Harnessing Agroecology to Build Climate-Resilient Communities

Subjects: Geography

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The need to build resilient health and food systems to meet societal needs is urgent, yet the present threats of climate change vastly outpace current measures to achieve these resilient systems and tend to exacerbate current climate change and food insecurity challenges. Climate change's multidimensional and complex impact on food and health has prompted calls for an integrated, science-based approach that could simultaneously improve the environment and nourish development-constrained communities. A transdisciplinary practice of agroecology that bridges the gap between science, practice, and policy for climate action is crucial in building climate-resilient communities through sustainable food systems. The transformative agroecological paradigm can provide farmers with a host of adaptive possibilities leading to healthier communities, improved food security, and restored lands and forests that can sequester greenhouse gases.

Keywords: climate change resilience ; agroecology ; food security ; crop diversification

1. Introduction

The United Nations Security Council recognizes that "climate change is the defining issue of the time" [1]. It poses a clear and present danger to global peace and security, as well as the health and well-being of communities. The Intergovernmental Panel on Climate Change [IPCC] [2] WGII Summary Statement says: "The cumulative scientific evidence is unequivocal: Climate change is a threat to human well-being and planetary health. Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a liveable and sustainable future for all. (Very high confidence)." Climate change has exacerbated the frequency and severity of extreme weather events such as heat waves, droughts, floodings, and storm surges [3][4]. For instance, heat waves affect people's cognitive performance [5], bringing about a higher risk of death from ischemic strokes, especially among women [6]. The year 2022 is set to be one of the warmest years on record, with the 2013–2021 period ranked among the top ten warmest years in the history of climate record-keeping [7]. Apart from the threat to human lives, the rise in temperatures causes high evapotranspiration and wildfires and may create conditions that facilitate the breeding of new pests, pathogens, and diseases that negatively impact crop growth in their various lifecycle and deteriorate human health [8][9]. While the world grapples with current climatic stressors, recent projections [10] reveal that the intensity and frequency of these extreme weather events will increase and become even more destructive in regions such as sub-Saharan Africa (SSA), where adaptive capacity is relatively lower [11].

The impacts of climate change on health and food systems are multidimensional, which complicates the identification, attribution, and assessment of these impacts [12]. Despite this complexity, it is apparent that the enduring impacts of climate change are particularly felt by rural areas in underdeveloped countries with low adaptive capacities. From the perspective of the Sustainable Development Goals (SDGs), the impacts of climate stressors on food systems are particularly concerning as SDG 2 (Zero Hunger) is crucial for meeting other goals, including SGDs 3 (health), 1 (poverty), and 13 (climate action). As a result, scientists have highlighted the need for an integrated approach to addressing food and health crises and for consolidated, strategic, evidence-based actions to reduce risks and impacts to meet global societal needs [2][13].

The need to build resilient health and food systems to meet societal needs is urgent, yet the present threats of climate change vastly outpace current measures to achieve these resilient systems and tend to exacerbate current climate change and food insecurity challenges. For instance, evidence indicates that the current capitalist agricultural system's emphasis on mechanized production, biological overrides, and mass production has failed to feed the world's poor and protect the environment [11][14][15]. These failures are also evident in the growing food insecurity in many parts of the world [2]. In particular, smallholder farmers, who produce more than half of the total global food supply, are the most food insecure [11]. It is important that actions are taken to make the global farming systems more resilient, especially in smallholder contexts.

Furthermore, there is a pressing need to move away from the current unsustainable farming regime that separates winners from losers, hinges on high-input applications, and causes ecological catastrophes, all while making food security a mirage for many smallholder farmers with few financial resources [16]. The United Nations Sendai Framework for Disaster Reduction 2015–2030 provides a seven-point plan that links with development, climate change, and resilience building to achieve these global goals. Similarly, the recent International Union of Food Sciences and Technology (IUFoST) Global Food Summit discussed the urgent need to develop strategies for sustainable and resilient food systems, primarily through integrated science-based approaches. The point of convergence among these global scientific communities is aptly captured in the UN Secretary-General's statement that "researchers are in a world in which global challenges are more and more integrated, and the responses are more and more fragmented, and if this is not reversed, it's a recipe for disaster" [17]. The scientific community's consensus is that there is a need for more place-specific and integrated interventions that bring together scientists, government, civil society, and local farmers to address climate change. Secondly, climate change interventions must follow a holistic approach to resilience by generating diverse pathways for incremental and transformational change towards more sustainable farming and food systems while also ensuring environmental sustainability.

