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Environmental factors are an important part of farmers' assessments of the value of agroecology

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The need for transformation of food and agriculture systems to be aligned with sustainable development goals is widely acknowledged. Evidence from many parts of the world shows that agroecology, which considers the social and environmental performance of agricultural systems along with economic aspects, is helping farmers transition to sustainable agricultural systems. However, there are demands from national, regional and international food and agriculture planners and funders for evidence that agroecology can work at scale. Providing that evidence requires understanding how farmers use environmental factors when selecting agricultural practices, which is poorly documented. This study contributes to filling this gap by reporting how environmental factors are important in farmers' decisions related to adopting agroecological practices. Qualitative and quantitative data from 239 key informants, a survey of 5025 farms, 85 focus group discussions with farmers and five participatory cross-benefit analyses in eleven case studies across eight African countries were used. We show that farmers use information on and perceptions of a wide range of environmental variables and processes when assessing the usefulness of agroecological practices. In most cases, farmers cited environmental factors more frequently than economic reasons for choosing to use agroecological practices. Most of the environmental factors articulated by farmers were components of the local or farm environment that were connected to their livelihood, including aspects of soils, water, microclimate, pests and diseases, other animals, and vegetation. Intrinsic and relational environmental values such as conservation of biodiversity, long-term maintenance of land quality and aesthetics were also important. These findings show first that providing data on environmental roles of agroecology will always be challenging because of the breadth of factors that are important. Secondly, viability or usefulness of an agroecological practice is not a characteristic of the practice alone, but also of the context in which it is used. Third, impact analyses of agroecological interventions cannot be confined to consideration of a few globally comparative indicators but need to include the context specific environmental factors that farmers care about.

KEYWORDS

agroecology, environmental, assessment, Africa, practices

1 Introduction

The need for transformation of food and agriculture systems to be aligned with sustainable development goals is widely acknowledged (HLPE, 2019). Agroecology is a science and body of knowledge, a set of practices and a political movement aiming to transform food systems to make them more equitable and sustainable (Wezel et al., 2020). Agroecology considers the social and environmental drivers and impacts of agriculture along with economic aspects. There is a wealth of documented experience of farmers in many parts of the world transitioning to an agriculture that is more aligned with agroecology, including smallholder farmers in Africa (Bezner Kerr et al., 2021). However there is still a common opinion that, while agroecology is an option for some farmers, it cannot form the basis of food security for all (Falconnier and Cardinael, 2023). The concerns centre on both productivity of agroecological systems and also the misunderstanding that agroecology means traditional farming that will keep people in poverty. These alternative narratives of agroecology are explored by Madsen et al. (2025). Hence there is a demand by national, regional and international food and agriculture strategists and funders for evidence that agroecology can provide the food people need while keeping the impact of meeting human needs within planetary boundaries.

Implementation of agroecological approaches requires holistic assessment across social, economic and environmental aspects and that, in turn, involves making choices about what to measure (Crossland et al., 2025). Choices are often driven by the sectoral interest from which a particular initiative comes, such as climate, biodiversity or human nutrition, resulting in decisions to measure indicators such as soil carbon, pollinator abundance, or child anthropometrics. While specific indicators may meet the narrow requirements of some users, they will not provide a balanced and integrated view of the contribution of agroecological practices to social, environmental and economic dimensions of agricultural systems. When providing evidence about system performance it is important to measure the components that are of concern and interest to those who will use the data and those who will be influenced by the outcomes of adopting practices. When evidence on system performance is used, for example, to make recommendations or set policy, then we would expect the system to move toward improving aspects that are assessed, while those that are not assessed might improve or degrade (Muller and Sukhdev, 2018; Stiglitz, 2020). For example, if soil carbon is the primary indicator that is monitored and used to make decisions, we would expect it to increase over time but food quality, farmer welfare or profitability may be compromised. This concept is summarised by the principle of "measure what matters," and that includes understanding the aspects of system performance that are of importance, or matter, to different groups with an interest in the system. The farmers in any system are one of those groups with an interest and hence what matters to farmers should influence the way systems are assessed, not least because this will influence, and ultimately determine, farmers' choices on what to do (Wiget et al., 2020). Anyone that aims to promote use of agroecological practices needs to understand the viability of practices from farmers' perspectives. It is often assumed that farmers are driven to do new things primarily by economic considerations, including whether they can afford the investment and whether the investment gives an acceptable return. This is particularly true in Africa where farmers are often resource-poor and there are limited options for alternative livelihoods. However, agroecological practices are designed to improve social and environmental dimensions of system performance, often ignored by policy makers, as well as economic aspects. Understanding farmers' choices and how they assess the effect of practices on system performance requires understanding their assessment of social and environmental factors in addition to economic aspects, and the trade-offs among them.

