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RESEARCH ARTICLE

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Assessing local perceptions of deforestation, forest restoration, and the role of agroecology for agroecosystem restoration in northern Malawi

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Abstract

Deforestation drives climate change and reinforces food insecurity in forest-dependent communities. What drives deforestation varies by location and is shaped by livelihood systems. But how locals perceive restoration is crucial for developing restoration policies. Evidence suggests that applying sustainable farming strategies can potentially restore forests and sustain livelihoods. Applying a broad-based conceptualization of deforestation and restoration in policymaking, however, results in missed opportunities for addressing deforestation and restoration. Here, we explore the drivers of deforestation, the perceptions of restoration, and the challenges to restoration among smallholder farmers in northern Malawi and examine how agroecology can contribute to restoring degraded agroecosystems. Participants report agricultural land expansion, charcoal production, climate change, burnt brick production, and government subsidies as the major drivers of deforestation. We observed that although perceptions of forest restoration reflect farmers' traditional ecological knowledge (TEK) to include reclamation of degraded farmlands, reconstruction of native tree species, and replacement of felled trees on farmlands, there are challenges including splitting families to gain access to more subsidized fertilizers and food aid, embedded cultural practices, growing demand for charcoal in cities, and weak ecosystem governance structures that hinder the effectiveness of restoration efforts. We, however, do find that agroecological intensification can increase yield from smaller farmlands and allow for larger and longer-lasting fallows of spare lands which regenerate forests. Key overarching implications of these findings include the need to integrate livelihoods more explicitly into restoration plans, accounting for TEK in restoration policies in forest-dependent communities and encouraging the adoption of agroecology.

KEYWORDS
agroecology, agroecosystems, ecological knowledge, forest restoration, participatory GIS

1 | INTRODUCTION

According to the 2020 *Global Forest Assessment Report*, forests currently cover 30.8% of the global land area (FAO, 2020). The total forest area is estimated to be 4.06 billion hectares (~0.5 ha of forest per person) and are disproportionately distributed around the globe (FAO & UNEP, 2020). The total amount of forest decreased from 32.5% to 30.8% in the three decades between 1990 and 2020, representing a net loss of 178 million hectares of forest (FAO & UNEP, 2020). The average rate of net forest loss declined by about 40% between 1990–2000 and 2010–2020 (from 7.84 million hectares per year to 4.74 million hectares per year), due to a reduction in forest area loss in some countries and forest gains in others (FAO, 2020). Africa had the highest net loss of forest area globally in the 2010–2020 period, with a loss of 3.94 million hectares per year (FAO & UNEP, 2020).

Deforestation is described as forest losses due to conversion to other land uses or the permanent reduction of canopy cover below the minimum 10% threshold that defines forest, and is caused primarily by agricultural land expansion (FAO & UNEP, 2020). Deforestation is one of the main drivers of climate change and biodiversity loss (MacDonald & Mordecai, 2019; Vargas Zeppetello et al., 2020) and has negative impacts on the livelihoods of millions of forest-dependent households globally [Díaz et al., 2020; Intergovernmental Panel on Climate Change (IPCC), 2019]. The rapid loss of forest biodiversity threatens ecosystem functioning—the activities, processes, or properties of forests, such as decomposition of organic matter, soil nutrient cycling and water retention—and consequently, the ability of these forests to provide ecosystem services—these are the benefits that human derive from healthy natural ecosystems (Duffy, 2009), to local communities.

Gains in forest area, on the other hand, may occur through: (1) natural expansion, for example, on abandoned/fallow agricultural land;or through (2) reforestation (occurs in a deforested area through natural or assisted natural regeneration or natural regeneration in a previously nonforest area); or through (3) afforestation (forest planting and/or seeding in areas that previously were not classified as forests) (FAO & UNEP, 2020). Forest restoration refers to the process of reversing land degradation or loss of productivity of ecosystem services such as food, biodiversity, and water either by rehabilitation (restoring some desired species), reconstruction (restoration of native species), reclamation (restoring severely degraded landscape such as farmlands), or replacement (replacing maladapted plants with new vegetation) (FAO & UNEP, 2020). In areas where livelihoods are intricately linked with forests, restoration is complicated because of the challenge of balancing conservation needs and livelihoods aspirations. Some researchers assert that in such complicated contexts where livelihoods are intricately linked with forests, efforts must be directed toward restoring the ecological functions (the potential of an ecosystem to deliver a service that is itself dependent on ecological processes and structures) of agricultural landscapes to revive ecological processes that eventually transition the degraded lands to semi-natural landscapes. Lamb (2011) suggested that in farming areas, short-rotation, single- or multiple-species plantations on degraded soils, restoration plantings in secondary forests or assisted regeneration in selectively logged forests are effective ways of regenerating degraded forests and agroecosystems—natural ecosystems that have been modified for the production of food and fibre (Hodgson, 2012).

In Malawi, where the majority of the population relies on rainfed agriculture, there are severe threats to ecosystems and biodiversity posed by a high rate of deforestation—~2.5% per annum (Government of Malawi, 2016). About 39.7% of agricultural land in Malawi is degraded (Mbow et al., 2019), and more than 80% of the population resides in rural areas and depend on agriculture and forest resources for their food, energy, and other livelihoods needs but where poverty is disproportionately higher (World Bank, 2019). Urban residents rely on primarily charcoal for their cooking fuel, and urbanization rates are increasing in Malawi (Ngwira & Watanabe, 2019). This combination of factors fueled by rural livelihood aspirations and urbanization reliant on charcoal is a recipe for higher rates of deforestation. Amid these environmental challenges, Malawi has largely pursued input-intensive agriculture policies such as the Fertilizer Input Subsidy Program (FISP), to increase crop productivity, with reported productivity gains from such approaches being underwhelming or at best overestimated (Messina et al., 2017). Considering the failure of input-intensive agriculture to address food insecurity, biodiversity loss, deforestation, and land degradation, compounded by growing inequality, agroecological management has emerged as a possible alternative for crop production in Malawi and the approach is gaining increasing importance (Bezner Kerr et al., 2019).

