TABLE Explainer

What is agroecology?

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TABLE

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Why should you read this explainer?

In response to concerns about global hunger and malnutrition, climate and environmental crises, and corporate consolidation in agri-food value chains, increasing numbers of stakeholders are arguing for agroecology as a way of providing healthy, nutritious food in an equitable and sustainable manner. This explainer provides an overview of the historical development and various definitions of agroecology and explores some of the major debates related to its use.

1. Introduction

Concerns about chronic hunger, malnutrition, climate change, biodiversity loss and environmental degradation have led to increased focus on the world's food system in recent years, with various actors putting forward different plans to tackle these interconnected issues. In this context, interest in agroecology has grown significantly, and it is now promoted by various social movements, policy makers, civil society organisations and intergovernmental bodies, including the United Nations' Food and Agriculture Organisation. Understandings and uses of agroecology vary however, and there is debate about different definitions of the concept. While some see it as essential for achieving sustainable, equitable and socially just food systems, others offer more fundamental critiques of agroecology as an approach to addressing interconnected food systems concerns. This building block provides an overview of the historical development and various definitions of agroecology and outlines some of the major debates related to its use.

2. What is agroecology? Historical context and definitions

Over the years, the term agroecology has been adopted by a multitude of actors across the world. Different stakeholders emphasise different aspects of the concept, understanding it – as we discuss below – variously as a science, a practice, a movement, or a combination of all three.[1]

2.1 Agroecology as a scientific discipline

The term agroecology began to be used in scientific publications in Europe and the US in the late 1920s, when scientists started to combine principles from ecology and agronomy in an attempt to better understand different agricultural systems.[1] Perceiving the field and the farm as 'domesticated ecosystems', scientists focused on the interactions between plants, animals, soils and climate to develop knowledge on, among other things, nutrient cycling, biodiversity and energy efficiency in crop production.[2] The science of agroecology initially focused on the environmental impacts of different productive systems at the scale of the field or the farm, and in certain contexts, for example Germany and parts of Europe, this is predominantly still the case.[1,3] In other parts of the world however, particularly the Americas, academic understandings of agroecology have broadened to incorporate 'the ecology of the entire food system'.[4] Many scholars working on the topic now reject purely scientific or technical understandings of agroecology, and instead promote a transdisciplinary, participatory, action-oriented approach combining insights from natural, environmental and social sciences.[5]

2.2 Agroecology as a(n alternative / oppositional) practice

As a practice and as a concept, agroecology has gradually expanded from a set of farming techniques, to a broader, more principles-based approach to agricultural development.

2.2.1 At the farm scale

Many of the farming techniques associated with agroecology have long been used by smallholder farmers around the world, or as part of other systems such as organic or biodynamic. The term agroecology however became popular in the 1970s and 1980s amongst agronomists and farmers seeking to improve and promote alternatives to industrial agriculture, due to their concerns about biodiversity loss, pollution and declining long-term yields. Various agronomists and farmers combined knowledge from traditional and indigenous farming systems and agroecological science to develop a set of farming techniques that would optimise production while minimising external inputs and

avoiding the degradation of natural resources[6] (*see Box 1* for more detail of the on-farm practices associated with agroecology). Agroecology became particularly popular in the global South, especially in Central and Latin America, amongst small-holder farmers seeking to improve their established farming systems at little extra cost, and to confront challenges such as soil erosion and climate disruption.[1,7]

Box 1. Key on-farm features of agroecology

Key on-farm features of agroecology	
Primary aims:	• Optimise the productivity, sustainability and resilience of agroecosystems • Enhance positive ecological interactions • Minimise reliance on external inputs • Conserve on-farm natural resources (water, soil, wildlife etc.) • Ensure efficient use of resources through recycling • Maintain and enhance the functional biodiversity of farming systems • Recognise and foster the multifunctionality of farming e.g. its nutritional, economic, social, and cultural role
Methods for achieving these aims:	• Complex or longer crop rotations (to improve soil health; control pests and disease) • Cover crops (to improve soil health; prevent soil erosion; control pests and diseases; modify microclimates) • Polycultures (to encourage complementary interactions; enhance yields) • Agroforestry systems (to encourage complementary interactions; enhance yields; prevent erosion) • Crop-livestock integration (to facilitate complementary interactions; provide organic matter; manage weeds) • Green manures (for soil health) • Natural irrigation systems (to prevent waste of water supplies; prevent erosion) • Minimal tillage (to limit soil disturbance) • Integrated pest and pollinator management • Production of food for human consumption rather than cash crops or industrial inputs

2.2.2 Moving from practices to principles

The practice of agroecology quickly expanded beyond a narrow attention to farm practices, in response to political and economic change. In many cases, rural poverty and inequality increased dramatically following the Green Revolution, with large numbers of farmers unable to afford the ongoing costs of agricultural inputs.[8] These problems worsened as food systems became increasingly globalised, and many smallholders struggled to compete with large-scale capital-intensive agriculture in markets flooded with subsidised products from industrialised countries.[9] In this context, the adoption of agroecology was often motivated by economic, as well as ecological, concerns: farmers sought to minimize inputs in order to reduce costs, and to diversify crop production in order to improve household food security and nutrition. Farmers worked alongside agrarian movements and civil society organisations (CSOs) to further improve the economic viability of smallholder farming, developing local markets and producer co-operatives to add value to produce and avoid prices set by large-scale processors and retailers in global markets.