2. Stimulates Sustainable Food Production

With its wide-ranging soil and land management options, agroecology presents significant opportunities for climate change adaptation and mitigation in resourced-constrained regions. A recent systematic review of agroecology on a global scale revealed that about 78% of studies found that agroecological interventions such as crop diversification, soil management, livestock integration, and pest management were positively associated with food security and nutrition [18]. Crop diversification, for example, ensures that farmers can get food from their farms over a longer duration due to the difference in maturity rates of the crops grown. Thus, these farms are resilient to climate variability, which builds household resilience to climate-related weather events. An ethnographic study of traditional agroforestry in Mexico found that households consumed over 60 different foods, the majority of which were sourced from family farms. The cultivation of varying cereal crops, legumes, and perennial tree crops provided the dietary diversity needed by the households and ensured that food was available year-round [19]. It has also been noticed in some contexts that agroecology-practising households were healthier than their counterparts who practised conventional agroecology. A study in Tanzania, for instance, revealed an increased dietary diversity among children living in agroecological practising households [20]. Given that children are among the most vulnerable to food insecurity and health, consuming diverse diets could mean that they can gain the necessary nutrients needed for a healthy and active life. In addition to food security, some studies have found that food security achieved through agroecological interventions was associated with positive mental health outcomes [21]. The net effect of these benefits is that households and communities become more resilient to climate change and its impacts.

In addition, agroecological participatory approaches, defined as the " active participation of farmers in designing, implementing and assessing agroecological farming strategies to improve yield through knowledge co-production and sharing" [22] (p. 31), are closely associated with the adoption of sustainable land management practices. For instance, farmers who engaged in a farmer-to-farmer-led agroecological intervention through the integration of local knowledge in Northern Malawi were more likely to engage in sustainable land management practices, including legume intercropping, terracing, mulching, manuring, composting, and crop residue integration [23]. This is especially necessary for transitioning food systems to be more sustainable as studies have shown in many contexts that farmers do not necessarily gain adequate information from extension officers, especially in rural contexts, due to structural constraints and may be less likely to abandon their methods for environmentally friendlier practices. These structural reasons may range from language barriers, infrequent visitation, and a low level of expert knowledge [24]. Yet, Son et al. [25] assert that integrating local knowledge into farming enhances community resilience to climate change.

3. Agroecosystem and Forest Restoration for Carbon Sequestration

Evidence points to the fact that agroecology leads to the restoration of farmlands and degraded forests [26][27]. In a study examining the perceptions of deforestation, forest restoration, and the role of agroecology, it was found that farmers who practise agroecology reported varied levels of forest restoration after applying agroecological practices on their farms compared to farmers who did not practise agroecology [27]. Agroecological practising farmers engaged in extended fallows and polyculture, which stimulated the revitalization of ecological functions that facilitate forest restoration and agroecosystems, ultimately increasing opportunities for carbon sequestration—more so than current capitalist monocultures. Agroforestry, legume integration, crop diversification and composting, for instance, also have an indirect effect of reducing deforestation as the need for new farmlands will be minimized, while effective pruning could provide the fuelwood needs of households.

By integrating trees and other plants into farming practices, this system can promote healthy soil quality and better yields without excess fuel being used for tilling the earth. In addition, agroforestry fosters the protection of trees, which are suitable for carbon capture, increases habitat for various species, and contributes to coolness during hot months. According to Ramachandran et al. [28], agroforestry practices such as parklands (trees and crops) and alley cropping (trees planted in rows between crop fields) can provide 20–100% more carbon sequestration than monoculture systems. This farming system can also help protect watersheds and other bodies of water as trees filter pollutants and help retain moisture [28].

Agroecological farms have greater carbon storage capacities than conventional farms and are more energy-efficient [29]. For instance, energy efficiency levels were found to range from 10:1 to 30: 1 [30] on Cuban farms applying agroecological innovations compared to their US counterparts who used 50% more energy for 1 unit of food energy produced (i.e., 1:1.5). An analysis by Rakotovao [31] showed that tree planting, whether in an agroforestry or forestry system, had the most significant effect on differentiating carbon footprints among distinct clusters of smallholder farmers in Madagascar.

Contrasting agroecology with monocropping, it has been noted that conventional input-agricultural practices have resulted in the depletion of soil organic carbon levels over time due to over-reliance on synthetic fertilizers or manure management systems that do not restore lost organic matter back into the soil [32]. To counteract this loss of soil carbon, agroecosystems use organic manures and fertilizers to restore the fertility of soils. In addition, mixed farming systems that utilize different plant species on the same piece of land have been shown to improve soil carbon storage by using a wide variety of plants which complement each other. This is particularly advantageous in tropical areas where mixing species on a variety of farms contribute toward regenerating degraded agricultural lands and biomass.

