POSITION PAPER

Why international agricultural research should draw on agroecology to support sustainable food systems

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1 Introduction

Agroecology is now widely advocated as an alternative paradigm to industrial agriculture (Giraldo, 2019; Kremen et al., 2012; Rausser et al., 2019). In discussions about international agricultural research to increase food security and well-being, however, agroecology is contested. *Box 1* defines agroecology as used in this opinion piece. On the one hand, a growing number of farmers, consumer groups and multilateral agencies are committed to agroecology (Bellon and Ollivier, 2018; Frison, 2020; Mier y Terán Giménez Cacho et al., 2018). For agriculture to become more sustainable, as they argue, farmers require greater independence from external inputs, and advance circular agriculture (Harris et al., 2019; HLPE, 2019; IAASTD, 2009). On the other hand, some researchers, governments and private sector actors argue for the intensification of agriculture through different versions of a Green Revolution (Buckwell et al., 2014; Levidow, 2018; World Bank, 2008). Both sides seek means to feed a growing population. Yet, their conclusions about the right technologies, business models or trade policies to achieve this goal differ (Foran et al., 2014). In this position paper, I explore the value of agroecology to support the transformation of agriculture and food systems to deliver food, health and well-being within planetary boundaries (Hatt et al. 2016; Gliessman, 2011).

The perspective offered in this article is informed by my work with one major stakeholder among the many international agricultural research organisations, the CGIAR (Consultative Group on International Agricultural Research). Organised in 15 centres with offices in over 70 countries, the CGIAR is the largest global research partnership dedicated to poverty reduction, food and nutrition security, and environmental health (CGIAR, 2015; ISPC, 2013). Though it is only one such organisation, the CGIAR has far-reaching ripple effects that can be seen in national agricultural research and extension organisations in Africa, Asia and Latin America. Currently, the CGIAR is undergoing a comprehensive organisational change towards 'One' CGIAR[3]. This reform provides an opportunity to bring agroecology principles to the fore in helping to guide the formulation of research questions, innovation and partnerships. Thus far, however, the conversation about how to better integrate agroecology into the CGIAR has been on the individual level rather than institutional.

In this invited paper, I analyse why this conversation about agroecology is not happening at a broader level, using the CGIAR as an entry point to this discussion. I further present five contributions agroecology offers international agricultural research to move towards more sustainable agriculture and improved food systems, especially when being adopted as an

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[3] The reform to transition to 'One' CGIAR aims to accelerate progress in key areas where innovation is needed, and as a result, deliver faster and more effectively on the SDGs by 2030. Essential changes shall lead to a unified governance, institutional integration, new research modalities, country engagement, and funding. For details see www.cgiar.org

Agroecology is an inter- and transdisciplinary science that studies the ecology of agriculture and food system to derive general principles about sustainable production, processing, consumption and disposal of food and non-food products. It generates evidence that helps developing equitable, ecologically sustainable, resilient farm and food systems delivering food and nutrition, fibre, energy and ecosystem services. In recent years, it has become useful to distinguish between agroecology as a science, a social movement that advocates for agroecological transitions of farms and food systems, and an agricultural practice on farms, informed by agroecological principles. Several community-based initiatives (such as the international peasant's movement La Via Campesina) and international organisations defined these agroecological principles. In 2019, the High-Level Panel of Experts at the Committee on World Food Security (CFS), see HLPE, 2019, expanded FAO's ten elements into 13 principles under three major categories:

1. Improve resource efficiency (recycling of nutrients in biomass, reduction of external inputs);
2. Strength and resilience (improving soil health, animal health, biodiversity, enhance synergies and economic diversification),
3. Secure social equity and responsibility (enhance co-creation, social values and diets, improve fairness, enhance connectivity, strength and land use and natural resource governance, ensure participation).

In short: Agroecology is the ecology of sustainable agriculture and food systems (Altieri, 1995).

BOX 1
Defining agroecology

overarching framework. In moving forward, I propose an open dialogue between the CGIAR and agroecology advocates, a multi-actor research platform and active policy engagement to strengthen agroecology principles in national and regional development plans. International agricultural research re-oriented in this way can undoubtedly be at the forefront of improving the sustainability of agriculture and nutrition with due respect for planetary boundaries.