Evidence on productivity of agroecological practices in Africa has been previously compiled, as in the recent meta-analysis by Romero Antonio et al. (2025). However, there remains a gap in knowledge of farmers' assessments or views on the social and environmental dimensions of agroecological practices. Likewise, little is understood about how economic, social and environmental aspects of agroecological practices are brought together by farmers to determine their choices and assessment of the viability, or utility, of those practices. A study to assess the viability of agroecological practices in Africa from farmers' perspectives (the "Viability Project") was conducted from 2021 to 2023, based on the concept of drivers and lock-ins influencing use of practices of which farmers are aware (Andrieu et al., 2025). It has generated insights on farmers' views about the advantages and disadvantages of, drivers and lock-ins associated with, and labour implications of, a wide range of agroecological practices in diverse contexts (Viability Project Team, 2023). The aim of this paper is to document, understand and summarise the evidence on the role of environmental dimensions in farmers' perceptions of viability of agroecological practices. This means understanding the values that farmers attribute to the practices, starting from a position of not knowing what those might be. Hence, we used an approach of values pluralism that is open to the diversity of environmental values that may be held by farmers (IPES-Food, 2016). This contrasts with an approach based on the assumption that economic, or any other single value approach, will capture the complexity of farmers' assessments of viability. It also means that we can not *a priori* select a single environmental factor, such as soil health, on which to focus.

The study and this paper focus on farm-level and household-level aspects of the viability of agroecology. Data collected from farmers and key informants during five stages of the Viability project have been summarised and examined for insights into the environmental aspects of agroecological practices that farmers are aware of and use in assessing their utility.

2 Approach and methods

2.1 Data collection

The project was established in January 2021 with the initial aim of understanding the viability of agroecological practices at farm and household level across environmental and demographic gradients in Africa. Objectives of the project included understanding (1) social drivers and lock-ins influencing use of agroecological practices, (2) their impacts on farm labour and (3) the role of environmental factors. A case study approach was used, with 11 cases in eight countries in Africa, some with multiple sites (Table 1). Each case study consisted

TABLE 1 Case studies contributing to the viability project.

Country	Focus	Lead organisation	Number of sites	Site names
Kenya (West)	Home gardens, community empowerment	Alliance of CIAT and Bioversity	2	Nyando, Vihiga
Tanzania	Diverse farm practices, farmer training	Sustainable Agriculture Tanzania	1	Morogoro
Senegal	Rangelands and livestock	CIRAD	1	Niassante
Burkina Faso (West)	Crop-livestock-tree systems	CIRAD	1	Koumbia
Tunisia	Mixed crop-livestock systems	CIRAD and ICARDA	2	Kairouan, Medenine
Madagascar	Diversification and restoration	CIRAD, FOFIFA and GSDM	3	Ampitafika, Andohanankivoka, Farafangana
Ethiopia (Central)	Crop-livestock integration and legumes	ICARDA	1	Bale
Burkina Faso (Central)	Crop-livestock integration and agroforestry	CIFOR-ICRAF	1	Nobéré
Kenya (East)	Crop-livestock integration and agroforestry	CIFOR-ICRAF	6	Kibwezi, Kitui, Mbooni, Mwala, Mwingi, Yatta
Ethiopia (North)	Watershed restoration	IMWI	1	Bahir Dar
Malawi	Soil, crop and human health	Cornell University	2	Dedza; Mzimba

of a location in which some research and development activities involving aspects of agroecology had previously taken place. Thus it was anticipated that in each location there would be farmers familiar with and using some agroecological practices and that it would be possible to learn something about farmers' assessments of those practices. The study did not focus on impacts of interventions or uptake of new practices, but on how farmers assess practices they are familiar with. Organisations participating in the project were asked to suggest case study locations. The selection of those to include was based on the above criterion of farmers' experience with agroecology, as well as (1) sampling a range of geographical, social and ecological contexts, and (2) practical considerations of available expertise and budget. Further information on the cases study approach is provided by Andrieu et al. (2025). In each location a Case Study Team led data collection. These teams were made up of researchers and practitioners who were already engaged in and familiar with the case.