Agroecology also became associated with specific educational and organisational practices. Agroecological techniques were developed through collaboration between agronomists and farmers and on-farm experimentation, and smallholders shared knowledge through field schools and farmer-to-farmer learning. These democratic methods

of knowledge exchange further distinguished agroecology from the Green Revolution, which was developed and implemented primarily in a top-down manner by national governments and large research institutes, with little input from farmers.[10] Indigenous farming systems informed many agroecological practices and agroecology often became associated with wider efforts to defend and revive indigenous cultures - for example local food varieties, seed saving practices and spiritual beliefs about "Mother Earth"[11] (*see Box 2* for more information on the link between agroecology and traditional farming systems).

Box 2. Agroecology and traditional farming systems: the milpa[12,13]

Figure 1: an example of the maize-bean-squash polyculture of the *milpa*. Photo by Nicholas Hellmuth, FLAAR Photo Archive of Flora of Guatemala. Reproduced with permission.

The *milpa* farming system is commonly cited as an example of a traditional farming system that uses agroecological techniques. It is a Mesoamerican method of agricultural production that is thought to have been in use for at least 9,000 years and is still widely used by small-holder farmers.[12] This system optimises interactions between plants by combining maize, bean and squash in a single area. The beans provide nitrogen, the maize offers structural support for the beans to climb and the squash prevents the growth of harmful weeds. Other combinations of domesticated and wild plants are also often incorporated into this polyculture, depending on the region. These three crops each play a different nutritional role, providing a variety of nutrients to ensure a balanced diet. In some cases, agroecological initiatives have built upon the traditional *milpa*, introducing techniques such as green manures, new nitrogen fixing crops and soil conservation techniques in order to further optimise production or regenerate degraded natural resources.[13]

The practice of agroecology thus developed in response, and as an alternative, to a particular political economic context, and specific set of social and power relations. Over time, it expanded its focus and evolved into a broader, more principles-based approach, prioritising democratic methods of governance and knowledge exchange, economic diversification and solidarity relations, and respect for diverse cultures and traditions. As can be seen in the FAO's definition of agroecology (*see Box 3*), such principles are important to current understandings of agroecology, including those promoted by more mainstream actors.

Box 3: FAO 10 Elements of Agroecology[14]

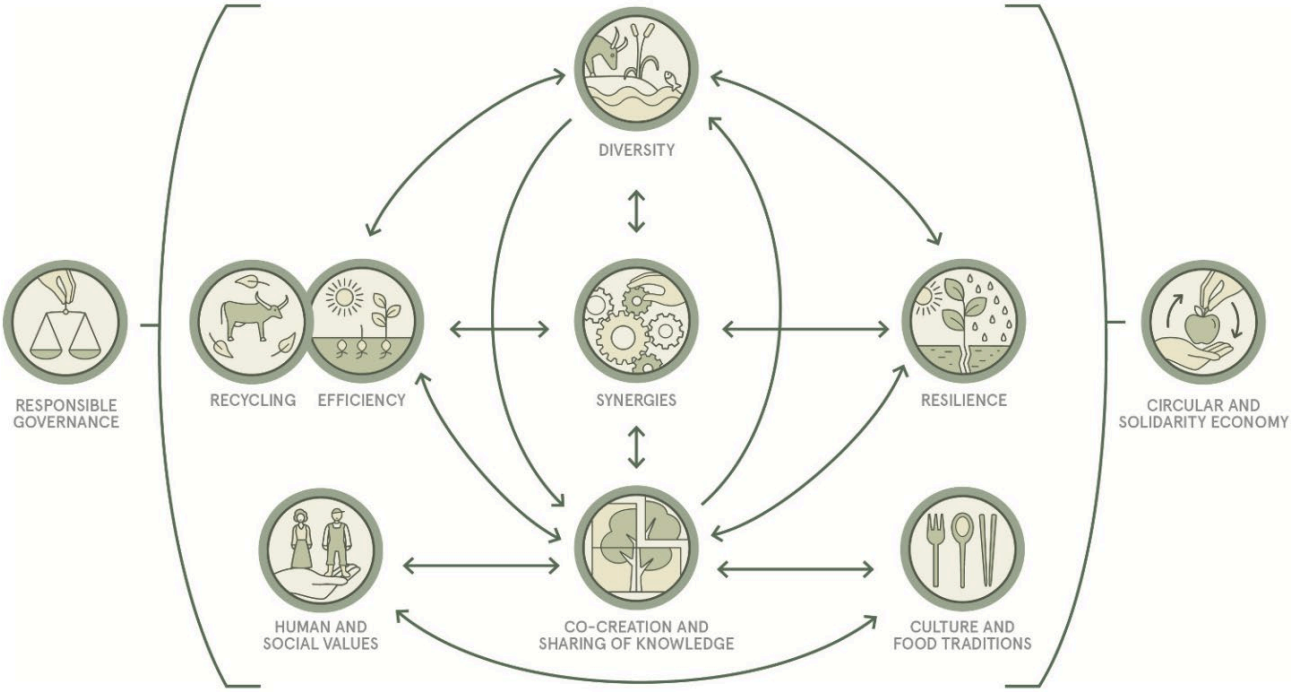

Image reproduced from FAO (2018).[14]