2 The problem

Agroecology is not new to the CGIAR. There is an array of excellent research that resonates with agroecology and its principles, including pre-existing studies. Take early soil microbial research of TSBF (Tropical Soil Biology and Fertility Program) that was later merged into CIAT (International Center for Tropical Agriculture), for example, or research to close nutrient flows on smallholder farms (Bekunda and Woomer, 1996). Researchers understood soil health comprehensively and contributed directly to today's agroecology paradigm. Also widely recognised are the cereal-legume inter-cropping systems developed by IITA (International Institute for Tropical Agriculture) in West Africa, biological pest control, and methods for better crop-livestock integration by ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) in southern Africa to improve soil fertility, human nutrition and income (Homann-Kee Tui et al., 2020). Early versions of agroforestry research at World Agroforestry investigated biological processes to improve the functionality of managed ecosystems (Steppler and Nair, 1988). Other examples include research on perennial grains (Rogé et al., 2017), trade-off analysis between the use of crop residue biomass (Tittonell et al., 2015), and recently, barriers to the agroecological transition of countries, such as Nicaragua (Schiller et al., 2020). Research on landscape restoration has been implicitly organised around agroecological principles. Moreover, the CGIAR has gradually expanded its research agenda from crops to natural resource management and policies (Harwood et al., 2006). Today, researchers in several CGIAR Research Programs support a transition to sustainable agriculture with knowledge, tools and capacity development that complies with agroecology (see for example FAO, 2015).

Given the remarkable development outcomes achievable from such research, what then is the source of the controversy that divides the international agricultural research community over the adoption of agroecological principles? One source is programmatic: there is a long-held approach that advocates agricultural intensification as a means to support global food and security. Although overly simplified, this Neo-Malthusian justification (Demont et al., 2007) considers increased farm productivity a central pathway to food and nutrition security. This thinking often leads back to research aimed at improving food crops to result in higher yields, which is one of the founding principles of the first generation of CGIAR centres. This is not to say that crop improvement has lost relevance. Current yield levels of maize, wheat, rice would be impossible without cutting-edge crops research. Researchers have developed food crops resistant to abiotic and biotic stresses, productive livestock breeds and multipurpose trees that provide farmers with additional income. But closing yield gaps through the improvement of farm commodities alone – as many researchers have argued before – is not a sure means by which the world meets nutritional demands of 9 billion people by 2050 (Blesh et al., 2019; Pretty, 1995; Pretty et al., 2003).

Moreover, crop improvement alone will not make food systems more just and ecologically sustainable. There are also issues of distributional barriers (UNDP, 2016), food loss and waste (Sheahan and Barrett, 2017), land health (Stevens, 2015), agrobiodiversity (Bailey, 2016), and the feasibility of policy measures to consider when transforming food systems towards greater sustainability and fairness. Yet, the focus on closing yield gaps often dominates the conversation about agricultural development in low- and middle-income countries. Therefore, IPES-Food (2016) identifies eight pertinent lock-ins that keep agricultural and agricultural research from supporting more fundamental farm and food system transformations.

Secondly, there are arguments about the 'right' agricultural technology. One division between agroecology and the CGIAR is around Genetically Modified Organisms – GMOs (Altieri, 2001). The CGIAR is seen as a stronghold of GMO research, rooted in the Green Revolution (Holt-Giménez and Altieri, 2013). Many in the agroecology movement reject GMOs as a means of improving crops and livestock. Also, up for debate is the difference in opinion about biofortification to combat micronutrient deficiencies in humans rather than system-based nutritional improvements (Tan et al., 2020). In that 'tug of war' between the schools of thought, agroecology and sustainable intensification seem two incompatible concepts (for details see Bernard and Lux, 2017).

