Frequently Asked Questions

What you need to know about agroecology

Even though there is an increasing recognition of agroecological approaches in the international and national arena, and among public and private stakeholders, there remain many questions and misinterpresentations about what agroecology is and what benefits it can offer for sustainable food systems transformations. This sections provides answers to some of the most common questions and misperceptions about agroecology. The explanations are compiled from a vast collection of reports and publications, and aim to present scientific evidence. A list of literature can be found below.

Frequently Asked Questions

1. Can agroecology "feed" a growing global population?

A question often raised is whether agroecological farming can produce enough to nourish a growing population. Critics allege that a transition to agroecological practices will lead to lower yields. However, the current evidence base does not support this claim. Quite in contrast, comparative studies on different farming systems show that agroecological farming practices have the potential to sustainably increase yields[1–3]. Given the evidence, the controversy around the potential of agroecology to "feed" the world seems misguided.

For example, a meta-analysis on studies from a diverse set of countries found that on average, yields were 16% greater for agroecological practices as compared to conventional practices[3]. Similar effects have been found for conservation agricultural practices, which are often included in the definition of agroecology[4]. However, a distinction between short-term and long-term effects should be made. While the intensive use of synthetic fertilizers in conventional and industrial farming systems could achieve short-term yield gains, agroecological and conservation approaches aim to sustainably manage the natural resource base, which can result in higher yield gains over time[5,6].

Furthermore, there is robust evidence that agroecology has a competitive edge from a nutrition perspective. Thanks to a diversity of crops and the integration of livestock, it can lead to a more balanced diet and increased availability of micronutrients[7–13]. Climate change and other disruptive factors further shift the balance in favour of agroecology, as agroecological systems are more resilient to external shocks and stresses[14]. Consequently, in order to ensure food and nutrition security for all, a shift in global dietary patterns and improved reduction of food waste and losses remains pivotal[15,16].

2. Is agroecology a promising approach for climate change mitigation or adaptation?

Food systems maintain a bidirectional relationship with climate change. On one side, the increase in global temperature, rainfall variation and the frequency as well as intensity of extreme weather events add pressure on food production and heavily affect food security[17,18]. On the other side, industrial agriculture is one of the most significant sources of greenhouse gas emissions, and its intensification is likely to worsen global warming. Consequently, there is an urgent need to transform food production systems in order to ensure global food security without exacerbating climate change[19,20.]

There is robust empirical evidence that agroecology based approaches can strengthen climate resilience of smallholder farmers and foster a low emissions pathway towards sustainable food systems[14,21,22]. Three

components play a key role in this regard: first, agroecology promotes the diversification of food production systems building on an integrated approach between agro-pastoralism, agroforestry and landscape farming[1,23,24]. Through the availability of multiple livelihoods, diversification can buffer climate induced shocks for the farmers such as harvest loss from floods and droughts[14,18,25].

Second, agroecological practices can improve soil condition and fertility, for example by closing natural resource cycles and ensuring synergies between plants, forests and livestock[14,26]. Among other benefits, healthy soils allow for retaining water during droughts and provide enough nutrients for reasonable harvests over a mid- to long-term period when climate change is expected to acerbate farming conditions[14].

Third, agroecology fosters locally adapted solutions by putting participation and context-specific knowledge at the centre[27]. Thus, actors of local food systems are more agile and flexible to adapt to their locally changing conditions and can swiftly replicate climate proofed knowledge through peer-to-peer networks.

There is also a broad range of indirect socio-economic benefits that result from selective, transformative agroecology elements (e.g. human values, circular economy or food traditions). See a non-exhaustive list here. However, further scientific evidence is needed to underpin this dimension.

Regarding climate change mitigation, healthy soils have an increased capacity to absorb and capture carbon dioxide from the atmosphere[28]. However, temporality of such sequestration needs to be secured. Additionally, agroecology practices reduce the need for pesticide and synthetic fertilizer use[13], that cause significant emissions at their production and implementation stages (e.g. from NO2 leakage)[29].

3. Is there a business case for agroecology?

Sceptics of agroecology often question the economic viability of agroecological practices. Despite this common critique, current evidence points to the contrary. Agroecological farming can in fact be economically viable and more profitable than conventional farming practices, as results of a meta-analysis show. Furthermore, agroecological practices can strengthen the resilience of agricultural businesses, fostering long-term, sustainable profitability[3].