2.3 Agroecology as a movement

During the 1980s and 1990s, many of the farmer organisations, academics and NGOS promoting agroecology united in their rejection of structural adjustment policies and neoliberalism and began to combine agroecology with political campaigning on trade and agriculture policies at a national and global scale. Agroecology thus became associated with wider collective efforts for change, and a form of 'politically engaged agroecology'[2] or 'agroecology as a movement' emerged.[1]

This is particularly evident in the way that La Vía Campesina (LVC), a transnational peasant movement, promotes agroecology. LVC describes agroecology as 'a key form of resistance to an economic system that puts profit before life' and perceives it as the means for achieving food sovereignty[16] (see our explainer What is food sovereignty?). This association of agroecology with food sovereignty unites different initiatives and actors (from small-scale farmers in the global South to academics in the global North) behind a vision of democratic, equitable and just food systems based on agroecological small-farm production.[16,17] For many activists promoting it as a movement, agroecology is inseparable from a particular set of values and priorities, including the expansion of collective rights and the commons; racial and gender equality; respect for diversity; and the rejection of anthropocentric worldviews and solely technological- or market- based responses to problems.

Agroecology's broad definition, as a science, practice and movement, reflects the different interests and needs of the multiple farmers, agronomists, scientists, social movements and CSOs who have contributed to its development. Interest in agroecology can therefore be motivated by a wide variety of concerns, including a desire to transform the global food system and address global injustices; to re-valorise and share traditional and indigenous knowledge; to ensure the economic viability of smallholder farming; to improve household nutrition; to address concerns about the environmental effects of industrial agriculture; to help conserve on-farm natural resources; or to study and optimise interactions occurring within agroecosystems.

3. Contentious issues

Due to its conceptual breadth, there has been much debate among the various actors involved about what agroecology is, or ought to be, and its relation to other ideas for food systems change. Agroecology also receives criticism from sceptics outside the movement, who question agroecology's potential to produce enough food for a growing population and who challenge some of the assumptions underlying claims that agroecology will generate more socially just food systems. The following subsections explore some of these debates and contestations.

3.1 Contentious issues: who defines agroecology? And how far reaching is it?

Many people draw attention to the ways in which approaches to agroecology shift according to the values and priorities of different actors.[18] As agroecology gains a wider following, questions therefore increasingly emerge about possible tensions that might arise in agroecology's application and the ways in which it interacts with other practices and scales as it evolves. To what extent, for example, must farmers adhere to the multiple elements of agroecology in order to describe their farm as agroecological? Can farmers producing for commercial export markets, subcontracted by large-scale retail or processing corporations, or renting land from large financial institutions be classified as agroecologists, if they use on-farm agroecological practices? And what of farmers who promote local food systems and methods of exchange, but utilise chemical inputs in certain circumstances?

Social movements and affiliated academics often distinguish between the 'reformist' or pragmatic approach of more mainstream organisations, and 'radical' or transformative understandings of agroecology that focus on agency, democracy, equity, and political and economic transformation.[19] They are often particularly critical of actors that approach agroecology merely as a technical tool or set of agronomic techniques. They vehemently reject, for example, the increasing use of the term by large corporations, whom they accuse of choosing particular elements of agroecology to mitigate the food system's worst environmental and social impacts, so as to continue 'business as usual'.[15,20]

Many agroecologists also oppose suggestions that agroecology could contribute to **sustainable intensification** (SI) (see our explainer What is sustainable intensification?) or **climate-smart agriculture** (CSA) if combined with other practices, including chemical inputs and genetically modified crops. This use of agroecology is increasingly popular, particularly in Europe and the UK,[21,22] and some people suggest that supporting only transformative, principles-based approaches to agroecology might limit the adoption of agroecological practices.[23] However, social movements and affiliated activist-academics claim that it is essential to defend such understandings of agroecology if it is to maintain its transformative potential. They denounce SI and CSA for failing to explicitly address the socio-economic and power inequalities of the food system, and suggest that the use of expensive technologies will maintain corporate control of agri-food systems and extractive, environmentally-harmful approaches to nature.[11]

The on-farm practices of agroecology and organic farming are often very similar. Many people therefore perceive organic as a 'legally defined and proven agroecological approach', that regulates agroecological practices by using legal standards and certification to enforce the removal of chemical inputs.[24] As with agroecology however, many people distinguish between different approaches to organic.[25] They suggest that broad versions of organic (which aim to achieve low-input farming through the recycling of resources within the farming system, and transform socio-economic structures and relationships with nature) share many similarities with agroecology. However, they also highlight that in some cases, particularly in the US, organic has been reduced to a much narrower understanding, that allows farms to simply substitute chemical pesticides and fertilisers for non-chemical inputs, in order to meet certification standards and achieve market premiums.[26] Agroecologists are keen to distinguish agroecology from these narrower forms of organic, suggesting that they maintain monocultures and large-scale land ownership and fail to truly transform agricultural practices.[27] Debates within the organic movement thus mirror discussions about

different definitions of agroecology, with concern that both concepts might be co-opted by agri-business in response to growing market opportunities.