Third, international agricultural research is conducted through a series of steps: discovery, proof of concept, piloting and scaling. Discovery research is highly specialised, but the later stages require both technical accuracy and social innovation, and thus are more multidisciplinary and applied in nature. Crop improvement through breeding may successfully increase the adaptability of a plant to a particular environment. But that crop also requires an enabling household economy, human aspiration, seed systems, market institutions and agricultural policies to unlock its genetic potential. Interdisciplinary research that assesses relations between crop physiology, soils, human nutrition and household economy (see for example Barrett and Bevis, 2015) are hardly done. Workplace pressure limits the time for reflection – or what Lamine and Dawson (2018) call 'relational reflexivity'.

Fourth, specialised research without integration leads to fragmentation where holistic views of development challenges are most needed. Such fragmentation hinders rather than supports transitions towards sustainable farm and food systems. Driven by the political economy supporting technology fixes, it also reinforces technical innovation from top-to-bottom, an approach the agroecology and the farmer-first movements reject (see Chambers et al., 1989; Scoones and Thompson, 1994, 2009). As a consequence, adoption rates of agricultural technologies remain low.

Fifth, low levels of technology adoption on the part of farmers has fundamental implications for impact. Compartmentalisation also reduces the ability of research to effectively address socio-ecological fragilities in some parts of the CGIAR mandate regions, especially in the Horn of Africa, West Africa and parts of South-East Asia. Moreover, there is relatively little awareness of the external effects that some agricultural technologies generate. Impact studies motivated by accountability rather than learning focus on crop yields, farm productivity and economic benefits. Less emphasis is put on environmental and social impacts. Although the impact agenda has widened in recent years, it is still too narrow for many advocating for agroecology.

Several of these divisions are resolvable (e.g. agreeing on unified outcome targets, strategies to improve adoption and impact), settling others is more complicated (e.g. defining the 'right' technology). For more information on concerns across these five domains see, for example, Hall et al., 2003 and Leeuwis et al., 2018.

3 Contributions

Agroecology offers international agricultural research a framework to improve the effectiveness and efficiency of research. Some aspects of this framework will strengthen the ecological foundations of agriculture; others draw attention to the social and political processes in areas where change is most needed to support sustainability. Five of these contributions stand out.

a) Unifying vision based on joint values

The first significant contribution that agroecology offers to international agricultural research is a means for critical reflection of the social norms and human values that underpin sustainable agriculture and food systems. Contributions include the focus on:

- 'Multifunctionality' of agriculture, food and environmental services, where food-producing landscapes can also serve as a harbour for biodiversity, as well as for cultural heritage – obvious but cannot be taken for granted.
- 'Equity', especially as related to fair trade, climate justice, food sovereignty.
- 'Energy and resource efficiency', especially with regard to fossil fuels, by increasing optimisation of ecological processes and circular resource economies.
- 'Holistic transition concepts' that recognise the linkages between farming practices, value chain actions, consumer behaviour and policies and politics, all linked through actors with explicit but often invisible power dynamics (Bezner Kerr et al., 2019).
- 'Pluralism', recognition of diversity in decision-making within the international agricultural research community, recognising the value of cultural diversity, gender and knowledge. Seeking diversity in technical and social solutions.

b) Unlocking synergies

The second significant contribution of agroecology recognises the complexity of farm and food systems and helps to operationalise it in lab and field research. Agroecology approaches:

- 'Provide a multi-level perspective' that allows seeing the back- and forward linkages between people, technologies and development outcomes on farms and in societies. Also, such a perspective helps to analyse trade-offs and identify synergies supporting agroecological transitions.
- 'Promote defragmentation': the systems-orientation of agroecology weaves components of farm enterprises together, such as 'One Health' concepts do when seeking to improve synergies between the health of soils, plants, animals and humans on farms.
- 'Advocate for geographical diversification' by working on geographically interconnected agriculture challenges in the Global South and the Global North in tandem; research to support global policy coherence is such an example.
- 'Embrace multidisciplinary' by involving both biophysical and social sciences to better understand the complexity

of transitions towards sustainable farming, especially during piloting and scaling.
- 'Improve the Theory of Change' supporting a flexible, learning-oriented approach addressing political and economic power locks-in, especially in view of scaling the impact of technologies and knowledge.