4. Agroecology Widens Farmers’ Scope of Adaptive Possibilities

Unlike conventional smallholder agriculture, which is mainly synonymous with monoculture, agroecological practices such as crop diversification, mulching, and agroforestry offer farmers a wide range of farm management options that are designed to protect agrobiodiversity, food security, and resilience to climate change [33]. For instance, agroecological practices reduce farmers’ dependency on ‘modern’ agricultural inputs like inorganic fertilizers, weedicides, and other agrochemicals that have long-term negative ramifications on soil, water, and air qualities. The reliance on locally sourced materials for farming implies that households improve yield at lower costs, thus improving family savings—money that can be used for other purposes such as obtaining health care which makes households resilient to climate-related sicknesses. This is in addition to the fact that multiple crops mean that farmers can sell excess crops for income [34], and they also become seed secure for the next planting season [35]. Similarly, when farmers diversify their crops, they minimize their risk of total crop failure and commodity price volatility [36] so that when a particular crop fails, they can rely on other crops to meet their dietary needs. Moreover, when leguminous crops (e.g., beans and peas), which are rich in nitrogen, are planted together with other crops (e.g., millet or maize), they help fertilize the fields.

Within the context of smallholder farming, Nyantakyi-Frimpong et al.’s [37] assessment of an agroecological intervention in Northern and central Malawi indicated that farmers who practised agroecology were more likely to report household food security and dietary diversity than farmers who did not practise agroecology. This is because farmers rely less on input-intensive practices like inorganic fertilizer purchase and the cultivation of one crop variety, which makes these farmers more prone to crop failure in the advent of unfavourable rainfall patterns (see also Snapp et al. [38]). Global-scale analysis of intercropping of grain legumes and cereals revealed that the practice improves soil nitrogen (N) and, as such, reduces farmers’ need for synthetic fertilizers by about 26% globally [29]. This is especially valuable in poor regions where farmers cannot afford to purchase chemical fertilizers to enhance the soil fertility on their farms. Chemical fertilizer prices and carbon footprints may also be reduced because of a reduction in global demand. Studies such as Sethuraman et al. [39], Mugendi [40], and Kumar and Nath [41] have also demonstrated crop diversity’s role in landscape biodiversity, stimulation of species production, and the enhancement of ecosystem service provision through the rejuvenation of species rendered redundant in monocultural landscapes.

Agroecology as a social movement can bring about empowerment and close gender gaps, which have long been characterized by the current agricultural regime [42]. Farmers are empowered by allowing room for active participation in designing and implementing farming strategies. Aipira et al. [43] note that bridging such gender gaps contributes to household and community resilience to climate change. By encouraging local participation and the use of locally available resources and knowledge, such as manure and compost and a deep understanding of the nature of agroecosystems in local areas and the principles by which such agroecosystems function, agroecology transfers ownership of the production process to local farmers which enables them to make decisions relevant to their situation and that suit local climatic conditions [44]. Due to its emphasis on traditional local systems, there is evidence to suggest that agroecology enhances the production of social connections. For example, Kansanga et al.'s [45] study of agroecology use in Malawi found a bidirectional relationship between agroecological practices and social capital among poor farmers. Kansanga et al. asserted that agroecological principles like the co-production of knowledge typified by the agroecological intervention examined in the study led farmers to build more robust social networks and become more likely to receive support and help in facilitating access to productive resources like agricultural information, soft loans, or communal labour. That is because a just farm management system like agroecology offers opportunities to destroy power imbalances and empowers farmers in communities, increasing their access to resources and resilience [46]. Pfefferbaum et al. [47] present that both personal and community resilience are increased by the social capital that emerges from improved social connections and social networks.

5. Conclusion

Despite the diversity of case studies, the existing body of literature strongly supports agroecology as a sustainable food and land management system that can provide the twin benefits of improved food security and environmental sustainability for improved health and well-being. Agroecology replicates the normal functioning of the local environment without the introduction of external inputs. As such, agroecological innovations are relatively affordable, ecologically friendly, and align with the culture and traditions of people. These qualities make agroecology particularly beneficial to smallholder farmers in poor and middle-income countries, as they may be able to achieve food sovereignty in the face of the climate crisis. The study reinforces the call for greater investment in agroecological research. The scientific community will benefit from continued research on agroecology that is informed by local food systems and is farmer-led.

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