3.2 Contentious issues: can agroecology feed the world?

With agroecology increasingly cited as a tool for reducing or eliminating global hunger and malnutrition, agroecology's ability to feed a growing global population has become a source of much debate. As we discuss below, people engage with the question of 'feeding the world' in different ways: while sceptics focus on productivity and agroecology's ability to 'scale up', proponents of agroecology emphasise resilience, equity and nutrient security, and agroecology's role in achieving these goals.

3.2.1 Is agroecology less productive?

There is little research on yields from farming initiatives explicitly defined as 'agroecology',[13] and findings have been heavily contested.[2] Studies of productivity in organic farming are relevant, however, due to the similar practices used. Research has often suggested that industrial agriculture produces approximately 20% higher yields than organic farming for a given area of land used.[28,29] The productivity of different farming systems is nevertheless highly contextual and depends greatly on the region, timeframe, crop type, methods, and measurement processes in question. Some people suggest that studies tend to over-estimate the productivity of organic agriculture, as they often fail to account for the land or cropping seasons needed to produce green manure, that might otherwise have been devoted to food production.[30] A variety of other studies however are more optimistic about organic farming's productivity: they find the yield gap to be less significant for certain crops (e.g. fruit and oilseeds); when 'best' organic practices are used (i.e. agroecological techniques such as crop rotation and multi-cropping); and when total outputs, rather than the yield of specific crops, are compared.[31,32,33] They also highlight organic agriculture's ability to maintain yields consistently over longer time periods and in the face of environmental stresses, particularly drought.[34] Much research highlights the potential for organic farming techniques to dramatically increase agricultural productivity as compared with baseline yields in countries with large numbers of marginalised smallholder farmers. These studies suggest that agroecological methods are generally low-cost, easily accessible and familiar to farmers already employing similar techniques,[35,36,37] however, some scientists contest the possibility of improving soil fertility through organic methods in heavily depleted soils, for example in Sub-Saharan Africa.[38] Many people emphasise that organic yields would increase further if organic farming were to receive the same level of research, investment and subsidies that conventional farming has to date.[31]

3.2.2 Moving beyond productivity – what is enough?

In response to debates about productivity however, agroecologists highlight the need to move beyond a narrow focus on yield to look at the diverse benefits of agroecology and the wider changes needed in the food system. They emphasise for example the importance of food's nutritional quality, the social and environmental conditions associated with its production and distribution, the ability of different farming systems to endure environmental and climate disruption, and the role that farming must play in generating fair and sustainable livelihoods (i.e. providing income to cover services such as health care and education and/or ensuring access to necessary natural resources such as firewood and medicinal plants).[33] Proponents of agroecology also point out that hunger and malnutrition, at least at the global level, do not result from a lack of available food but from inequitable and unsustainable patterns of distribution and consumption. They therefore emphasise the importance of political and economic change, as well as changes to production.[15,16] Indeed, comparisons of industrial and agroecological food systems that account for changes in diet (particularly the reduction of grain-fed livestock, i.e., pigs and poultry), food waste, and industrial crop usage, find that agroecological farming can produce enough food for a growing population, and can do so in a

sustainable and equitable manner.[39,40]

3.2.3 Can agroecology 'scale up'?

It is widely recognised that, if agroecology is to play a significant role in the food system, it will need to 'scale up and out' (i.e. be applied on a larger scale, such as on larger farms, and/or over a wider area, on more small-scale farms).[41] Agroecologists emphasise how farmer-to-farmer networks, NGOs and agrarian movements have dramatically increased the uptake of agroecological practices, particularly amongst smallholders in the global South.[10,42] Many actors continue to build on this tradition and adopt a 'bottom-up' approach to scale out agroecology.[43]

It is less clear however how agroecological practices might be used on large farms reliant on agricultural machinery and a small workforce, given that diversified production tends to require a high input of labour and is not easily supported by machinery designed for standardised cropping systems.[44] This suggests that while agroecology could easily be 'scaled out' in areas with large numbers of small farms (or with a large rural population ready to farm following land redistribution) or perhaps be 'scaled up' in areas with a rural workforce able to provide labour on large agroecological farms, it might be less appropriate in areas with smaller rural populations or, as is discussed below, if people object to labour intensive work.[44] Critics draw attention to increasing rural-urban migration to question the viability of agroecology. However, agroecologists challenge assumptions about the inevitability of continual urbanisation, and suggest that agroecology can provide rural livelihoods and therefore stem or reverse migration from rural areas.[9]

Sceptics also highlight the difficulties of 'scaling out' agroecology, given the potential complexity and inefficiency of distributing produce from multiple small farms on a wide scale in urban areas.[45] In response to such critiques, agroecologists reflect on the food systems that might be developed if agroecology were to receive the high levels of state and private sector resources mobilised during the Green Revolution.[46] They point to cases such as Cuba and India,[47,48] where government support for agroecological food systems has increased the uptake of agroecology, and facilitated the emergence of local markets for the sale of domestically produced staple crops (although there is debate about the extent to which these have improved access to affordable food amongst urban populations).[49,50] Agroecologists also highlight the successes of social movements and CSOs in creating territorial rural-urban food networks[42,51] and developing plans for circular city-region food systems that facilitate food distribution in urban areas and the use of urban waste on farms.[52,53]

3.3 Contentious issues: can agroecology generate a more equitable food system?

Proponents of agroecology, particularly transformative agroecology, present a vision of equitable, inclusive food systems, based on the principles of food sovereignty - 'dignity, individual and community sovereignty, and self-determination'.[54] They highlight the role that agroecology can play in achieving these ideals, by addressing socio-economic inequalities and power imbalances in a food system dominated by large-scale agri-business.