c) Improving priority setting
Thirdly, agroecology helps to identify entry- and leverage points that support farm and food system transitions and help to broaden research and development partnerships between public organisations, the private sector and the sustainable agriculture and food movements. Agroecology helps to:
- 'Identify and address knowledge gaps' across all science domains, ranging from crop biology to food policies, commodity markets, consumers and human behaviour (Bellamy and Ioris, 2017).
- 'Advance the co-design of research and co-creation of knowledge', as promoted by Bergez et al. (2019) or Page et al. (2016), which will ensure that from the very beginning of a research initiative farmers on the ground bring their experience to the research process, improve the design and uptake of technologies, and help research to learn from social movements for scaling science-based technical, economic, social or policy-related solutions.
- 'Increase return on investment', in other words, agroecology would not only make research more applicable but increase the return on investment of funders – mainly development-oriented agencies measuring direct impact on poverty reduction, food and nutrition security and food sovereignty.
- 'Expand sustainability benchmarks' informed by the elements of agroecology (see *Box 1*) to derive better criteria for ex-ante impact assessments and improved prognoses of benefits of development interventions.
- 'Reorganise division of labour' and set criteria for effective partnerships, especially when developing agroecological pilot programs and when making scaling efforts.

d) Tracking impact rigorously
While a unifying vision and joint values 'to do the right thing', this fourth contribution of agroecology is critical for 'doing things right'. Contributions include:
- 'Alignment of impact assessment criteria and indicators' with the multiple functions of agriculture, rigorous impact assessment against SDGs and planetary boundaries.
- 'Expansions of development outcome indicators'. Applying an agroecological perspective to impact assessments will widen assessment domains and indicators beyond the farm into society where production links with processing, trade and consumption.
- 'Integrated metrics framework' to assess the impact of technologies and practices concerning sustainability outcomes.
- 'Assessments of negative externalities', undesirable consequences of agricultural intensification and preventing the external cost of sustainable intensification.
- 'Learn from failed development', assess with rigour technology failures, and assess dis-adoption of technologies (see, for example, Simtowe and Mausch, 2018).

e) Broadening accountability
Finally, through agroecology international agricultural research received inputs towards additional performance management criteria.
- 'Expand the definition of stakeholders', for example, by multilateral, civil society organisations or the global peasant movement and consumer groups, all equipped with leverage and multiplier potential at the national and regional level.
- 'Embrace social business and social entrepreneurship' (for examples see World Bank, 2012), based on new accountability standards contribute to new business models, including versions of fair-trade.
- 'Progress citizen-led collaboration'; although no blueprint for positive outcomes (Gaventa and Barrett, 2010), partnerships with consumer groups and farmer organisations are essential, for example, when developing product profiles for new food crop varieties – their knowledge and needs should figure into CGIAR's priorities for the future. Such citizen-led partnerships also build on excellent farmer-participatory research done with partners from the CGIAR in the past.
- 'Improved performance' through impact evaluation that involves multiple users of technologies, direct, quantitative feedback to strengthen impact pathways (Springer-Heinze et al., 2003).
- 'Improve economic efficiency'; although a good cost-benefit ratio (Raitzer and Kelley, 2008), there is room to improve through better-informed decisions about resource allocation to research projects in line with overarching sustainability targets.

Delivering on the mission of the CGIAR requires integrated thinking during the formulation of development results, the innovation needed to achieve results, along with the research questions, partnerships and management procedures to manage highly complex innovation processes. While only a few would disagree with the overarching areas where the impact is urgently needed, the science of agroecology helps to specify lower-level targets better connected to the agroecology principles. Finally, an agroecology framework enables a more universally shared commitment to international agricultural research delivering development results, and compliance of research with overarching sustainability targets. In other words, by doing the right thing right, the scaling performance of sustainability outcomes increases.

4 Institutional innovation

As agroecology gains traction, the 'what next' question shifts in the foreground. It should not come as a surprise that I argue for a bold move to integrate agroecology into international agricultural research more explicitly and visibly. Each of the actors in international agricultural research must find

its way in doing so. Among the many strategic moves the international agricultural research community could take, I present three.