Agroecology is defined as "…the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions" (Francis et al., 2003, p. 100). As a farming system, agroecology involves a set of practices and principles (Nicholls et al., 2016). These practices and principles include nutrient recycling, using natural means for controlling insect/pests and diseases, using biological means, such as organic matter, to enrich the soil, optimization of energy pathways to minimize energy, water, nutrient, and genetic resource loss, farm-level and landscape-scale genetic diversification and facilitation of further synergistic interaction through the promotion of ecological processes (Wezel et al., 2020). Implementing these principles ensures that farmers can increase yield from relatively smaller farmlands (Cassman, 1999).

The rate of deforestation/biodiversity loss rates tends to vary spatiotemporally based on local context (e.g., law enforcement, collaborative management, political interference) under which drivers such as population, poverty, market access, and commodity prices operate to influence forest cover, degradation, regeneration, and perceptions of restoration outcomes (FAO & UNEP, 2020). As such, while studies have identified drivers of deforestation and understanding of restoration in Malawi more generally (Ngwira & Watanabe, 2019; Zulu, 2010), knowledge gaps may still exist due to local variations in contextual factors. Our study seeks to identify possible gaps in the understanding of the drivers of deforestation and how farmers perceive forest restoration in smallholder systems where poverty and food insecurity abound. Further, with current rates of food insecurity and land degradation in Malawi, a crucial question worth investigating is whether the growing adoption of agroecology can contribute to restoring degraded agroecosystems into semi-natural landscapes.

Specifically, this study seeks to identify the contextual drivers of deforestation, explore farmers' perceptions of forest restoration, and examine the inhibiting factors to long term forest restoration in northern Malawi through the lens of the livelihoods framework. Secondly, we seek to assess the potential for agroecology farming practices to reinvigorate the ecological processes that facilitate forest restoration to semi-natural landscapes in degraded agroecosystems. Examining contextual drivers of deforestation and farmer perceptions unearths local variations in the underlying drivers of deforestation in different parts of the country, and the findings will provide functional knowledge about how basic farming methods can drive large-scale restoration of agroecosystems in the Global South.

In the remainder of the article, we describe the livelihoods framework as a lens for guiding the study, which followed by a description of the methods and materials section well as the findings of the investigation.

2 | LIVELIHOODS FRAMEWORK

This study focuses on linking livelihoods and forests (deforestation and restoration of forests) in rural Malawi. Therefore, the livelihood framework is used to explain how people's desire to satisfy household needs can concurrently drive deforestation, hinder restoration efforts, but may also contribute to forest restoration in forest-dependent communities. Hussein (2002) asserts that livelihood research is primarily integrative, with a focus on how local people in particular locations organize environmental, economic, and social resources to meet challenges to their well-being and achieve various goals. Livelihoods are regarded broadly as "...systems of local resources and networks intermittently connected to social, economic, political, and environmental relations that cross scales" (Carr, 2015, p. 333). Ellis (2000, p. 10) on the other hand defines livelihoods as "...the assets (natural, physical, human, financial, and social capital), the activities, and the access to these (mediated by institutional and social relations) that together determine the living gained by the individual or household." A critical concern that comes up in livelihoods-related analysis is how to ensure that households and individuals gain their living with minimal environmental impacts—the concept of sustainable livelihoods (Ashley & Carney, 1999).

While the discourse on livelihoods often focuses on local people and places, local-level decisions about livelihoods and outcomes of such decisions are linked to broader scale factors and processes outside these local spaces (Bebbington, 1999; Hussein, 2002). These translocal factors shape the intensity and frequency of exploitation of resources, the motivation to restore such resources, and the vulnerability of livelihood systems to external shocks (Adger et al., 2004; Folke et al., 2005). For instance, in northern Malawi, tobacco production, which is an important source of income for many households, has seen a significant growth over the decades because of increased demand by tobacco marketing companies that are located in the Global North. Major changes to legislation connected to structural adjustment policies have also influenced the production of tobacco over the period (Van Donge, 2002). Indeed, the scope of the livelihoods framework includes not just local spaces (rural or urban livelihoods) but also occupations (farming, pastoralism or fishing livelihoods), social differences (gendered, age-defined livelihoods), directions (livelihood pathways, trajectories), and dynamic patterns (sustainable or resilient livelihoods) (Scoones, 2009, p. 172). It is within these dynamic patterns that solutions can be found to address challenges brought about by livelihood systems in the first place, such as using sustainable farming methods to restore degraded agroecosystems.

In this study, we conceptualize livelihoods from both Hussein's and Ellis's perspectives because of the complexity of the factors that shape smallholders' livelihood strategies and the impacts of these livelihood strategies on the environment. The interlinked nature of the issues concerning deforestation and livelihoods in Malawi calls for interdisciplinary methods to allow for a thorough explication of the underlying drivers. We further explore how other livelihood strategies (i.e., agroecology farming) can contribute to restoring degraded agroecosystems in smallholder agriculture systems using participatory geographic information systems and statistical analysis.

3 | MATERIALS AND METHODS

3.1 | Study context

The study was conducted in the Mzimba District of northern Malawi (Figure 1). The district covers a land area of 10,430 km^2, has moderately fertile soils that are generally medium to light textured, mostly sandy-loam and loamy, with moderate to good drainage, thus making the soils suitable for growing cereals, legumes and tobacco (Gama et al., 2014). The climate type in the district is sub-tropical with average monthly maximum temperatures ranging from 27°C to 33°C. In the winter months, temperatures fall to between 0 and 10°C, while annual rainfall amounts range from 650 to 1300 mm (Government of Malawi, 2008). The district is often affected by extreme climatic events such as floods and droughts, with predictions that these extremes will worsen with the rapidly changing global climate (Gama et al., 2014). *Dimba gardens* (dry season farms) in *dambos* (wetlands) contribute significantly to household food security and income in the area for those households with access to the *dambos* (Chinsinga, 2012).