To analyse the economic profitability of businesses engaged in agroecology, one has to consider their *yields*, *prices* and *productivity*. As discussed in the answer to Question 1, there is sound evidence that agroecological farming can increase *yields* compared to conventional practices[1,3,4]. Empirical evidence on *productivity* and *prices* remains limited. However, a three-country study found that smallholder households practicing agroecology had higher productivities: 17% in Senegal, 32% in India, and between 26% and 48% in Brazil[30]. These productivity benefits stem from a reduction of external input use, which outweigh increased labour costs. The same study also found that agroecology increased net-incomes by between 14% and 49% through higher sales prices[30]. These effects are in line with results of a meta-analysis on conservation agriculture practices[4]. An important requirement to achieve higher profitability is access to price-differentiated markets that reward agroecologically produced crops[31].

Lastly, the *resilience* of production methods is an important determinant of long-term, sustainable profitability. Here again, agroecological practices have an advantage over conventional farming systems[31]. Their diverse multi- and intercropping designs are more resilient to pests, external shocks and climate change[3,14,22,32,33].

For a more extensive discussion, see Business Case section.

4. Is agroecology only suitable for smallholder farmers?

It is often assumed that agroecology can only work for smallholder and subsistence farmers, because it supposedly has no commercial potential. The existing evidence does not support this claim and shows that many agroecological farmers sell their produce on markets and can thereby achieve higher incomes[30]. As already discussed in the answer to Question 3 and in the Business Case section, there is clear economic potential for agroecology. Case studies from several countries show that agroecological farmers can in fact expand their production and increase net-incomes[13,30]. Furthermore, a study from Guatemala finds that the share of commercialized produce is significantly higher for agroecological farms than for the conventional comparison group[34]. This directly contradicts the notion that agroecological practices are unsuitable for commercial farmers.

Moreover, the practice of agroecology is not geographically limited to developing countries. A comprehensive review article finds that agroecology offers a "huge potential" and allows to achieve higher agricultural incomes in 13 European countries[35]. It should be noted that while many European farmers adhere to agroecological principles, only very few explicitly label themselves accordingly. This could potentially explain the skewed perception that agroecology is only applied by poor smallholders in the Global South. Finally, few examples do exist of large-scale commercial farming that follows the principles of agroecology and complex management, both in the Americas and in Europe[36]. A broad transition to agroecology in large-scale farming is possible although knowledge and research gaps remain important in this field.

5. Why is agroecology not yet widely adopted by farmers around the world?

Agroecological practices can help to reduce smallholder farmers' vulnerability to climate shocks, land degradation and price volatility[37]. In marginal and resource-poor environments, agroecology may even present the only viable option for food production. However, prevailing beliefs about the need to industrialize agriculture and political pressure from actors with vested interests result in persisting constraints that slow down the adoption of agroecology around the world[38].

On one side, IPES-Food[24] identifies a number of lock-in's that reinforce the prevailing mode of industrial farming, which many national governments still favour. Among others, these are the currently dominating sectoral path dependencies built on industrial production and the maxim of state strategies to export their agricultural products. Furthermore, subsidy programs for specific commodity crops, the expectation by consumers of cheap food, the focus on short-term productivity as well as compartmentalized and short-term thinking are major hurdles for alternative production systems to thrive. Finally, the existing dynamic of concentrated political and economic power is also a predominant reason why industrial agriculture is kept in place[24].

On the other side, agroecological practices are rather knowledge and management intensive[39]. This means that they need a large number of "soft inputs" and time-consuming labour, especially in the early stages of transition: they require a lot of social skills and coordination between farms in order to manage the landscapes holistically and efficiently. Furthermore, as agroecology is considered a long-term approach, with its full benefits and profitability only showing after several seasons, it can create trade-offs between farmers' short-term and long-term objectives. Consequently, immediate needs, together with insecure

land tenure and lack of access to natural resources can discourage farmers from adopting practices that require long-term investments[38].

In sum, the components that make agroecology such a promising approach, including its systemic thinking and its focus on long-term success, simultaneously create some of the main challenges for its implementation. Thus, mainstreaming agroecological practices requires reducing the polarisation between agroecology and intensive, high-input agriculture[14,24]. Agroecology should not be considered as an alternative that stands opposite to the prevailing production model but as a set of principles that can be integrated in intensive agriculture and which could help to reduce its negative environmental and social impacts.

6. Can agroecology halt the biodiversity crisis?

Evidence shows that biodiversity loss is happening at an alarming rate and is likely to be accelerating. It is predicted that before the middle of the century, a species loss compared to that at the age of the extinction of the dinosaurs will have happened[40]. Agriculture is one of the main causes for biodiversity loss, an analysis of IUCN red list data has shown[41]. Similarly, a review of empirical literature finds that intensification of agriculture in various forms is a main cause of farmland biodiversity loss[42]. This demonstrates an urgent need for alternative forms of agriculture that help to preserve biodiversity at local, regional and global level[40].