A Methods Group was appointed to develop the methods. It was made up of social, environmental and economic scientists familiar with agroecology and with extensive experience in Africa. The methodological approach used a common framework that could be adapted to the specific contexts of each case. In consultation with Case Study Teams, the Methods Group designed and piloted data collection methods that involved a number of steps and combined qualitative and quantitative methods. The overall sequence of steps consisted of assembly of secondary data, key informant interviews, a farm and household survey, focus group discussions, then additional optional studies on labour and perceptions of costs and benefits. For each data collection step, standard guides and protocols[1] were shared with all case study teams for local adaption and translation as needed. The details of selection of participants engaging in data collection was different in each case study because of their different contexts and histories. However, in all cases the aim was to involve a representative sample of respondents from the cases study area, including both those who had and had not directly taken part in agroecological interventions. Note that the study focused on farmers' understanding and assessment of practices not on the impact of interventions promoting practices. Further details and a critique of the methods are given in Andrieu et al. (2025). Data from five of these are steps used in this analysis (Table 2). Protocols for the complete study underwent a research ethics review by the Centre for International Forest Research and International Centre for Agroforestry Research (CIFOR-ICRAF) Research Ethics Committee.[2] It confirmed that the study was low risk and verbal consent to data collection was appropriate, as described in the protocols. In each case study location, teams had been working with farmers and communities for a number of years, building social capital that mitigated the risk of farmers feeling pressure to take part. The risk of personal data being inappropriately shared was mitigated by use of strict data confidentiality procedures.

Each Case Study team was responsible for analysis of their own data. In December 2022 findings from each Case Study were presented, initial conclusions extracted (Viability Project Team, 2023) and themes for cross-case analysis identified. This cross-case analysis aims to identify common patterns across diverse contexts while acknowledging the site-specific complexities that inform local agroecological viability.

1 Guides to the methods and protocols are available at: https://stats4sd.org/resources/viability-porject-methods-guide-2025-04-11 and https://stats4sd.org/resources/participatory-cost-benefit-analysis-group-discussion-protocol-2025-03-18.

2 Definitions, standards and procedures of the CIFOR-ICRAF research ethics process are available at: https://www.cifor.org/fileadmin/downloads/CIFOR-Research-Ethics.pdf

TABLE 2 Summary of data collection steps in the viability project used in this analysis.

Step	Aim	Method	Data generated	Provided these results
Secondary data	Describe and understand the context of each case study site	Assembly of existing information	21 sites across 11 cases studies in 8 countries	
Key informant interviews	Understand context and status of agroecology in each location.	Semi-structured interviews with key informants (KIs)	239 interviews from all Case Studies	3.1. Environmental aspects of agroecology understood by Key Informants 3.2. Environmental effects of agroecology understood by Key Informants
Farm survey	Generate data on farm structure and agroecological practices used.	Farm survey using standard questionnaire.	5,025 farms surveyed in 9 Case Studies	3.3. Environmental reasons farmers use agroecological practices
Focus group discussions	Understand drivers and lock-ins of practice use.	Focus group discussions (FGDs) with farmers who had been surveyed, using a common protocol.	85 FGD records from 7 Case Studies	3.4. Deep discussion with farmers reveals more environmental aspects
Qualitative cost benefit analysis	Understand factors influencing farmers' overall assessments of agroecological practices and systems.	Group discussion of alternative systems and practices using an advantage/disadvantage (or cost/benefit) framework.	Analysis of selected systems and practices from 5 Case Studies	3.5 Participatory cost–benefit analysis of agroecological farmer's practices

The project was established to understand viability of "agroecological practices" which were defined as follows.

> "In the study, we defined "agroecological practices" with reference to the agroecological principles (Wezel et al., 2020). We defined agroecological practices as those that, deliberately or not, implement or make use of one or more of the principles of agroecology and where a less agroecological alternative practice is also used." (Andrieu et al., 2025)

Reasons for and implications of this definition are discussed further in Andrieu et al. (2025).

Data analysis

In each step of data collection, farmers or key informants described beliefs about agroecological practices, their properties and impacts, and reasons for using them or not. For this analysis we have attempted to separate environmental factors or dimensions of agroecology from other dimensions. To do this we took as environmental any reference to the biophysical environment (land, air, water and the non-human life it supports). This rule was applied except when the environmental factor was directly *related by the respondents (key informant or farmer)* to production or economic effects. At all stages, multiple classifications were used when needed. For example,

- "protects insects" was classified as environmental because no effect on production or economic outcome is mentioned.
- "reduce crop damage from insects" was classified as a production or economic factor because no environmental factor has been identified (eg fewer insects, different insects, or different insect behaviour).
- "improved soil fertility and crop yield" was classified as both environmental and production.

