and scientists should therefore have a high priority.
- Multi-stakeholder engagement - Overcoming our collective challenges means harnessing the energy of different groups to generate new ways to produce and deliver safe and nutritious food, more consistent policy for safer products, better stewardship, improved trade, greater transparency, better technology and improved farm economics and resilience. But most of all, these complementary skills and knowledge need to be brought together.

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

- Agroecology can serve as an overarching scientific and practical concept for orienting farming systems towards the SDGs, in low-income countries as well as in Switzerland. Agroecology is a fast-growing part of the strategies of sustainable (or ecological) intensification and is viable and successful in many parts of the world.
- Agri-environmental policy measures as they are in place especially in European countries are important incentives for farmers to implement the first steps. Specific support for the transition to agroecological systems helps to overcome the sometimes high entry costs due to the need for knowledge and training, and higher labor requirements.
- International trade relations should include/allow specific tools or mechanisms to foster the marketing of products derived from agroecological systems. Bi- and Multilateral trade agreements should not include policies or ask for laws that might hinder agroecological production and even put its central elements as defined by FAO at risk.
- Measures need be taken to reduce food waste, influence eating patterns and reduce the competition between food, feed, fuel and bio-economy demands on arable crop land. This can be done by eliminating subsidies for biofuels, awareness rising, capacity building and technical approaches. Although agroecology can be very productive under the conditions of subsistence agriculture, it currently limits the productivity of intensive agriculture. Therefore, efficiency as the overall narrative of agriculture must be complemented with sufficiency.

6. References

Aboukhalil R (2014). The rising trend in authorship. The Winnower 2:e141832.26907, DOI: 10.15200/winn.141832.26907.

Adamtey N et al. (2016). Productivity, profitability and partial nutrient balance in maize-based conventional and organic farming systems in Kenya. Agriculture, Ecosystems & Environment 235:61-79.

Altieri MA (1995). Agroecology: the science of sustainable agriculture (2nd ed.). Westview Press. Boulder, USA.

Altieri MA, Nicholls C & Funes F (2012). The scaling up of agroecology: spreading the hope for food sovereignty and resiliency. A contribution to discussions at Rio+20 on issues at the interface of hunger, agriculture, environment and social justice. SOCLA's position paper for the United Nations Conference on Sustainable Development - or Rio+20 on *20*-22 June 2012. Rio de Janeiro.

Armengot L, Barbieri P. Andres C, Milz J. & Schneider M (2016). Cacao agroforestry systems have higher return on labor compared to full-sun monocultures. Agronomy for Sustainable Development 36(4):70.

Beausang C, Hall C & Toma L (2017). Food waste and losses in primary production: qualitative insights from horticulture. Resources, Conservation and Recycling 126: 177-185.

Bruinsma J (ed.) (2003). World agriculture: towards 2015/2030; An FAO perspective.: Earthscan Publications Ltd, Taylor & Francis Group. London & New York.

Chappell MJ & LaValle LA (2011). Food security and biodiversity: can we have both? An agroecological analysis. Agriculture and Human Values 28(1): 3-26.

COAG (2018). Agroecology: from advocacy to action. Discussion paper for the Twenty-sixth Session of the FAO Committee on agriculture on 1-5 October 2018. Rome.

CNS-FAO (2016). Working towards sustainable agriculture and food systems. Swiss National FAO Committee. Bern. https://www.blw.admin.ch/blw/de/home/international/institutionen/multistakeholder-partnerschaften/cns-fao.html.

De Schutter O (2010). Report submitted by the Special Rapporteur on the right of food, Oliver de Schutter. Paper presented in the sixteenth session General Assembly of the United Nations Human Rights Council. United Nations. A/HRC/16/49. Geneva. https://www2.ohchr.org/english/issues/food/docs/a-hrc-16-49.pdf.

Development Initiatives (2017). Global Nutrition Report 2017: nourishing the SDGs. Bristol, UK. http://globalnutritionreport.org/wp-content/uploads/2017/11/Report_2017-2.pdf.

Edwards MA & Roy S (2017). Academic research in the 21st century: maintaining scientific integrity in a climate of perverse incentives and hypercompetition. Environmental Engineering Science 34: 51-61.

European Commission (2013). Regulation (EU) No 1310/2013 of the European Parliament and of the Council. Strasbourg.

Fanzo J, Hunter D, Borelli T, & Mattei F, eds. (2013). Diversifying food and diets – using agricultural biodiversity to improve nutrition and health. Taylor & Francis Group. London & New York. https://www.bioversityinternational.org/e-library/publications/detail/diversifying-food-and-diets/.

FAO (2017a). The future of food and agriculture – Trends and challenges. Rome. http://www.fao.org/3/a-i6583e.pdf.

FAO (2017b). Food and agriculture: Driving action across the 2030 Agenda for Sustainable Development. Rome. http://www.fao.org/3/a-i7454e.pdf.

FAO (2018a). Agroecology Knowledge Hub. http://www.fao.org/agroecology/en/.

FAO (2018b), FAO's work on agroecology – a pathway to achieving the SDG's. http://www.fao.org/3/i9021en/I9021EN.pdf.

FAOSTAT (2018). www.fao.org/faostat/en.

Farrelly, M. (2016). Agroecology contributes to the Sustainable Development Goals. *Farming Matters*, *32*, 32-34.