Agroecologists emphasise the economic advantages of agroecology for smallholder farmers and the role that agroecology can therefore play in addressing corporate control of agri-food value chains.[9] Initial studies suggest that agroecology improves farmer incomes and generates rural livelihoods and economies, allowing smallholder farmers to remain in rural areas and maintain agricultural ways of life.[55,56,57] Agroecologists also highlight how agroecology's democratic and inclusive methods of knowledge exchange and social organising facilitate the inclusion of indigenous communities and minority groups. They emphasise the importance of such processes for people whose practices and values have often been marginalised by mainstream agriculture and development programmes imposed by policy makers or development practitioners.[11]

There are undoubtedly, however, many complexities and challenges involved in generating social movements and food systems that benefit multiple different people and communities. There has sometimes been a tendency for the agroecology and food sovereignty movements to overlook such complexities, and present a simplified and idealised understanding of peasants and family farmers.[58] Many within the movement however increasingly acknowledge the diverse, and potentially conflicting, interests of different types of food producers (e.g. landless people working for wages, peasants producing for local markets, or middle-sized family farmers producing for global export) as well as the various gender, racial and ethnic inequalities that permeate rural societies.[59,60] Addressing these complexities remains a challenge for the agroecology and food sovereignty movements. Efforts are, however, being made to ensure that the benefits of agroecology are widely shared, by broadening the movement's membership base and promoting land reform and gender equality as core components of agroecology.[16]

Some critics however are less convinced of the benefits of agroecology, and question whether this approach really is desirable or beneficial for smallholders. They draw attention in particular to the high labour input associated with agroecological farming and suggest that agroecology ties people to poverty-stricken and labour-intensive rural livelihoods. They suggest that this is particularly problematic for women, who often undertake additional farm work.[2,61] These critics promote alternative visions of rural development instead, suggesting that non-agrarian livelihoods might be preferable for smallholders,[58] or that smallholders lives will be best improved by agricultural modernisation, improved technological inputs and better access to global markets.[61,62]

Some people also express concerns about the impact that agroecological food systems would have on consumers, particularly marginalised, less affluent communities. Agroecological food could be more expensive, as fair returns for farmers often result in higher prices for consumers. Moreover, dietary changes associated with agroecology (e.g. reduced meat, sugar and processed food consumption)[39,40] might disadvantage some people more than others, as reliance on processed food often stems from a lack of financial (and other) resources, and many people in less wealthy countries are only beginning to incorporate meat into their diets as incomes increase.[63] Agroecologists however suggest that the wider socio-economic and political changes associated with agroecology would help confront many of these issues. Government support for agroecology, for example, would reduce profits for agro-industry and marketing of processed foods, and therefore help avoid major food price rises while also reducing dependence on or preference for processed foods.[63,64] People also suggest that global disparities in meat consumption can be addressed through reduction in historically high consuming nations, thus allowing for increases in meat consumption elsewhere.[65]

3.3 Contentious issues: environmental sustainability and the question of working with nature

Advocates of agroecology suggest that farming practices that avoid chemical inputs, foster on-farm biodiversity and 'work with' nature are better for the environment than industrial agricultural practices. However, some critics challenge these assumptions.

3.4.1 What are the environmental impacts of agroecology?

Agroecologists argue that there are multiple and connected environmental benefits to agroecology, particularly compared with industrial farming methods. They emphasise the role that agroecology can play in tackling soil erosion and degradation; avoiding pollution associated with the use of pesticides and fertilisers; sequestering carbon; and reducing greenhouse gas emissions and reliance on fossil-fuel inputs (through a reduction in on-farm machinery, long-distance food transportation, and energy-intensive off-farm processes e.g. the production of ammonia).[21,66] Although it is very difficult to measure the impact of different agricultural practices on atmospheric carbon,[67] various studies highlight the role that agroecological practices such as agroforestry, cover crops and the inclusion of native

vegetation and perennial crops, can play in sequestering carbon and reducing emissions.[68]

Some people worry however about the indirect impact that agroecology could have on biodiversity, particularly on specialist species, whose numbers tend to decrease in agricultural landscapes.[69] In what is often framed as a choice between 'land sparing' and 'land sharing' critics express concerns that agroecology, and other low-input types of agriculture, would use more land than necessary for agri-food production, particularly once the production of green manure is considered)[30] (see our explainer on What is the land sparing-sharing continuum?). They suggest that higher net levels of biodiversity would be achieved by employing higher yielding practices, which could, in theory, release more land for dedicated conservation and carbon sequestration efforts elsewhere, for example through afforestation or rewilding (see our forthcoming explainer on rewilding).