Similarly, environmental factors were distinguished from social (including human welfare) factors when respondents themselves stated the connection with the environment. For example, "human health" was classified as a social factor but "improved health because of less chemical pollution" was classified as both social and environmental. Classifications done during the cross-case analysis were confirmed by teams from case study sites. Some ambiguous cases remain but their frequency was low enough for them not to make a substantive difference to the results. For the farm surveys, the categories of reasons for using agroecological practices (for example, protect environment or better yield) were selected during piloting of the data collection tool. Enumerators collected classified responses in the field, with multiple classifications permitted. They used a common codebook and were trained in data collection. The responses in the "Other" category were classified as environmental if further clarification from the farmer indicated an environmental reason. For example, a farmer might give the reason as "Other" and explain this was "Improve water holding capacity." This was then classified as an environmental reason. The classification of "Other" responses was done by the lead analyst and decisions were discussed with case study teams when there was any ambiguity.

Environmental effects reported by respondents were included in the analysis, whether or not they aligned with other sources of knowledge.

Different respondents group practices in different ways. For example, "mulch," "ground cover," "conservation agriculture" and "soil and water conservation" form a nested sequence of practices (each is part of the next) but all were mentioned by respondents as practices. When analysing the data, we aimed to use the labels for practices that respondents had used, but unified alternative names for the same practice. For example, the practices recorded as "agroforestry," "diversified agroforestry," "planting agroforestry trees" and "tree planting on the farm" were all labelled as "agroforestry." Case study teams were consulted when the meaning of a term was not clear. Thus, the overall approach to classification of agroecological practices and reasons for using them was a combination of deductive (starting with the concept of social, economic and environmental aspects of agroecology) and inductive (using respondents' own terms and rationalising them).

Quotations selected to be illustrative of specific points are included and are identified by the country from which they came. Those not recorded in English have been translated by the team leading each case study.

The focus group discussions (FGDs) were designed to get deeper understanding of the drivers and lock-ins to the use of agroecological practices. The topics farmers wanted to discuss were anticipated to be dominated by social factors but environmental aspects also emerged. The information was extracted from focus group discussion meeting notes and entered into a database, with case-specific coding decisions. Quantitative information from FGDs is based on counts of practices discussed. The first part of each FGD involved validation of agroecological practices used that had been identified in the farm survey. Then in each FGD, participants identified the practices they wanted to discuss, as described in the protocol. There are data records from 84 FGDs that discussed a total 1,421 practices, an average of about 18 practices per FGD. These 1,421 practices were not all distinct since several FGDs discussed the same practice. The structure of the data is complex as the nesting of cases/sites/FGDs is very uneven. Some cases held one FGD per site while others used several. As a result of this, we focus on qualitative information from the FGDs.

The qualitative cost–benefit analysis of agroecological farming practices used a method similar to that described by Mkindi et al. (2021). In a focus group setting, participants select a small number of systems or practices to compare based on those discussed in the FGDs. For each, they identify and rate benefits and disadvantages, and the overall balance. The method was used by five case studies with variations in details of the design and process (Table 3). We analysed each case separately by looking at the pattern of advantages and disadvantages; that is, factors that support or hinder use of the practice. The factors were classified as social, economic or environmental. Some teams returned data with the classification completed, others were coded during cross-case analysis. Factors could be assigned to more than one category.

Case study teams that collected data held follow-up meetings with participating farmers to share results and discuss findings. The results of cross-case analyses, such as those in this paper, were not shared with participants for both logistical reasons and the likelihood that they are not necessarily relevant to individual farmers.

Data were processed in R (R Core Team, 2025) with additional coding and labelling done by examination of individual records. Frequency analysis was used where appropriate.

3 Results

3.1 Environmental aspects of agroecology understood by key informants

Key informants (KIs) were asked about their understanding of the term "agroecology" and references to environmental aspects are summarised here. A few KIs, particularly in Ethiopia, used the term "agroecology" in the sense of "agro-ecozone" defined by climate, altitude, soil and landform but most understood the term in the way we have used it in the project.

More than half the KI respondents (123/237) referred to aspects of the environment when describing agroecology. Many aspects were mentioned, related to soil, water, trees, vegetation, wildlife, microbes, insects, pollution, rain, and microclimate. They included both positive (protection and enhancement) and negative (degradation and damage) effects. The spatial scale of these environmental aspects was often not mentioned explicitly, but where it was the focus was predominantly on the local, "immediate" or farm environment. No KI respondents mentioned global environmental concerns such as climate change or biodiversity loss. However, reference to future generations implies a long-term view in a few cases. For example, "Agroecology is a practice that aims at increasing farm production while conserving the environment for both current and future generations to use" (Kenya), or "preserving health of soils, human and animals including useful insects" (Burkina Faso Centre) and "Agroecology has no official definition, but it is a sustainable mode of production, with a better management of natural resources for future generations" (Madagascar).