Literature reviews comparing conventional and organic agriculture in temperate climate found that organic agriculture is beneficial for biodiversity[43,44]. On average, the number of species is larger on both arable land and the land at the interface to the natural vegetation under organic than under conventional farming[45]. Another meta-analysis argues that, on average, species abundance is 50% higher in organic farming systems compared to conventional systems[42].

A common concern is that, although species richness is higher under agroecological practices, an adoption of agroecology will lead to increased agricultural land use and thus still lead to an increase in biodiversity loss. As shown under the answer to Question 11, the adoption of agroecological food production is unlikely to lead to a higher share of land dedicated to agriculture than under a business-as-usual scenario. On the contrary, it is becoming more and more clear that agroecological methods can offer both higher agrobiodiversity and higher overall productivity at farm level[38,46]. Additionally, biodiversity takes an important role in maintaining productive ecosystems[47,48]. Thus, changing to an agroecological food and agriculture system promises not only to be beneficial for biodiversity but also for productivity.

Agriculture has a key role to play in mitigating the biodiversity crisis as agriculture occupies more than 40% of the earth's surface[49]. It is hence crucial to adopt agricultural practices that protect biodiversity and agroecology can make an important contribution to this transformation.

7. Is agroecology an option to attract youths to a career in agriculture?

A key aspect of making food systems more sustainable and counteracting rural exodus is creating perspectives for the rural youth to work in agriculture[16,50]. From a theoretical perspective, agroecology has the potential to achieve this goal thanks to its knowledge intensity and explicit focus on social values such as equity and co-creation[51,52]. Since it is more labour intensive than conventional and industrial agriculture, it can create new jobs and income perspectives, thereby incentivizing young people to start a career in agriculture[16].

Existing experiences confirm this potential. Reviews of agroecological case studies find that peasant movements often train youth in agroecological practices as well as in leadership and political skills[6,53]. In Burkina Faso, for example, participatory knowledge accumulation in soil conservation techniques has led to the formation of new working groups, consisting of young men[54]. Moreover, an engagement of young people in peasant movements has been shown to increase the inclusiveness of the latter[55]. Lastly, agroecological practices play a vital role in increasing climate resilience, which is crucial for all generations but especially young people entering the agricultural sector since they will have to deal with the effects of the climate crisis for a longer time and more severely[14].

A recent report by the High Level Panel of Experts on Food Security and Nutrition (HLPE) explores ways to promote youth engagement and employment in the agricultural sector. It explicitly mentions agroecology as a key component and presents the success of certain agroecology in engaging youth. Finally, it recommends policies related to agroecological principles like participatory governance, agroecology transitions and other actions to preserve the natural resource base, certification and price premium programmes for agroecological, fair trade, organic and other social and ecological approaches as well as community-based research partnerships[56].

8. What is the difference between agroecology and other concepts of sustainable agriculture?

Sustainable agriculture is a very broad and loosely defined concept, based on the value to generate food and nutrition without compromising the economic, social and environmental bases of current and future generations. Consequently, there are many terms and practices associated with this idea[57]. Under the umbrella term sustainable agriculture, next to agroecology, we find many common concepts calling themselves sustainable, such as sustainable intensification, conservation agriculture, precision agriculture, regenerative agriculture, ecological agriculture, agroforestry, climate-smart agriculture, organic agriculture, fair trade, permaculture, bio-dynamic and food sovereignty to just name a few.

Truly sustainable and thereby transformative agriculture approaches recognize the need to holistically combine ecological, social and economic dimensions as well as creating an enabling environment to thrive

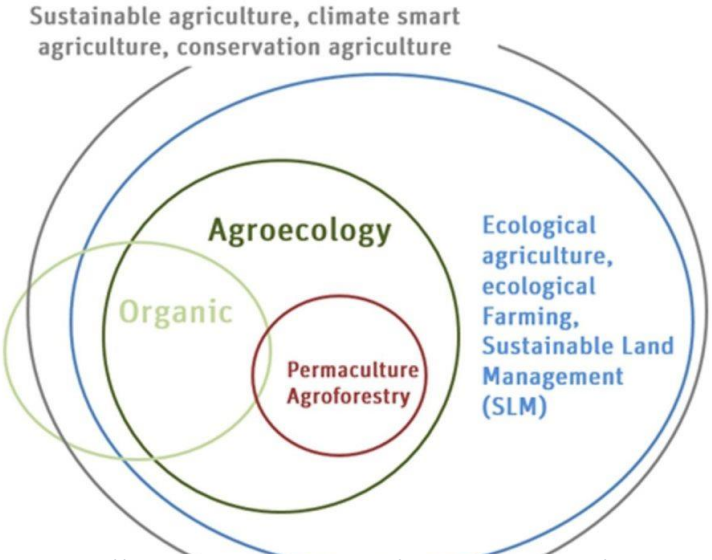

Figure 1 https://www.agroecology-pool.org/associated-concepts/

(governance). Agroecology, according to the current definition by FAO's 10 elements51 or HLPE's 13 principles[22] is such a holistic, sustainable approach.