3.2 | Data collection and analysis

3.2.1 | Research design

A mixed-method design involving in-depth interviews, participatory geographic information systems (PGIS), and focus group discussions

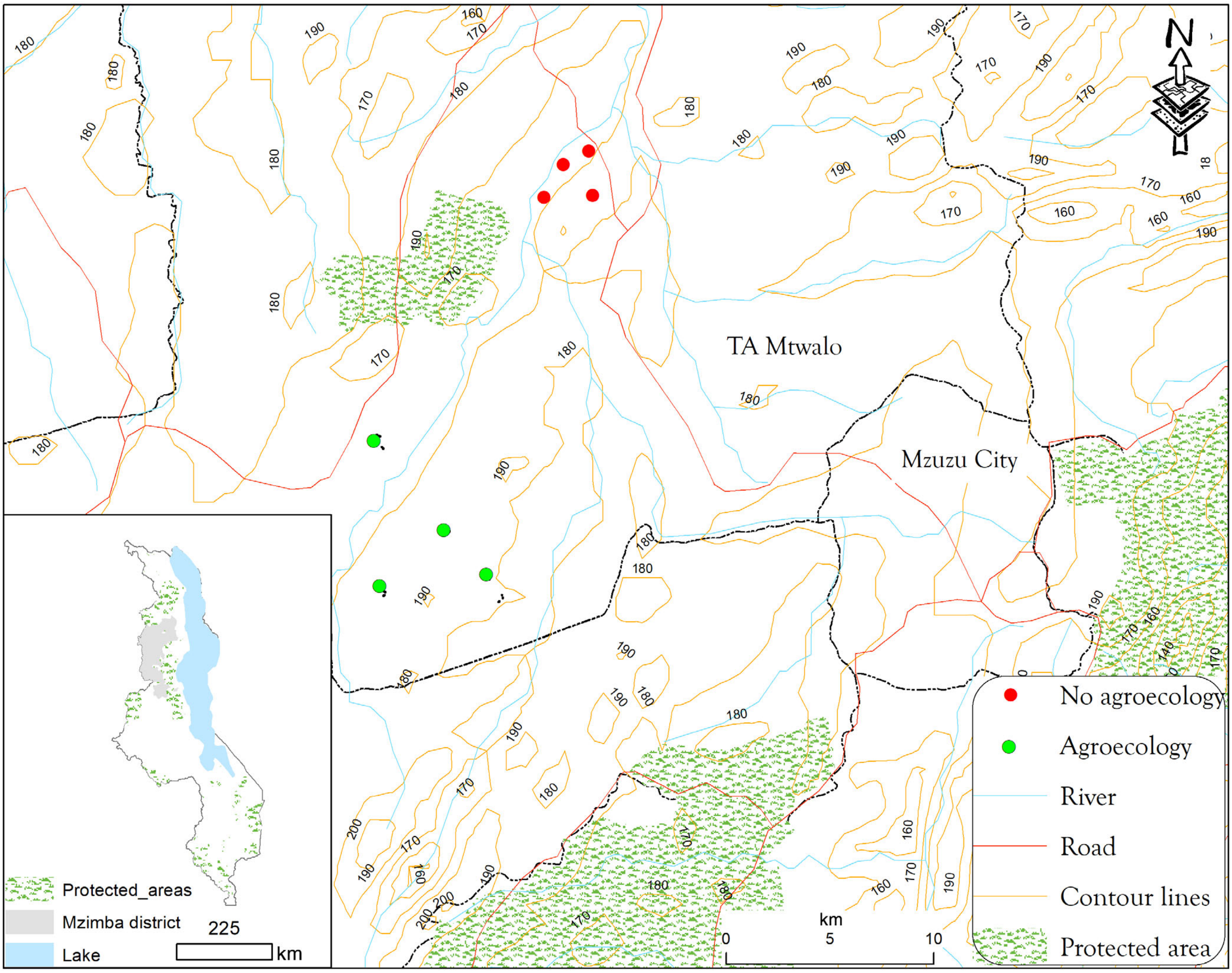

FIGURE 1 Study villages categorized by agricultural practices [Color figure can be viewed at wileyonlinelibrary.com]

were used to address the research questions. Participants from the two study locations (see Figure 1) were selected based on farm size (≤2 ha) (see Lowder et al., 2016) because the study focused on smallholder farmers - those who practice agroecology versus non-agroecology or those who practice conventional farming. The agroecology farmers were participants of an intervention known as the Malawi Farmer-to-Farmer Agroecology, which was implemented from 2012 to 2017 in northern and central Malawi. The intervention was designed to improve food security and ensure environmental sustainability among more than 6000 vulnerable households. We used results from a follow-up survey conducted in the summer of 2019 ($n = 609$) that identified farmers who still practice the agroecology methods they learned during the intervention.

A random sampling strategy similar to what was used to identify the agroecology farmers was used to select the nonagroecology participants from a village area that was involved in another research project that is focused on building on the networks and benefits of the agroecology intervention. We further selected farmers from both village areas with fallow lands and used mental mapping to retroactively assessed how the farmlands and fallows were used in the last 5 years. The goal was to determine the rate of agricultural land use change and how that might affect the regeneration of ecological processes in agroecosystems. The 5-year assessment period is consistent with the FAO's forest assessment time frame of every 5–10 years (FAO, 2020). We ensured that both male and female farmers were included in the study because both men and women are actively involved in agriculture in the study location.

3.2.2 | In-depth interviews and focus group discussions

In-depth interviews were used to elicit the perceptions of 56 farmers (30 female farmers) in 8 villages. Perceptions are an indispensable form of evidence that is useful at all stages of biodiversity conservation from planning and implementation to ongoing management (Bennett, 2016). The focus group discussions were held in 2 locations—one each for agroecology [9 participants

(5 female farmers)] and nonagroecology village areas [16 participants (7 female farmers)]. We discussed local factors that drive deforestation and those that hinder forest restoration. We further examined some of the key issues raised during the in-depth interviews by individual farmers during the focus group discussions for clarification. The issues raised in both in-depth interviews and focus group discussions formed the basis for interviewing the key informants. The participants also discussed the linkages between local and national policy and livelihood strategies that interact to enhance deforestation and inhibit forest restoration.

The in-depth interviews and focus group discussions were conducted in the local Tumbuka language with the help of an interpreter and lasted between 45 and 60 min. The interviews and focus group discussions covered cross-cutting themes including the livelihood systems, agronomic practices implemented, perceptions about the impacts of livelihood strategies on forests, and the challenges to forest reforestation. The tape-recorded interviews and focus group discussions were translated into English by research assistants and transcribed verbatim for thematic analysis using NVivo (version 11).