The environmental consequences of using agroecological practices were mostly positive, such as "sustaining," "protecting," "conserving," "respecting," "taking care of" or "enjoying" aspects of the environment. There were actions concerned with preventing environmental problems ("avoiding conflicts," "not harming" and "minimising disturbance"), or reversing damage ("rehabilitating," "restoring"). Some important, though less common, statements such as "[agroecology] is not aggressive with the ecosystem…," "allows ecological succession" and "means keeping a natural balance" indicate thinking about ecosystems rather than only environmental effects on production.

Two other important characteristics of agroecology were mentioned only rarely in relation to the environment. Systems, interactions and complexity are evident in a few statements such as "[agroecology involves] managing interrelationships between farm and the environment…." Many KIs referred to "nature" when describing agroecology in statements, for example "farming without conflicts with nature" and "maintaining the value of nature." However, there were only a few references to drawing inspiration from natural processes, such as "trying to mimic nature."

3.2 Environmental effects of agroecology understood by key informants

The environmental effects of agroecology articulated by KIs were similar to those listed when describing environmental aspects of agroecology, such as soil improvement, protecting biodiversity, and watershed protection. Some effects were more general, for example saying agroecology was "environmentally friendly" or "provided green cover." The coexistence of generalised environmental descriptors and more technical observations (e.g., "provides litter," "improves soil moisture") suggests a spectrum of environmental awareness among KIs, with implications for how agroecological messaging is received and interpreted. Also described were effects on human health, with the implication that this was environmentally mediated through agroecology reducing toxin load in the environment. However, we did not examine references to human health in detail.

TABLE 3 Cases that carried out a participatory cost benefit analysis with summary results.

Case	Sites used	Groups making assessment	Comparisons made	Summary of environmental dimensions of results
Tunisia	2 Mixed crop-livestock system in semi-arid central Tunisia. Agropastoral system in the south Tunisia.	Mixed farmer group at each site	Cropping site: animal manure, tea manure, manual weeding. Agropastoral site: resting pastureland, crop residues for fodder.	• Negative and positive environmental, social and economic factors play a part in assessment of each of the practices considered. • Positive environmental factors are most prevalent for "resting of pastureland." These include reduced erosion, recovery of plant cover, increase in soil seed stock, protection of biodiversity, recovery of aromatic and medicinal plants and increasing landscape attractiveness. • A negative environmental factor in resting of pastureland is increasing pressure on open grazing – pressure is transferred from the conserved area to other non-conserved areas. • Other negative environmental impacts need location specific insights to understand. For example, "use of manure" is described as having a negative impact in summer due to human health implications. The overall balance was judged as positive for the three practices discussed by crop farmers and negative by the two practices assessment by agropastoralists.
Burkina Faso (West)	1	Men's group, Women's group	Four farm types differing in viability and agroecology intensity	• The groups gave their overall balance of agroecology and viability with men and women agreeing: Small crop-oriented farms negative in terms of agroecology and viability, Medium size crop-oriented farms positive in terms of agroecology and viability, and Livestock-oriented farms positive in terms of agroecology however negative in term of viability, and large crop-livestock oriented farms similar to the medium. Environmental factors were mentioned as a basis for regarding Medium size crop-oriented farms as sustainable. • Positive environmental factors referred to include: soil fertility protection and enhancement, availability of bio-resources including manure, low use of chemicals and general environmental preservation. The negative factors are low availability of fodder and manure and poor soil conservation.
Burkina Faso (Central)	Four villages in same zone	Cotton farmers (mixed m + f), Non-cotton farmers (mixed m + f)	Cotton farming compared with non-cotton. Cotton-farming was selected as an archetype of "non-agroecological farming" but the alternative is not necessarily agroecological by our definition.	• Similar factors are mentioned by cotton farms and non-cotton farmers in assessment of both systems. • Environmental factors are less prevalent than in other cases, with economic factors dominating both positive and negative aspects. Both positive and negative social interactions associated with money are important • Negative human and animal health impacts of the high pesticide inputs on cotton are recognised by both farmers growing and not growing cotton, but apparently are an acceptable risk to the cotton-growing farmers.
Ethiopia (North)	1	Less agroecological farmers (mixed m + f) More agroecological farmers (mixed m + f)	Three farm types (more, intermediate and less agroecological) compared by both groups.	• Both groups assessed the three system similarly, with the most agroecological as positive and the least as negative. Positive criteria mainly focused on meeting diverse needs, particularly food security. Negative aspects of the most agroecological were associated with labour requirements. • Environmental factors invoked in assessments were soil fertility, hydrological effects, micro-climate and aesthetics.
Kenya (East)	6	Less agroecological farmers (mixed m + f) More agroecological farmers (mixed m + f)	Three farm types of differing agroecological intensity (crop-legume, crop-livestock and agroforestry).	• 1/12 groups judged the crop-legume system as having a positive benefit–cost balance. • 9/12 groups judged crop-livestock system as having a positive benefit–cost balance. • 11/12 groups judged the agroforestry system as having a positive benefit–cost balance. Details elaborated in Table 9.