Many people, however, criticise the limited focus on biodiversity and yields in 'land sparing' / 'land sharing' debates, and the emphasis placed on the intrinsic value of conserving wild species.[70] Such commentators highlight the importance of other natural resources provided by sustainably managed agroecosystems, such as clean water, soil health and carbon sequestering landscapes.[71] In particular, agroecologists emphasise the importance of *agricultural* biodiversity, highlighting the role that diverse agroecosystems play in increasing resilience to climatic stresses and pests and diseases, and in ensuring that farming systems can be adapted to local ecological niches.[66] Moreover, many people challenge assumptions that agroecology would require the conversion of more land for farming, suggesting that truly agroecological systems (based on changes to diet, food waste, use of crops for feed and fuel and perhaps wider political economic changes) would allow for both agricultural biodiversity *and* land spared for nature.[39,71,72]

3.4.2 (How and why) should we work with nature?

The desire to work with nature and build upon ecological processes is fundamental to agroecology (and also to related agricultural practices such as organic and regenerative agriculture).[7] Rather than centring the design of agroecosystems on human (or market) demand, agroecologists draw on a detailed understanding of the ecosystems and natural resources of different contexts, aiming to promote and modulate interactions taking place within natural communities to deliver a range of functions and services.[73]

Some critics however contest the value of working with or mimicking nature, questioning in particular the ecological thinking upon which agroecology is founded. Drawing on Darwinian evolutionary biology to suggest that natural selection happens only at the level of individual species, not ecosystems more widely, they undermine conceptions of ecosystems as 'superorganisms' and question whether natural communities have the capacity to organise themselves to reach a state of equilibrium or improve over time.[74] Concluding that 'evolution has improved trees much more consistently than it has improved forests' they suggest that attempts to build on the interactions of ecosystems are misguided, and that the study (and improvement) of individual plants and animals would be more worthwhile.[74,75]

This Darwinian focus on individual components of the natural world, however, is the subject of growing critique. Increasing numbers of scientists and social theorists focus instead on mutualistic and symbiotic relationships within natural communities, highlighting examples such as pollination and fungi-plant relationships to demonstrate how certain components of ecosystems construct ecological niches and provide essential services that allow other organisms to flourish.[76] Such scientists suggest that although ecosystems are fluid and contingent and might not have as powerful an optimisation mechanism acting upon them as natural selection, they also undoubtedly possess features that promote their ability to reproduce, adapt and sustain themselves over time.[77] This resilience is particularly valued by agroecologists. They emphasise that while ecosystems might not maximise productivity, they sustain themselves in the face of serious disruption, and in this sense, provide a useful model for agriculture.[78] This kind of thinking provides the foundation for the increasing interest in soil biodiversity and symbiotic relationships within soil ecosystems, which increasingly informs work on agroecology, regenerative and organic farming and has been taken up by global bodies such as the UN FAO.[79]

Although there is debate in the scientific community about how ecosystems organise themselves and evolve, it seems that disagreements about the value of working with nature often arise due to different priorities for agricultural systems. While sceptics primarily value productivity and efficiency,[74] agroecologists highlight the importance of resilience and long-term stability.[78] They therefore disagree on which features of the natural world farmers should choose to encourage and build upon, and on the extent to which examples derived from the study of ecosystems might be usefully applied in agriculture.[75,78,80]

4. What future for agroecology?

In the context of concerns about our current climate crisis and increasing corporate consolidation in agri-food value chains, increasing numbers of stakeholders are arguing for agroecology as a way of providing healthy, nutritious food in an equitable and sustainable manner. Certain aspects of agroecology now feature in food policy dialogue, particularly in Europe and the EU, and elements of agroecology, for example farmer learning practices, are being used to encourage transitions towards more sustainable, resilient farming systems. However, as both critics and proponents of agroecology point out, there are still questions about the ways in which agroecology could and should relate to technological change, global trade and corporate agriculture. There is also uncertainty about the viability of agroecology on a larger scale given its dependence on changes to political and economic processes, consumption habits and rural-urban dynamics.

In their efforts to generate significant food system transformation, agroecologists sometimes avoid these complex questions and reject all but the most far-reaching and radical understandings of agroecology. While such definitions of agroecology might be useful as a political tool, they can also make agroecology vulnerable to criticism from sceptics who perceive it as a dogmatic movement that restricts smallholder farmers, based on an ideological opposition to technology, modernisation and capitalism.[61] This said, these more simplified, oppositional understandings of agroecology do not necessarily reflect the complexities of its use on the ground. As many agroecologists increasingly recognise, transitions 'are often messy, chaotic and non-linear' and are highly context-specific.[81,82] It therefore remains to be seen how agroecology will be shaped by the increasingly diverse array of actors involved; the extent to which it will overlap with, or be surpassed and superseded by, other plans for food systems change; and what kinds of sustainable food futures it will foster.

Glossary

Agroecology

Agroecology is commonly understood as a science, a practice and a movement. As a science, it uses principles from the field of ecology to study the interactions between organisms in agroecosystems. It is often associated with transdisciplinary and action-oriented research, and the study of the entire food system. As a practice, agroecology combines indigenous and traditional knowledge, and scientific research, to generate productive, sustainable and resilient farming systems with minimal external inputs. This is achieved by optimizing processes and interactions occurring within agroecosystems, for example through crop rotations, cover crops, polycultures, crop-livestock integration, agroforestry and minimal tillage. It is generally associated with smallholder farming, and focuses on the production of nutritious food suitable for personal consumption and local markets. As a movement, agroecology seeks to address power imbalances within the food system, and generate a more just and equitable food system based on the principles of food sovereignty.