3.2.3 | Participatory geographic information systems (PGIS) activities

We selected 24 farmers from the 8 villages based on the criteria that the farmers had a field currently being cultivated and another one in fallow. We labeled the first field that was visited as A and the second field as B. Based on the two fields, each farmer was engaged to describe how they used the land (either cultivated or fallow) over the past 5 seasons (2014/15 to 2019/20). Each farmer used an Etrek 10 Vista HCx handheld GPS device to map the farm sizes after they were trained to use the devices. The .gpx files from the GPS were exported to ArcGIS Pro and converted to feature classes, which were then overlaid on high-resolution ESRI base maps to show the geolocation and extent of the fields (see Figure 2). The attribute tables of the polygons were exported for a nonparametric Mann–Whitney *U*-test analysis. The statistical analysis was to test for significant differences between the area of cultivated farmlands and fallow lands to assess the impact of agronomic practices in reviving ecological functions of agroecosystems for restoration. The Mann–Whitney *U*-test (Mann & Whitney, 1947) was used because the data are continuous,

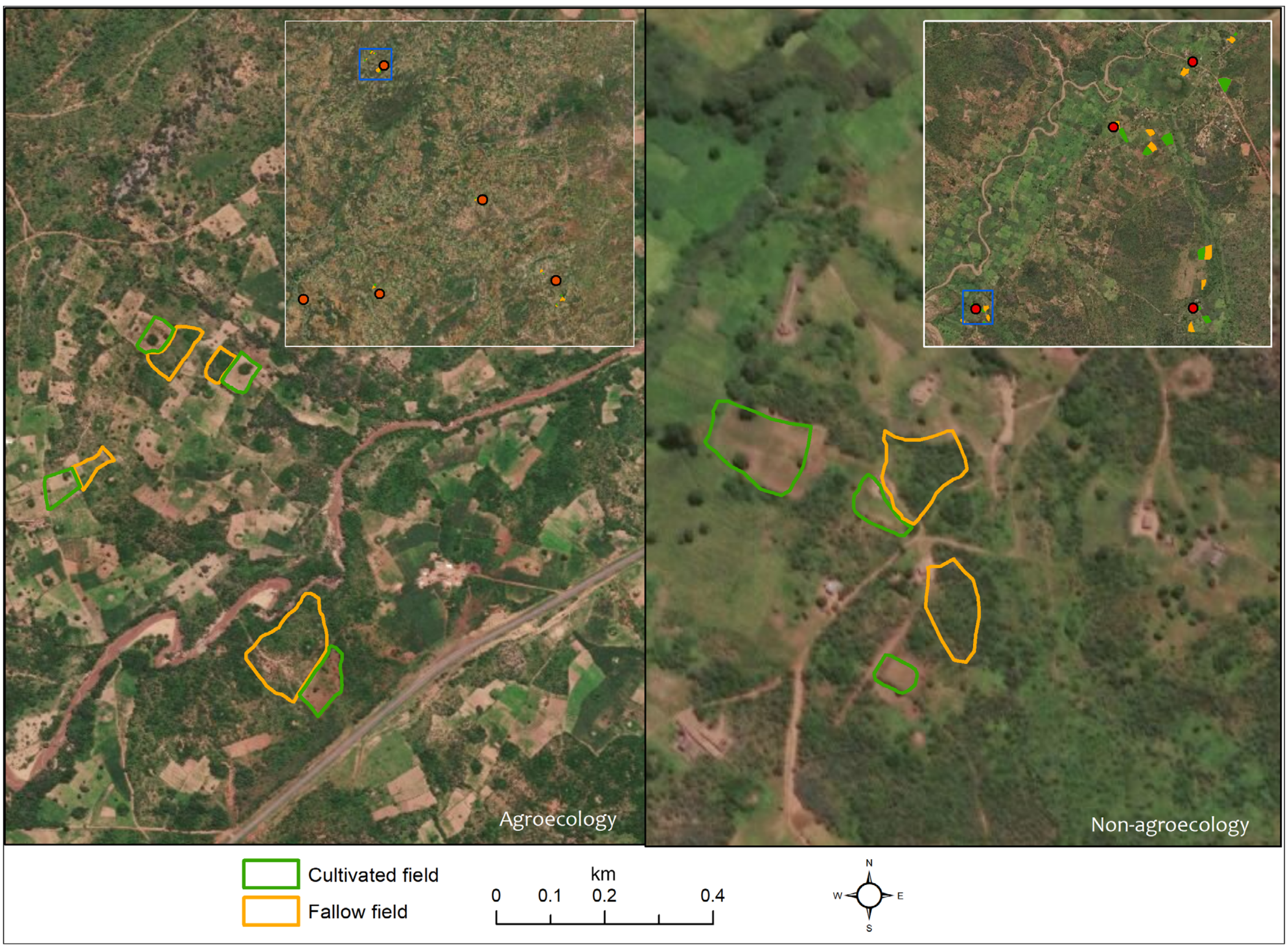

FIGURE 2 Sample fields for agroecology practicing and non-practicing villages (source of the base map: ESRI base maps, ArcGIS) [Color figure can be viewed at wileyonlinelibrary.com]

the sample sizes are relatively small, and the measurement of land sizes is not normally distributed (Nachar, 2008). Ethical approval for the research was granted by the Western University Non-Medical Research Ethics Board (NMREB# 113568).

4 | RESULTS

4.1 | Participant characteristics

In both locations, female farmer participation was high, 53% for the agroecology-practising area and 47% for the nonagroecology practising location (Table 1). Most respondents in both locations had household sizes ranging from 4 to 7, indicating similarity in labor force characteristics. The age distribution of respondents was also similar for both locations (Table 1). There are, however, differences in land management practices, with more respondents from the agroecology villages adopting sustainable land management practices.