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Some specific quotes from KIs reveal views about overarching issues as drivers of farmers interest in, or use of, agroecological practices, as in the following.

- "People used to do it before, then chemical companies came and provided easy farming solutions without considering environment, soil health and quality of food harvested." (Kenya)
- "No, agroecology is not common in the area…. But consumer awareness is beginning to emerge in relation to the environment and the quality of the agricultural products consumed and this supports revival of an agriculture that respects the environment, the land and trees." (Tunisia)
- "…environment conservation is, for the last few years, integrated in all developmental sectors including the agricultural companies and agricultural development projects… hence the importance of agroecology." (Madagascar)

When KIs were asked about who uses agroecology practices and why, some 200 different practices were described in 583 responses, though the number of distinct practices depends on how they are categorised. Only 46/583 (8%) of the reasons listed were explicitly environmental, such as "restore degraded land," "protect land against erosion" and "adapt to climate change," as well as less tangible environmental aspects such as "beautification." A further 16% of the responses included reference to soil improvement. In contrast to responses on why farmers use agroecological practices, most KIs (70%) described environmental effects of using agroecological practices (Table 4).

We did not have a standard list of practices so KIs named or described them in many different ways according to their own categorisation, with the entries in Table 4 being based on one way of grouping responses that we used for present purposes. For example, the agroforestry category groups many different tree species used in different configurations on farmland interacting with different crops and livestock. Soil fertility and soil health are the most commonly reported environmental effects, with water relations second. A few negative or undesirable effects were described denoted with (N) in Table 4. The data collection method does not allow us to distinguish between effects that have been directly observed and those that are expected by respondents. Many of the environmental effects of practices listed in Table 4 are known to science. Some effects have to be understood in the specific context from which the observations come. For example, use of manure is reported to reduce pollution and protect aquatic life because, in this case, it was being used as an alternative to mineral fertiliser, a practice that led to nutrient run-off damaging water bodies.

3.3 Environmental reasons farmers use agroecological practices

The results from the farm survey, used in nine of the case studies, about why farmers used agroecological practices comprised five coded reasons, as well as an "other" category (Table 5). The numbers of farmers responding and number and nature of practices described varies greatly between cases. For example, the practice of "exclosure" was only mentioned in the case from Northern Ethiopia and that of "reforestation" only in Madagascar. Therefore, the overall percentages of farmers giving different reasons is estimated giving each case equal weight, rather than each response.

Environmental reasons were by far the most common reasons (84%) given by farmers for using a practice while economic reasons (income generation) were next most common (52%). The exceptions were case studies in Senegal and Eastern Kenya, where economic reasons for using agroecological practices were as common as environmental (Table 5).

The practices reported as used by farmers in the survey (Table 6) are broad and described at different levels of integration, similarly to those described by KIs previously in Table 4. While the mix of practices reported is different in each case, the high level of environmental reasons for use of nearly all practices results in the high overall rate in Table 5.

For some practices the total number of responses was small so we cannot interpret results. Of the practices with larger numbers of responses, the results are as expected. For example, 94% of the 451 respondents that used agroforestry recognised it as protecting the environment, while improved varieties were not seen as protecting the environment. The responses for some practices were surprising, such as 0% of respondents reporting environmental reasons for "residue use." This label was used to describe crop residues used for animal fodder, and the benefits are seen as animal health and productivity, rather than anything environmental. When the respondents explained how the practices protect the environment, most reasons concerned productive aspects of the environment, such as soils, water, pests or microclimate but a few farmers described more general reasons such as practices being "sustainable."

With close to 100% of respondents describing environmental effects as reasons for using the practices, there is little scope for exploring how the various other reasons are connected with the environmental reasons, though there is some evidence that environmental considerations interact with other reasons. In Table 7 the percent of farmers giving environmental reasons for use of practices is disaggregated by whether or not (yes/no) each of four other reasons are also given. Except for health benefits, these differences are small absolutely but statistically significant and have some intuitive interpretation. They are consistent with farmers seeking health and yield benefits whether or not environmental benefits are also obtained, but choosing practices that have environmental benefits independently of whether they are cheaper or income-increasing.

Only a few farmers reported reasons for not using a practice that were related to environmental factors, with those reported falling into three categories:

1. Productive aspects of the environment either did not support the practice (for example, "not enough rain" or "inadequate soil") or were such that the practice was judged as not needed (for example, "no run-off" or "no soil erosion").
2. The practice increased pests, mainly insect pests but also bird pests and, in one case, elephants.
3. In one case the use of animal manure was perceived as making the environment less healthy for people.