Agronomy

Agronomy is a science and practice seeking to understand and improve the cultivation of plants for food, fibre and fuel. Agronomists focus on a variety of factors relating to crop production, including yield, disease, climate and soil.

Anthropocentrism

Anthropocentrism literally means human-centred. It refers to a philosophy and worldview that bases moral worth on the capacity for analytic thought and judgement, and therefore sees humans as separate from and distinctive to the rest of the natural world. In some cases, this thinking is associated with the perception that nature only has value in the extent to which it can be exploited to meet human needs. It is often suggested that capitalism and western liberal democracy are informed by an anthropocentric worldview, and some people blame anthropocentrism for climate and environmental crises and the depletion of natural resources.

Biodiversity

Biodiversity refers in the broadest sense to the variety and variability of living organisms in a particular area, or on earth in general. More specifically, the concept is used to denote different aspects of the variety and variability of life, e.g. the number of species in an area (species richness) or the size of species' populations (species abundance). Biodiversity is measured in different ways and at various scales from the genetic through to the landscape level.

Biodynamic agriculture

Biodynamic agriculture is a form of agriculture rooted in the ideas of German philosopher Rudolf Steiner, promoting holistic approaches to farm management, and the use of ecological methods rather than chemical inputs. Its on-farm practices overlap significantly with organic methods. However biodynamic practitioners also emphasise spiritual and mystical elements of human/nature relationships and many use astronomical calendars to guide sowing and harvesting, and fermented herbal remedies to promote plant and soil health and healing.

Climate-Smart Agriculture

Climate-Smart Agriculture (CSA) was first introduced by the FAO in 2010 as an integrated approach geared at reorienting and redesigning agricultural systems to address and build resilience to climate change, and is often discussed in the context of low-income countries. CSA involves three interconnected elements: increasing agricultural productivity and incomes; adapting and building resilience to climate change; and the mitigation of greenhouse gas emissions. It aims to identify context specific agricultural strategies supporting these elements and guide coordinated actions among stakeholders (e.g. farmers, researchers, private sector, civil society and policy makers) from the farm to the global level. CSA is criticised for justifying nearly any form of agriculture (thereby 'greenwashing' unsustainable practices) and for failing to address enduring inequalities in food production and distribution. CSA is closely related to the concepts of sustainable intensification and ecological intensification but differs from them in its strong focus on planning and implementation for climate change adaptation and mitigation, and less on reducing

environmental impacts beyond emissions.

Cover crops

Cover crops are crops that are grown with the purpose of protecting or improving the soil, rather than for harvest. Cover cropping can prevent soil erosion, improve soil fertility and quality, and help prevent pests and diseases. This practice can reduce the need for chemical inputs and is commonly associated with agroecology, regenerative agriculture and organic farming.

Crop-livestock integration

Crop-livestock integration refers to the practice of combining the cultivation of one or more crop with at least one type of livestock. This integration is designed to reduce reliance on external inputs, as the crops provide feed for the animals, and the animal manure provides nutrients that foster crop production. Integrated crop-livestock farming is associated with agroecology, regenerative agriculture and organic farming.

Crop rotation

Crop rotation is the practice of growing different types of crops in sequence across the same area of land. It is designed to optimize nutrients in the soil, improve soil health, and counter pressure from pests and weeds. This practice can reduce the need for chemical inputs and is commonly associated with agroecology, regenerative agriculture and organic farming.

Ecology

Ecology is a field of science that studies the interactions and connections between plants and animals and their natural environment.

Farmer field schools

Farmer field schools allow farmers to acquire skills and knowledge through participatory and hands-on learning. They are designed to facilitate experimentation and discussion amongst farmers and to encourage the uptake of more sustainable production practices. This approach is favoured by the UN FAO, and has long been an important feature of agroecology movements.

Food sovereignty

Food sovereignty is a political movement that emphasises the rights of food producers, distributors and consumers to have control over the food system, as opposed to coorporations and market institutions. It has been defined as the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems.

Green revolution

The Green Revolution was an agricultural modernisation programme in the 1950s and 1960s that promoted the widespread adoption of fertilisers and pesticides, agricultural machinery and higher-yielding varieties of maize, wheat and rice around the world, particularly in Latin America and Southeast Asia. It was led by the US government along with the Rockefeller Foundation and the Mexican government, and was further promoted by development agencies, agronomists, and policy makers. Different reasons are attributed to its widespread promotion, including concerns about increasing food supplies to meet the demands of a growing global population, worries about rural unrest in the context of the Cold War, and a desire to expand farm input markets. The impacts of the Green Revolution are a topic of much debate. Proponents who seek a new 21st century Green Revolution highlight its role in increasing agricultural yields in Asia and Latin America; critics, on the other hand,emphasise that it did not effectively tackle hunger and malnutrition and that it resulted in environmental degradation, serious social inequalities and unhealthy dietary change.

La Via Campesina (LVC)

La Via Campesina (LVC) is a transnational social movement, made up of 200 million people across 81 nations. It was

formed in 1993 by peasants and smallholder farmers from around the world in response to the negative impacts of trade liberalisation and diminishing state support for small-scale agriculture. It has since grown to include landless people, rural women and youth, indigenous people, migrants and agricultural workers. LVC has played a key role in the food sovereignty movement, leading protests against global free trade agreements and promoting agroecology and smallholder farming. LVC has a decentralised structure, made up of multiple autonomous organisations, and prioritises inclusivity and democratic decision making.