Gliessman SR (2018). Defining Agroecology. Agroecology and Sustainable Food Systems, 42 (6): 599-600.

Gliessman, S. R. (2006). Agroecology: the ecology of sustainable food systems (3rd ed.). CRC Press, Taylor & Francis Group, London & New York.

Human Rights Council (2018). Draft declaration on the rights of peasants and other people working in rural areas. United Nations, New York.

https://www.ohchr.org/Documents/HRBodies/HRCouncil/WGPleasants/Session5/A-HRC-WG.15-5-3.pdf.
IIED (2015). Summary report of the high-level workshop on scaling up agroecology to achieve the SDG's. https://infohub.practicalaction.org/bitstream/handle/11283/594772/Agroecology_Workshop.pdf?sequence=1&isAllowed=y.
IFPRI (2016). 2016 Global Food Policy Report. International Food Policy Research Institute, Washington DC. http://dx.doi.org/10.2499/9780896295827.
La Via Campesina (2018). https://viacampesina.org/en.
Mäder P, Fliessbach A, Dubois D, Gunst L, Fried P, & Niggli U (2002). Soil fertility and biodiversity in organic farming. Science 296: 1694-1697.
Müller A, Schader C, Scialabba NEH, Bruggemann J, Isensee A, Erb KH, Smith P, Klocke P, Leiber F, Stolze M & Niggli U (2017). Strategies for feeding the world more sustainably with organic agriculture. Nature Communications 8: 1290.
Niggli U (2015). Incorporating agroecology into organic research-an ongoing challenge. Sustainable Agriculture Research 4(3):149-157.
Oakland Institute and AFSA (2018). Agroecology Case Studies. https://www.oaklandinstitute.org/agroecology-case-studies.
OECD (2003). Glossary. https://stats.oecd.org/glossary/detail.asp?ID=81.
Parmentier S (2014). Scaling-up agroecological approaches: what, why and how? Discussion paper. Oxfam-Solidarity, Belgium.
Pretty J, et al. (2018). Global assessment for agricultural system redesign for sustainable intensification. Nature Sustainability 1(8): 441-446.
Pretty J, Toulmin C & Williams S (2011). Sustainable intensification in African agriculture. International Journal of Agricultural Sustainability 9(1): 5-24.
Pretty, J et al. (2006). Resource-conserving agriculture increases yields in developing countries. Environmental Science and Technology 40(4): 1114-1119.
Pretty J, Morison JI & Hine RE (2003). Reducing food poverty by increasing agricultural sustainability in developing countries. Agriculture, Ecosystems & Environment 95(1):217-234.
Rosset PM, Machín Sosa B, Roque Jaime AM & Ávila Lozano DR (2011). The Campesino-to-Campesino agroecology movement of ANAP in Cuba: social process methodology in the construction of sustainable peasant agriculture and food sovereignty. The Journal of peasant studies 38(1): 161-191.
Schader C, Müller A, Scialabba NE, Hecht J, Isensee A, Erb KH, Smith P, Makkar HPS, Klocke P, Leiber F, Schwegler P, Stolze M & Niggli U (2015). Impacts of feeding less food-competing feedstuffs to livestock on global food system sustainability. Journal of the Royal Society Interface 12(113): 20150891.
Smolik JD, Dobbs TL & Rickerl DH (1995). The relative sustainability of alternative, conventional, and reduced-till farming systems. American Journal of Alternative Agriculture 10(1): 25-35.
Sonkin F (2017). Revaluing the marginal: an agroecological approach to waste in food production and consumption in Spain. Urban Agriculture Magazine 33: 70-71. https://www.ruaf.org/revaluing-marginal-agroecological-approach-waste-food-production-and-consumption-spain.
Sütterlin S, Reinig A & Klingholz R (2018). Food, Jobs and Sustainability. What African agriculture needs to achieve. Berlin Institute for Population and Development, Berlin. https://www.berlin-institut.org/en/publications/studies-in-english/food-jobs-and-sustainability.html.
Tittonell P (2014). Ecological intensification of agriculture—sustainable by nature. Current Opinion in Environmental Sustainability 8: 53-61.
TWN & SOCLA (2015). Agroecology: key concepts, principles and practices. Third World Network Penang, Malaysia & Sociedad Científica Latinoamericana de Agroecología (SOCLA), Berkeley, USA. https://foodfirst.org/agroecology-key-concepts-principles-and-practices/.
UNCTAD/UNEP (2008). Organic Agriculture and food security in Africa. United Nations, New York. https://unctad.org/en/Docs/ditcted200715_en.pdf.
UN (2017). General Assembly resolution Dec 2017. United Nations, New York. http://undocs.org/A/C.2/72/L.33/Rev.1.
UN (2018). United Nations Declaration on the Rights of Peasants and Other
People Working in Rural Areas. United Nations, New York. http://undocs.org/en/A/C.3/73/L.30
Uphoff N (2007). Agroecological alternatives: capitalising on existing genetic potentials. Journal of Development Studies 43(1): 218-236.
Wezel A, Bellon S, Doré T, Francis C, Vallod D. & David C (2009). Agroecology as a science, a movement and a practice. A review. Agronomy for Sustainable Development 29(4): 503-515.