3.4 Deep discussion with farmers reveals more environmental aspects

The deeper discussion of practices in the focus groups showed farmers interests and concerns about environmental, as well as social and economic, aspects of practices. Of the total of 1,421 practices (not

TABLE 4 Environmental effects of agroecological practices identified by key informants.

Practice	Summarised environmental effects
Agroforestry	Soil health improvement. Improved water management. Biodiversity protection. Scenic, beautification.
Bee keeping	Crop pollination.
Bio-pest control	Reduced chemical pollution and harm from chemicals. Protect biodiversity and beneficial organisms.
Circular farming	Protect environment from waste.
Compost	Soil health improvement and restoration. Reduced chemicals and clean environment. Water retention.
Conservation agriculture	Erosion control and soil restoration. Conservation of natural resources (land, water)
Crop rotation	Soil health and restoration. Increase in soil microbes. Reduced need for chemicals.
Diversification	Soil health improvement. Conservation of biodiversity.
Drought tolerant crops	Soil health improvement. Sustainable ecosystems. (?)
Fallow	Soil health improvement. Water management.
Fodder	Protection from land degradation.(?)
Ground cover	No fires. Reduced soil degradation and pollution. Maintaining humidity and life in the soil
Improved breeds	Environmental conservation through reduced animal pressure.(?)
Integrated pest management	Reduce chemical use. Maintain ecology. Beneficial insects not killed.
Integrated watershed management	Reduce land degradation. Restores vegetation. Soil health improvement. Improve water use and dry season flow.
Intercropping	Soil health improvement. Reduce erosion.
Irrigation	Disseminates weeds (N). Increases erosion (N)
Legume integration	Reduced chemical inputs.
Livestock conflict resolution	Reduced land degradation.
Livestock integration	Soil fertility improvement. Destructive if poorly managed because of vegetation removal (N)
Manure	Soil health improvement. Reduce pollution, protect aquatic life.(?)
Mixed cropping	Support pollinators.
Mulching	Soil health improvement. Improved soil water. Improve life in soils
Organic fertilisers	Reduce chemicals. Saves environment. Reduce use of slash and burn.
Pasture management	Environmental conservation. Erosion avoided.
Pit planting	Soil health improvement. Water retention.
Reduced tillage	Reduce soil erosion. Increase soil water. Increase weed seed bank
Reduced weeding	Changing patterns of plants and animals.
Rice-fish integration	Water saving. No chemical inputs.
Terracing	Soil health improvement. Avoid erosion.
Water harvesting	Less run off and erosion.

(N), negative effects. (?), effects possibly in contradiction to scientific knowledge.

all distinct) discussed across the FGDs, 337 (24%) were selected for discussion by the FGD members because of "affecting the environment on or around the farm."

The environmental effects mentioned by FGD participants are very similar to those in survey responses and from KIs, frequently referring to soil, water, erosion, insects and pests, microclimate, and pollution. However, the deeper discussion also brought out understanding of the influence of environmental aspects beyond the farm, multifunctionality and the interaction of environmental with social and cultural motivations for the use of agroecological practices. These are illustrated with the following quotations from FGD transcripts with the practices they refer to in brackets.

- "A large land covered with trees improves the climatic conditions of the entire area" (farmer managed natural regeneration)
- "Good for biodiversity" (rangeland resting)
- "Trees add beauty to the environment and also hold soils together to prevent wind erosion." (agroforestry)
- "Trees are a source of beauty" (agroforestry)
- "Trees are a shelter to other organisms" (agroforestry)
- "Shrines for cultural practices" (agroforestry)
- "Agroforestry minimises the effects of climate change" (agroforestry)
- "Shelter for birds and source of nectar" (farmer managed natural regeneration)
- "Minimise environmental pollution" (biopesticides)

TABLE 5 Percent of farmers citing reasons for using agroecological practices in each of nine case studies.

Reason for using practice	Case study										Average
	Burkina Faso (C)	Burkina Faso (W)	Ethiopia (C)	Ethiopia (N)	Kenya (E)	Kenya (W)	Malawi	Senegal	Tanzania	Tunisia	
Protect environment	85.9	48.9	90.5	98	94.9	98.8	95.7	41.2	96.3	93.8	84.4
Better human health	6.3	10.6	12.2	36.7	36.7	53.7	47.6	52.9	74.1	3.6	33.4
Cheaper	17.2	4.3	7.5	36.7	42.8	70.7	34.9	0	44.4	4.2	26.3
Increase yield	89.1	25.5	12.2	51	61.6	91.5	5.6	17.6	33.3	4.9	39.2
Increase income	20.3	31.9	38.1	81.6	93.5	82.9	67.1	41.2	44.4	17.7	51.9
Other	0	2.1	0	0	0.2	0	0	0	0	2.2	0.5
Total responses	140	47	147	49	430	82	1,106	17	27	1,548	

The average weights each case study, not each farmer, equally.