Malnutrition

Malnutrition refers to deficiencies, excesses, or imbalances in the energy, macronutrients, or micronutrients that a person obtains. This is either because their diet is lacking or because their body is not able to fully absorb the nutrients from the foods eaten, e.g. due to illness. Malnutrition is an umbrella term that includes overnutrition (an excess of food energy), undernutrition (a lack of food energy and macronutrients such as protein), and micronutrient deficiencies (insufficient micronutrients such as iron, vitamin A or iodine).

Minimal tillage

Minimal tillage, no-till, or zero-tillage farming, refers to the farming of crops without disturbing the soil through tillage. Tilling methods include such activities as shovelling and ploughing or the use of cultivators to crush clods and smoothen the soil. Zero-tillage farming requires fewer machinery inputs and related energy use, and often less human labour per unit of output. Tillage is used to eliminate weeds, and zero-tillage farming is often associated with higher pesticide and herbicide levels. Zero-tillage farming is particularly associated with the production of genetically modified crops and the use of glyphosate-based broad-spectrum herbicides such as Roundup that kill many different types of weeds.

Neoliberal economic policies

Neoliberalism is an ideology and a political and economic policy model that emphasises the importance of freedom from state intervention, the privatisation of public goods, and the primacy of economic growth and free market competition. Neoliberal policies were championed in the 1980s by US President Ronald Reagan and UK Prime Minister Margaret Thatcher – these policies included cuts to state spending and efforts to promote economic growth by privatising public services and deregulating the corporate sector. Neoliberal thinking has since gained traction amongst many national and global policy makers, and in the 1980s and 1990s led by the World Bank and International Monetary Fund to promote economic restructuring in countries around the world. More recently however, neoliberalism has received various levels of criticism. The 2008 financial crisis for example has prompted many economists and policymakers to call for greater government regulation of the financial and banking sectors. Although neoliberalism is recognised for increasing the wealth of certain portions of the world's population, it has also been responsible for widening socio-economic inequalities and worsening climate and environmental crises. Debates about the value of economic growth and the ability of markets to efficiently and fairly allocate resources are therefore ongoing.

Organic farming

Organic farming is an approach to farming in which synthetic chemical insecticides and herbicides and inorganic fertilisers are entirely or largely avoided. Underpinning organic farming is the idea that farming should rely on ecological processes, biodiversity, and cycles adapted to local conditions, rather than the use of inputs with adverse effects (e.g. agrochemicals such as pesticides and synthetic fertilisers). Certification bodies (e.g. the Soil Association in the United Kingdom) specify the practices, methods of pest control, soil amendments, and so forth that are permissible if products are to achieve organic certification.

Polycultures

Polycultures consist of cultivating two or more crops (or animal species) on the same piece of land. Polycultures are often grown in groupings that either complement their nutritional needs or growing habit. Though polycultures have long been practiced in traditional farming systems around the world, the development of farm machinery,

synthetic fertilisers and pesticides and a preference for simpler, more intensive systems that lend themselves well to economies of scale led to the displacement of polycultures in many contexts. Polycultures are associated with agroecology, regenerative agriculture and organic farming and are favoured for their role in enhancing biodiversity, improving soil health and reducing the need for chemical inputs.

Regenerative agriculture

Regenerative agriculture aims to generate farming systems that improve soil health, increase biodiversity and sequester carbon through the use of practices such as cover crops, crop rotations, minimal tillage, organic compost, agroforestry and crop-livestock integration. Many of these practices are also associated with organic farming and agroecology. Various certification schemes are being developed which will specify the processes and outcomes required for products to be classified as 'regenerative'.

Rewilding

Rewilding is a form of conservation aiming to build biodiversity and restore and protect ecosystems through the promotion of natural processes rather than human inputs. Rewilding typically focuses on providing connectivity between wilderness areas, and reintroducing large herbivores, predators and/or keystone species, so that they influence natural processes and interactions throughout the food chain and minimize or eradicate the need for human land management.

Structural adjustment

Structural Adjustment Programs (SAPS) were introduced by the International Monetary Fund and World Bank in the 1980s in response to a series of economic crises in the global South. During this era, these institutions made access to loans by poor countries conditional on a set of economic policies that aimed to reduce state spending and open up their economies to international trade. Proponents of SAPs claimed that they would encourage economic growth; however they have been heavily criticised for undermining national sovereignty, deepening social inequality and further marginalising many poorer countries in the global economy.

Sustainable intensification

Sustainable intensification is a recently developed concept that is understood in different ways by its critics and supporters. A common understanding is that it denotes the principle of increasing or maintaining the productivity of agriculture on existing farmland while at the same time, reducing its environmental impacts. Understood in this way, SI designates a goal for the development of agricultural systems but does not, a priori, favour any particular agronomic route to achieve it. It may involve the intensification of different types of agricultural inputs (e.g. of knowledge, biotechnologies, labour, machinery) and apply these to different forms of agriculture (e.g. livestock or arable; agroecological or conventional). Forms of intensification that can be called sustainable intensification must lower environmental impacts and land use, relative to yields. However, for some, to merit the term 'sustainable' social, economic, and ethical criteria must also be considered.

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