Figure 1 presents a simplified understanding of the relationships between the most common sustainable agriculture approaches.
Some of these concepts overlap, some are nested in each other, while others only share a few principles. For instance, fair-trade is heavily focused on the social sustainability and employment conditions within farming systems[58], organic agriculture has a bigger emphasis on the ecological dimension by reducing external inputs and supporting market labels[59], while conservation agriculture has a very narrow focus on conserving soils[60].

9. Is agroecology able to reduce the health burden associated with the industrial food system?

The COVID-19 pandemic painfully highlighted the health risks posed by zoonotic diseases directly related to industrial globalized food systems[61,62]. The health burden caused by unsustainable agriculture and food systems is, however, far larger than that caused by zoonoses like H1N1, Ebola, Swine Flu and Nipah Virus alone and can be broadly grouped in three broad yet far from comprehensive categories:
Firstly, in the context of malnutrition in the developing world, one is talking of the triple burden[63]: Next to undernutrition, micronutrient deficiencies and overnutrition are also emerging in poor countries. The majority of the top-ten risk factors causing health problems globally, is directly diet-related[64]. Hunger is on the rise since 2015 and globally, over 2 billion people do not have regular access to safe, nutritious and sufficient food, despite the technological advances over the last decades. Undernutrition and obesity increasingly occur simultaneously in the same locations, not only highlighting the drastic inequity of our food systems, but also resulting in a dramatic health burden as the coexistence of overnutrition, undernutrition and micronutrient deficiencies take a dramatic toll on human populations around the globe[65].

A further category is occupational health and producer and consumer health related to pesticides and other agrochemicals: Hazardous chemicals and heavy machinery in combination with limited worker rights, make the agricultural sector one of the world's most dangerous sectors to work in[66]. Numerous health effects associated to pesticide use include dermatological, gastrointestinal, neurological, carcinogenic, respiratory, reproductive and endocrine effects[67]. Pesticide residues have been identified on nearly all conventionally produced foods and beverages. While the individual concentrations are in most instances within legal limits, synergistic effects between different pesticides and diverse environmental chemicals implies that the real health risks for consumers are strongly underestimated[68]. These issues are even more pronounced in many countries of the Global South, such as Kenya, where highly hazardous pesticides (HHPs) are widely used, often without adequate safety equipment[69].

Finally, food system-related environmental health issues[70,71]: A sheer endless list in this category encompasses highly diverse health hazards, such as (i) water pollution, due to nitrate and phosphorous runoff from excessive fertilizer use; (ii) zoonotic disease spill-over due to factory farming and destruction of natural habitats; (iii) spread of antibiotic resistance due to excessive antibiotic use in livestock; (iv) exposure to endocrine-disrupting chemicals (EDCs), ubiquitous in industrial food systems; (v) air pollution, for instance due to fertilizer production and application; and (vi) detrimental health impacts of climate change, which is to a large degree caused by industrial food systems.

Traditional food systems avoid many of the listed health issues, yet often fail to produce sufficient quantities of food for growing human populations. Agroecology combines the strengths of traditional knowledge and practices with the insights and approaches of diverse modern scientific disciplines. Thus, agroecology ameliorates the above-mentioned issues as follows:

Firstly, agroecology is highly productive over the long-term[3] but emphasizes dietary diversity and local food networks, ensuring access and availability of sufficient high-quality food for local populations taking cultural values and preferences into account[24,72,73]. Growing evidence suggests that agricultural diversity improves dietary diversity as well[9,11,12] and that in particular agroecological practices have a significant positive effect on dietary diversity[74]. Further studies confirm the positive effect of production diversity on dietary diversity. However, they find that access to markets is an even more important driver of dietary diversity[7,10,75,76]. Dietary diversity in turn has clear health benefits, for example through higher consumption of key nutrients[24].

Furthermore, agroecology emphasizes dignified working conditions and drastically reduces or eliminates the use of synthetic agrochemicals by optimizing synergies between diverse components of agroeco- and food systems[22,24,71].