First, it is time for the CGIAR and agroecology proponents to change mindsets and beliefs to engage more actively in unbiased, impartial conversations about the utility of agroecology as a framework for ending hunger by 2030 – using science to transform food, land and water systems amidst a climate crisis. Fundamental questions are: What is the purpose of agricultural transformation? What are the preferred models for supporting the transitions? Who should govern agricultural research to support transitions? Although these questions create friction between the different schools of thought (for its multilateral dimensions see Duncan and Claeys, 2018), the international agricultural research organisations – and the CGIAR – must have an open conversation with development partners and funders about agroecology and its paradigmatic fundamentals. Such a conversation will not only encourage a shared understanding of agroecology and offer evidence to support a comprehensive agroecological narrative (for a debate on narratives see Rivera-Ferre, 2018). It also avoids what Taylor (2018) calls a depoliticised debate about technological fixes, and places questions around social norms, institutions and politics more prominently on the research agenda. Also, such conversations can help bring up to date the lower-level targets of the CGIAR results framework, especially regarding the reduction of the carbon footprint of food production, the integration of resource flows on farms and landscapes and between urban and rural areas, support towards circular agriculture, dietary diversity and equity in local and global food economies. Finally, such conversations enable all those criticising the CGIAR to see a good share of strategic public research already aligned with global sustainability targets.

Second, the CGIAR could initiate a multi-actor platform aimed at progressing the science of agroecology, in cooperation with FAO and other key partners. As done at CGIAR platforms (e.g. 'Excellence in Breeding', 'Gender' and 'Big Data'), researchers would work with development partners to support agroecology at the national, regional and global level. One benefit of such a platform would be the mainstreaming of agroecology principles in research and outreach. Such a platform aids in developing a shared research agenda, providing methodological support to research programs implemented by several CGIAR centres and partners, helping to integrate research insights into agricultural advisory services, and assists in steering the international policy discourse to support transitions towards sustainable farm and food systems.

Third, as Nelson (2020) suggests, much tighter linkages between agroecological practices, international agricultural research and multilateral policy processes are needed. These include coordination with the UN Committee on World Food Security (CFS), the International Panel of Experts on Sustainable Food Systems (IPES-Food), and TEEB for Agriculture and Food. Undoubtedly, international agricultural research can underpin policy reforms with evidence.

Yet, it would be wrong to rebrand the CGIAR into an 'agroecology research consortium' (see also Mockshell and Kamanda, 2018). There are also many good reasons for maintaining, and in some areas intensifying compartmentalised disciplinary research with a comparative advantage – be it in the field of genetic improvement of crops and livestock, or experiments to understand the decision-making of farmers. But the future focus of research must be less on isolating problems and more on spearheading innovation through integrating new technologies with social innovation in cooperation with bridging agents and multipliers.

What are the benefits of the three strategic moves for farmers, countries and the international community? Overall, I anticipate greater food sovereignty as being demanded by many social movements and local communities. In my opinion, agroecology principles applied in research provide evidence-based strategies for three major transitions. The first aims to increase the well-being of farmers through agriculture, and to strengthen the resilience of small farms to shocks, especially during protracted crises – including those caused by COVID-19 – and in fragile environments. To many farmers in these environments, sustainable agriculture is a livelihood and a safety net at the same time. The second is to ensure that transitions to commercial, market-oriented agriculture become complies with SDG targets. The third support shifts from resource depleting food production to circular agriculture within planetary boundaries. This concerns the Global South and the Global North equally. All three transitions are critical for moving towards sustainable food systems in countries and regions where the CGIAR conducts research.

5 Conclusion

In conclusion, agroecology should provide direction to the One CGIAR reform, but the recommendations put forth would be applicable for many others engaging in international agricultural research. If done well, research informed by agroecology guides quests for transforming agriculture and food systems towards sustainability. Although some may object, in my perspective, the question is not whether international agricultural research should adopt a unified position on agroecology or self-claim its promotion on opportunistic grounds. Instead, the science of agroecology offers evidence to advance the needed farm and food system transitions. With strong regional programs and country offices in Africa, Asia, Latin America, Europe and the USA, the CGIAR is in a strategic position to offer such support. But for realising this potential, a paradigm shift towards agroecology is indispensable. The ongoing CGIAR reform is an unprecedented opportunity for nudging this shift.

Disclaimer

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