4.2 | Contextual drivers of deforestation in northern Malawi

The farmers mostly stated that they expand farm sizes to account for poor soil quality and drought or unpredictable rainfall that results in lower yields and to increase productivity to meet household food needs. One elderly farmer thinks, from a historical perspective, that:

> "…everyone wants to increase their farm sizes because the yields are no more as good as they used to be. The rains are not as consistent as before, so if you have a small field and there is rainfall failure then yield will be poor" [male farmer, nonagroecology village].

While many farmers noted that agricultural activities, charcoal burning, and fuelwood harvesting are the main drivers of deforestation, many elderly farmers observed that climate change has also become a major contributor to the problem. The following comment by an elderly farmer who has been farming in the area for over 35 years summarizes the view of most participants:

> "I used to clear the trees to plant crops, but they used to grow back in a few years if we allowed the land to fallow. Now there are droughts all the time and trees cannot grow back. Even trees that we have planted do not survive because of persistent droughts" [male farmer, nonagroecology village].

Meanwhile, the role of tobacco production in driving deforestation was highlighted by the two key informants who explained that tobacco production is such a potent driver of deforestation because planting tobacco on old lands (previously cultivated lands) results in disease infestation, for which reason new lands are always required.

TABLE 1 Characteristics of in-depth interview respondents ($n = 56$)

Variable	Agroecology farmers (%)	Nonagroecology farmers (%)
Gender		
Male	12 (56)	14 (54)
Female	16 (53)	14 (47)
Household size		
0–3	9	7
4–7	13	15
8 or more	6	8
Age		
25–35	7 (50)	7 (50)
36–45	12 (55)	10 (46)
46 or more	9 (45)	11 (55)
Farming practices		
Mulching	21 (88)	3 (13)
Residue burying	28 (76)	9 (24)
Animal manure	27 (68)	13 (32)
Legume integration	28 (82)	6 (18)
Composting	26 (67)	13 (33)
Other livelihoods		
Fishing	13 (43)	17 (57)
Charcoal burning	9 (27)	24 (73)
Dry season farming (dimba)	24 (51)	23 (49)
Livestock rearing	17 (40)	25 (60)

Additionally, burnt brick production to satisfy the growing demand of real estate developers in especially urban areas was a major driver of deforestation in the communities. Farmers expressed concerns about the environmental impact of harvesting such quantities of wood for brick production. A comment by one of the farmers highlights how the compounding effect of climate change contributes to the degradation of forests:

> "…people want to build stronger houses that will withstand the frequent storms [heavy rains and winds] that are prevalent in recent times. Burnt bricks produce stronger homes that are resistant to inclement weather which has increased demand for them [the bricks] in both rural and urban areas" [male farmer, agroecology village].

Another factor mentioned mainly by the nonagroecology farmers was the impact of government input subsidies in driving deforestation. Some of the farmers indicated that having access to fertilizers incentivizes increased land cultivation to increase yield, thus resulting in more land being cultivated, as indicated by the comment below. This assertion reflects the influence of translocal factors on local livelihood decisions, which in turn influence environmental resource use.

> "…having access to subsidized fertilizers is an opportunity to expand farmlands and increase yield. For me, the subsidies give me more disposable income to rent more land for cultivation" [male farmer, non-agroecology village].

4.3 | Farmer perceptions of forest restoration

Generally, farmers perceived forest restoration as the transitioning of degraded agricultural lands through various stages back to semi-natural landscapes. Figure 3 describes the stages in farmers visualizing forest restoration from an agricultural land rehabilitation perspective. Based on their experiences and ecological knowledge on restoration, farmers perceived that cultivated farmlands (Figure 3a), if allowed to lie fallow over time (Figure 3b) could begin to revive ecological functions/processes and begin the process of transition to shrublands (Figure 3c) and likely semi-natural forests over longer periods (Figure 3d). But they noted that oftentimes, the shrublands do not transition to semi-natural landscapes because they are cleared again for farming (Figure 3e).

From the perspective of restoration of nonagricultural lands, participants perceived forest restoration in terms of reconstruction of native species, which they have historically relied on for provisioning and cultural ecosystem services such as food, housing construction, and medicinal purposes, as highlighted in the following comment:

> "There were a lot of trees that once served many purposes such as food for humans and animals, provided wood for house construction and herbs for medicinal purposes. Most of these trees are no more. So, for me forest restoration means finding ways of getting these trees to grow back in the forest so we can derive these benefits" [male farmer, agroecology village].

Other farmers also commonly perceived restoration as involving the planting of trees provided by government institutions, NGOs, and individual initiatives to *replace* trees that have been cut for to serve various livelihood purposes including crop cultivation, tobacco curing, and charcoal production as highlighted by the views of the following farmer:

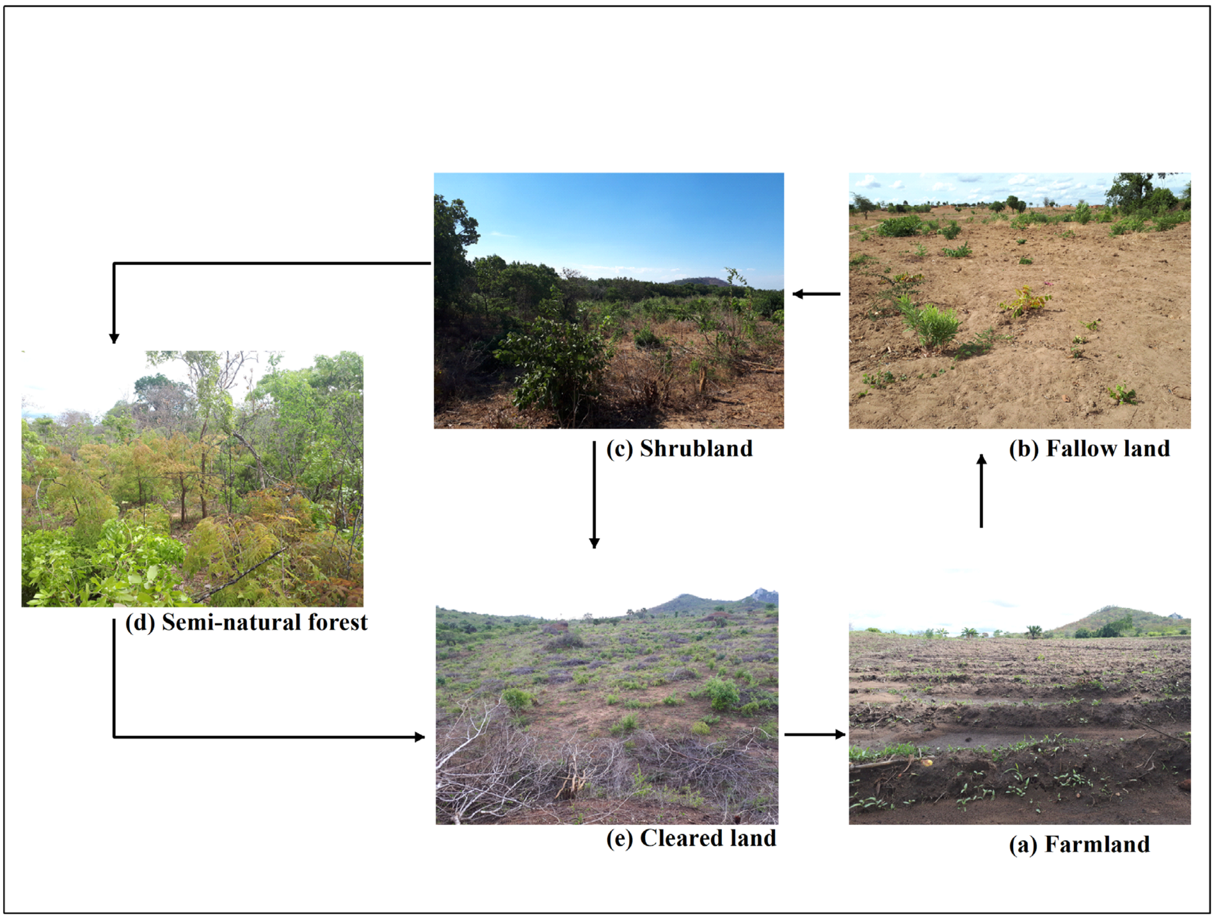

FIGURE 3 Farmer visualized their perception of the transition of forests from farmlands to fallows, shrubland and semi-natural landscape or they get cleared again for farming and the cycle begins again [Color figure can be viewed at wileyonlinelibrary.com]

> "Replacing trees which we cut when preparing our farmlands by planting more trees is a way of restoration. Over the years, I have received tree seedlings from the government agencies and NGOs to replace these logged trees even though most of them have failed to grow to full trees" [female farmer, non-agroecology village].

4.4 | Perceived challenges to restoration of degraded agroecosystems

4.4.1 | 'Splitting' families for economic gains from subsidies and food aid

Most farmers were of the view that the subsidy distribution system inhibits forest regeneration. During the focus group discussions, the most dominant view was the splitting of families to create new villages[1] to gain access to the subsidy increases the pressure on land and the forests on them. Families also split up to gain more access to food aid provided by the FAO and other oraganizations. The farmers revealed that when families move to new locations on the landscape with forest cover, it creates an avenue for the vegetation to be cleared for crop production, housing construction, and other purposes. They are also able to rent the land to other farmers. The following comment by one of the discussants reflects the views of most farmers:

> 'Certainly, splitting families to create new villages in different locations intensifies deforestation and prevents degraded lands from recovering. The new occupants intensify land usage for farming and charcoal production and fallow areas are also put into use again. The new occupants may also rent the land to other farmers, especially tobacco producers for economic gains' [male farmer, agroecology village. Focus group discussion].

4.4.2 | Embedded cultural practices

In the northern region of Malawi where patrilineal inheritance is practised, only men can decide to plant trees on the land though women farmers are the majority. Female farmers must have the backing of a male landowner to plant trees, as explained by one of the farmers:

> 'We uphold the patrilineal system, where we [male farmers] can make long-term plans only on our father's land. Also, women in this part of the country are usually not allowed to plant trees due to cultural reasons. So, reforestation to replenish depleted forests cannot be achieved in such contexts since female farmers is the majority' [male farmer, roecology village. Focus group discussion].

4.4.3 | Commercial charcoal production

The farmers highlighted charcoal production as by far the biggest driver of deforestation in the area. They linked the high rate of charcoal production to poverty, the nonexistence of other economic opportunities, and the lack of alternative livelihood strategies. Key informant 1 elaborated on the complexity of this issue as follows:

> "Deforestation and poverty in these communities are inextricably linked. Charcoal production is by far the biggest contributor to deforestation but cutting wood to sell to burnt brick producers is equally an important driver. The reason for producing charcoal is to supplement the meagre income derived from farming. Until they address poverty, we cannot address deforestation. By extension, we cannot restore the lost forest" [key informant 1].

4.4.4 | Weak ecosystem governance structures

The village areas are politically structured such that there are traditional areas (ruled by chiefs), area development committees, and village development committees. These governance structures are responsible for, among other things, ensuring effective management of forest resources. But as stated by the key informants, operations of such local political structures, which were in some cases imposed during authoritarian regimes, participate in corrupt management practices, and are often influenced by the powerful tobacco and construction companies that require wood and other environmental resources:

> "The local political governance structures have completely broken down. The chiefs and committee members who are supposed to impound and report vehicles carrying charcoal and large volumes of wood fail their responsibilities. Some of them connive with the merchants to avoid arrest" [key informant 2].

Farmers also blamed the nonexistence of forestry officials in their communities or corrupt officials, where they are available, for the unattainability of fully restored forests. They alluded to the practice whereby police at checkpoints allow vehicles transporting logged trees to go rather than arresting the drivers as they are mandated to do. For instance, during one of the focus group discussions, while discussing the question "*Do you think deforestation will ever stop?*" most other participants agreed with the following perspective from one of their colleague farmers:

> …the forestry officials collect money [bribes] from those who cut trees and allow them to go and sell to burnt brick producers in the city when they are supposed to enforce the laws. Even if you take the offenders to the forestry officials and the village head, they let them off-the-hook. You may even end up in trouble with powerful people [female farmer, non-agroecology village. Focus group discussion].