Finally, agroecology mitigates environmental health issues by working with nature, using regenerative approaches, avoiding synthetic fertilizers and pesticides and increasing environmental resilience[13,14,71,77–79], which is argued to have a positive effect on health outcomes[80]. Furthermore, food produced without the use of chemical pesticides has been shown to contain more health-beneficial compounds like antioxidants or omega-3 fatty acids[24].

10. Is agroecology holding back modernisation of agriculture?

A common misconception is that agroecology is synonym of subsistence agriculture and is holding back progress in agriculture. On the contrary, it is a modern approach that promotes a transition away from poor subsistence farming toward redesigned functional agricultural systems in ways that maximize biodiversity, optimize interactions between different plants and species or connect farmers to markets[24]. See also Question 4.

Innovation plays a key role to achieve this transition[22]. It combines the strengths of traditional with the latest scientific knowledge to achieve the best results for farmers and consumers in a context-specific manner. Some central features of agroecological innovations are the emphasis on locally-generated innovation, local ownership of innovations, greater attention to institutional innovation and market mechanisms, in addition to technical improvements[82,83]. Specific methodologies have been developed over the years for promoting farmer innovation and horizontal sharing and learning. Still, agroecology does not overlook the importance of fundamental breakthroughs in technology, such as the advent of smartphones and other digital technology to scale up its transition, as long as those technologies are compatible with fundamental principles of sustainability, fairness, decentralisation or self-governance[22]. In this regard, the questions of how and by whom technologies are used and incorporated within local contexts are central for agroecological innovators[84]. For example, agroecological farming is perfectly compatible with a gradual and adequate mechanization of farming, within the boundaries of the needs, size and resources of peasants[85]. Technologies compatible with agroecology range from tailored watering, sowing, agro-equipment adapted to mixed crops, such as specialized machines for sustainable weed management or composting, open-source information tools such as crowdsourced soil data[86]. Putting

technology at the service of agroecology provides a real opportunity to enhance farming in harmony with ecological processes through knowledge development and sharing.

Hence, agroecology is above all a bright new vision of food systems that reconciles aspects of tradition and modernity, giving a prominent role to local innovators, formal and informal researchers and scientists of all disciplines and suggesting a more reflective and considerate use of low- and high-technologies.

11. Will an increased adoption of agroecology result in massive conversion of natural vegetation to farmland?

The underlying assumption behind this question is that agroecology produces lower yields, which in consequence cause an expansion of land under agricultural production in order to compensate for these yield deficits. This is a very common allegation, mostly raised by proponents of conventional, intensive agriculture[87,88]. While this is indeed a very important global aspect to consider - as we only have finite area to grow our food - this question needs to be looked at in a more integrated and differentiated way:
First, as pointed out in the response to Question 1 , while conventional and industrial farming may be more productive in the short-term, agroecological and conservation practises are able to produce higher yield gains over time[5,6]. This comparison might even be more favourable of agroceology if a higher amount of funding went into its research and the optimization of practices.

Second, this assumption is underlined by a production narrative that states that we have to produce even more and more food to feed a growing world population. However, it is not just production that must be addressed to address food security but also consumption. Our agricultural lands are not only used to produce food for human consumption, but to larger extents to produce feedstock for animal production as well as to produce biofuel crops[89,90]. If we want to protect our remaining natural habitats (and keep the climate crisis at bay), the industrialized world must eat less meat and cannot produce biofuels on fertile agricultural lands. In short, a transformation of the global agriculture to agroecology would certainly be insufficient, if we are not also changing consumption levels of meat[91].

Third, the claim completely ignores the negative long-term effects of today's unsustainable conventional production and practices, such as soil degradation, biodiversity reduction and other negative spill-over effects. Through these effects, conventional agriculture itself also leads to land expansion, in fact is one of the main causes today of deforestation and land expansion[24].

Fourth, the claim also ignores the fact that biodiversity can again thrive within agroecological landscapes, so a strict distinction of intensive production areas (dead zones for everything else) and protected areas for nature is misguided according to latest knowledge: Producing with nature instead of reworking landscapes to fit a maximum yield under standardized conditions (monocultures), is increasingly seen as the only way forward to accommodate food security needs and simultaneously protecting our natural resources[86,92].

Finally, the latest evidence also clearly points to the inverted effect: Agricultural production benefits significantly of including and fostering (Bio)diversity, it increases yield stability and the resilience of agricultural production. The reasons for that are manifold, key aspects are creation and maintaining of healthy soils, pollination plants, controlling pests, making nutrients available, purifying water, providing protection against both extreme weather events and price volatility, and delivering a range of other vital services[47,93].

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