4.5 | Agroecology for agroecosystems restoration

The PGIS activities showed that farmers who practised agroecology had extended fallows, which allowed degraded agroecosystem to begin a slow but gradual process of reviving the ecological functions that facilitate forest restoration on agroecosystems. Table 2 presents results indicating the usage of agricultural lands in the past five growing seasons from farmers' mental mapping of agricultural land uses. The results show that the agroecology farmers intensively cultivated one field, while the other(s) fallowed over a relatively longer period while nonagroecology farmers switched between farms more frequently, allowing the degraded trees on these farmlands less time to restore the ecological functions. The 12 agroecology-practising farmers cultivated a total area of 3.43 ha (for the 2019 season) with 9.73 ha of fallow land compared to 9.59 ha cultivated (for the 2019 season) and 4.05 ha fallow land, for the 12 nonagroecology practising farmers (Table 3), suggesting that the agroecological intensification strategies adopted by the agroecology farmers produced higher yields with smaller farm sizes.

As shown in Table 4, the Mann–Whitney *U*-test results show that the cultivated farmlands of the agroecology farmers are statistically significantly smaller (median = 0.27 ha) than those of nonagroecology farmers (median = 0.70 ha), $U = 10.0$, n1 = n2 = 12, $p < 0.0001$. Further, the fallow lands of the agroecology farmers are statistically significantly larger (median = 0.70 ha) than those of nonagroecology farmers (median = 0.37 ha), $U = 13.0$, n1 = n2 = 12, $p < 0.001$, suggesting that larger fallows can restore the ecological processes that can result in restoration of degraded vegetation on farmlands.

Indeed, both key informants asserted that based on their observations in the communities they work in, using conservation agriculture and agroecological practices helped the transition of fallow lands to recovery paths and reduce the need for expanding fields:

TABLE 2 Trend of agricultural land cultivation and fallowing for two fields belonging to 24 farmers during the past five growing seasons

	Season					Fallow years		
Village area	2019	2018	2017	2016	2015	Field A	Field B	Agroecology
1	B	B	B	B	B	5	0	√
2	A	A	A	A	A	3	2	×
3	B	B	B	B	B	5	0	√
4	A	A	A	A	A	1	4	√
5	A	A	A	A	A	2	3	×
6	A	A	A	A	A	3	2	×
7	B	B	B	B	B	4	1	√
8	B	B	B	B	B	2	3	×
9	A	A	A	A	A	4	1	√
10	B	B	B	B	B	3	2	×
11	A	A	A	A	A	5	0	√
12	B	B	B	B	B	5	0	√
13	B	B	B	B	B	1	4	√
14	A	A	A	A	A	0	5	√
15	B	B	B	B	B	5	0	√
16	B	B	B	B	B	5	0	√
17	B	B	B	B	B	2	3	×
18	A	A	A	A	A	1	4	×
19	B	B	B	B	B	3	2	×
20	B	B	B	B	B	3	2	×
21	A	A	A	A	A	2	3	×
22	A	A	A	A	A	2	3	×
23	B	B	B	B	B	2	3	×
24	A	A	A	A	A	0	5	√

Note: [green] shows cultivated; [yellow] shows fallow; √ shows practices agroecology; × shows no agroecology.

TABLE 3 Descriptive statistics of cultivated and fallow lands (ha) ($n = 24$)

	Cultivated land		Fallow land	
Statistic	Agroecology	Non-agroecology	Agroecology	Non-agroecology
Average	0.286	0.799	0.811	0.337
Median	0.267	0.698	0.691	0.369
Minimum	0.171	0.269	0.338	0.105
Maximum	0.462	1.770	1.638	0.501
Total area	3.428	9.585	9.729	4.045

TABLE 4 Results of the non-parametric Mann–Whitney *U*-test comparing area (in ha) of cultivated and fallow lands of agroecology and nonagroecology farmers

			Ranks		Test statistics	Significance		
Field status	Agroecology	*N*	Mean rank	Sum of ranks	Mann–Whitney *U*	Asymptotic. (2-tailed)	Exact [2* (1-tailed Sig.)]	Decision
Cultivated	Yes	12	7.33	88	10.00	0.000***	0.000***	Reject the null hypothesis
	No	12	17.67	212				
	Total	24						
Fallow	Yes	12	17.42	209	13.00	0.001***	0.000***	Reject the null hypothesis
	No	12	7.58	91				
	Total	24						

***Significant at the 95% confidence level

> "In one of the villages, I work in, the farmers use a lot of organic fertilizers called Mbeya and Bokashi which increases yields very well. As such, they need small farms for cultivation to get adequate yields. Also, the rate of deforestation is very minimal in that village because farm expansion and frequent land rotation are not that prevalent, and the tree is re-growing fallow lands have the trees re-growing" [key informant 2].

5 | DISCUSSION

Farmers identified agricultural land expansion, commercial charcoal production, burnt brick production, and climate change as the main drivers of deforestation in the study context. These observations are similar to findings in other studies in Malawi and subSaharan Africa (Ngwira & Watanabe, 2019; Zulu, 2010; Zulu & Richardson, 2013). An important, albeit nuanced, observation these previous studies have missed is how the interaction of different drivers act to reinforce deforestation. For instance, some farmers mentioned that the intensity and frequency of storms (floods and strong winds) drive demand for burnt bricks since they are more resilient to inclement weather, thus fueling higher demand for burnt bricks (Faria et al., 2019). Another novel finding in the study context is the report that government policies such as the FISP incentivize deforestation, which was observed in the nonagroecology villages. The distribution method encourages village splitting, while at the same time, the fertilizer application alone is insufficient to sustain yields. While this observation may appear counterintuitive, research has shown that fertilizers do not address underlying factors such as soil health or erosion, as such they do not sustain yield in the long term (Messina et al., 2017). Therefore, farmers adopting synthetic fertilizers will only increase yield by expanding land sizes. This observation is consistent with findings by Goers et al. (2012) that macroeconomic policies that provide agricultural subsidies influence deforestation rates in some tropical countries.

An important issue to examine when discussing the restoration of degraded forests is exploring local people's perceptions. Understanding people's perceptions can be a starting point to engaging local people in restoration planning that will achieve desired outcomes faster (Bennett, 2016) because perceptions integrate and reflect the traditional ecological knowledge of local people. Farmers' perceptions of restoration ranged from the rehabilitation of agricultural land, reconstruction of indigenous trees that serve important provisioning and cultural ecosystem services, to the replacement of tree species that are getting extinct, due to changes such as climate change, in their habitats. These perceptions varied based on agronomic practices adopted (agroecology/non-agroecology) and individual characteristics (male/female). Studies have shown that contextual factors, past experiences (including traditional ecological knowledge), individual attributes, livelihood strategies, and preferences mediate and influence the perception of people regarding restoration (Adams & Sandbrook, 2013; Levine et al., 2015; Satterfield et al., 2009). Not only does the foregoing observations indicate the need for integrating various perceptions in forest restoration into policymaking, but they also tell policymakers to anticipate complexities that are influenced by these contextual and individual differences when implementing restoration/conservation policies.

The reasons the farmers iterated as the main challenges to forest restoration reflect the complex mix of socio-economic, environmental (such as the use of burnt bricks to adapt to extreme weather), and cultural factors that shape how livelihoods systems mediate the use of local resources. Splitting their villages to create new villages to increase access to subsidized fertilizers and food aid, for example, allowed farmers to take advantage of material opportunities in light of ongoing challenges (Messina et al., 2017), or to increase income, farmers continuously clear existing land or expand them to satisfy household food and income needs. Additionally, while some cultural norms such as traditional ecological knowledge contribute to the restoration and conservation of ecosystem services in the study area (Kpienbaareh et al., 2020), we found that some embedded cultural practices such as patrilineal inheritance, hinder rehabilitation, reconstruction, and replacement of degraded forests for some households. Farmers also highlighted poverty, low income from farming and lack of economic opportunities in general as factors that hinder restoration because the farmers are trapped in livelihood systems that drive forest degradation. While some studies show that forests can help address multidimensional poverty (DeFries et al., 2021; Miller et al., 2021), Cao et al. (2021) note that where restoration policies do not address 'poverty traps' and urban demand for forest products from forest-rich rural areas, such restoration efforts fail, as observed in northern Malawi (see Figure 3). Finally, we found that weak ecosystem governance structures militate against long-term large scale forest restoration in local communities. Djenontin and Zulu (2021) found similarly that the current ecosystem governance system in Malawi does not foster adequate cooperation to address challenges of limited resource capacity, inequitable resource distribution, and negative institutional externalities, while Birhan et al. (2021) further identify the lack of accountability, low efficiency, lack of fairness, and ineffectiveness as major challenges of good forest governance, as observed in our study.

Despite the challenges to forest restoration, we found that practising agroecological intensification can contribute to restoring degraded agroecosystems to semi-natural landscapes directly and reducing the rate of deforestation indirectly. By applying agroecological farming methods such as intercropping, legume integration, composting, and agroforestry, the agroecology farmers increased yield to meet household food needs using relatively smaller farmlands but with larger and longer-lasting fallows (>4.5 years on average) where they had spare lands. Farmers who practised conventional agriculture, however, had larger cultivated lands but with smaller, shorter-lasting fallows (<2.5 years on average). Abandoned farmlands or fallows often revive their ecological functions and begin the process of restoration, which explains why farmers perceived restoration in terms of rehabilitation of deforested farmlands. The observations support the contention that agroecology as an approach promotes ecological processes and can lead to the restoration of degraded ecosystems (Nicholls et al., 2016). Studies by Vieira et al. (2009) in southeastern Brazil show that agrosuccessional restoration, involving green manure and farmer-managed natural regeneration strategies, contributed to the rehabilitation of degraded farmlands within a short period. Our finding complements prior works on agroecological production as an environmentally sustainable alternative for simultaneously increasing yield and ensuring the ecological integrity of the environment (Cassman, 1999; Geertsema et al., 2016; Kleijn et al., 2019) with evidence from rural Africa.

Indirectly, practising agroecology could reduce the rate of deforestation. The reduced need for expanding farm lands because of agroecological intensification implies that the rate of deforestation will likely reduce. Thus, since farmers cited poverty and low income from farming as one of the restoration challenges, our findings suggest that practising agroecology can potentially increase yield to address food needs, which would reduce dependence on livelihood systems that incentivize forest exploitation. If decent markets could be obtained for agroecological products, restoring agroecosystems/forests could in turn likely reduce poverty, all other things being equal, and break the 'poverty trap' (Cao et al., 2021). Policy initiatives that support agroecological markets, as described in Brazil (Valencia et al., 2019), could be pursued for these twin goals of viable rural livelihoods and forest restoration.

6 | CONCLUSIONS

Our study revealed complex interacting factors—socio-economic, cultural, and political factors—that drive forest degradation. Exploring smallholder farmers' perceptions about restoration is a basis for harmonizing farmer reality, the scientific understanding, and traditional ecological knowledge on restoration to better shape policies that are designed for landscape restoration. Agroecology is emerging as a pro-poor alternative that supports food security among forest-dependent households and restore forests compared to conventional input-intensive capitalist agriculture that contributes to degradation. The findings suggest widespread adoption of agroecology could complement global efforts towards addressing food insecurity and promoting environmental sustainability.

The findings point to the critical need to reassess forest restoration objectives and place livelihoods of forest-dependent people at the forefront of where, how, and what interventions governments and local people pursue to enhance ecosystem services and biodiversity. Reports that subsidies contribute to deforestation, for instance, call for a relook at the FISP policy in Malawi and highlight the need for agroecology as an alternative to such input-intensive approaches. Future studies should use remote-sensing classification for trend analyses of agricultural land use change in the agroecology and nonagroecology areas to assess the long-term impacts of agroecology on forest restoration. Such analyses will incentivize policymakers to place importance on public education to promote widespread adoption of agroecology to ensure large-scale forest restoration.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ENDNOTE

[1]The Government of Malawi provides subsidies per village, distributed by village leadership, which affords the village leaders some control over important resources, related political power and prestige. The farmers revealed that many villages split into 2 or more, because individuals wanted access to these resources and power.

DATA AVAILABILITY STATEMENT

Data available upon request.

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