- "Exclosure forest gives environmental beauty, protects soil from runoff, leaves improved soil fertility, protects the environment, protects the soil not to be taken by wind, leaves like croton and others used for soil fertility. Even used for cultural and religious meetings, for example, we are now under tree shade" (exclosures)
- "It allows certain species of plants to still exist" (managing fodder)

The FGDs also revealed farmers' understanding of environmental processes that underlie the practices, such as decomposition, soil engineering, water movement and microbial action.

These data give an opportunity to investigate consistency in views. For example, the case in Northern Ethiopia had 12 FDGs that largely discussed the same practices. For both soil and water conservation structures and exclosures there was agreement across the 12 FGDs on the environmental benefits and these are clearly drivers of their use. However, for home gardens, six FGDs did and six did not cite environmental benefits. Those that did included the following reasons:

- "[A house with home garden] is attractive to see, people always like to see such a garden"
- "Home gardening improves the microclimate of the house and is beautiful to the homestead"
- "[Home gardening] is used to moderate the air and the plant roots retain and hold the soil. This is also good for environmental beauty."
- "[Home gardening] is used for environmental beauty. If you enter into homes that have vegetables you will be satisfied."
- "[Home gardening] is used as shade for resting and makes the air cool"
- "[Trees around the homestead] Attractive for observation… For instance, coffee, gesho [*Rhamnus prinoides*] and other fruit trees in home gardens are attractive to see"

The six groups that did not mention environmental reasons for using home gardens described their contribution to food security and income as the key drivers of use.

The FGDs discussed labour implications of 426 out of 1,461 practice by location combinations, categorising them as having low, moderate or high labour requirements. Hence, we can look at the occurrence of environmental reasons for use of practices disaggregated by labour requirements (Table 8).

High labour practices were twice as likely to have environmental reasons for their use than low labour options, consistent with the environmental benefits making those practices worth the high amount of labour invested.

3.5 Participatory cost–benefit analysis of farmers' agroecological practices

The comparisons made in the participatory cost benefit analysis and the farmers making them were adapted to the local context and hence were rather different across the five cases that used the approach (Table 3). However, it is clear from the summary results that environmental factors feature strongly in farmers' positive and negative assessments of systems and practices, confirming findings from the previous steps.

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TABLE 6 Number of farmers describing use of agroecological practices and percentage reporting environmental reasons for their use.

Practices	Case study										Total n	Env reason (% yes)
	Burkina Faso (C)	Burkina Faso (W)	Ethiopia (C)	Ethiopia (N)	Kenya (E)	Kenya (W)	Malawi	Senegal	Tanzania	Tunisia		
Agroforestry	50		26		113	27	114	1		120	451	94
Soil conservation	35		56				76			193	360	97
Compost	16	3	10	1	40	4	102		5	145	326	86
Grass strips	28						102			161	291	90
Live hedge	12									238	250	98
Reforestation										247	247	98
Mulching	13	14	4		48	1	46			95	221	91
Animal manure	58	1	5		7	13	82		7	47	220	80
Legume residue fodder			1		5	4	192		2		204	100
Legume rotation			14		9	14	148		2		187	93
Biopesticides	3		1		1	1	70		7	70	153	88
Pit planting			10		90	2	34	1			137	85
Legume intercropping	25		2		5	12	86		4		134	81
Terracing					104						104	100
Variety diversity		3	8		3	4	46				64	78
Crop rotation	59				2						61	34
Crop husbandry										56	56	100
Fodder stocks	55							1			56	0
Double cropping	47		2								49	12
Pasture parks	49										49	10
Exclosure				44							44	100
Microdosing fertiliser	44										44	43
Legume integration										42	42	76
Improved varieties										40	40	45
Eco pest management			2		1		8	4		24	39	90
Tree litter for soil	38										38	42
Green manure										33	33	94

(Continued)

TABLE 6 (Continued)

Practices	Case study										Total n	Env reason (% yes)
	Burkina Faso (C)	Burkina Faso (W)	Ethiopia (C)	Ethiopia (N)	Kenya (E)	Kenya (W)	Malawi	Senegal	Tanzania	Tunisia		
Improved fallow	30		1		2						33	55
Liquid manure	2									21	23	87
Residue use		21									21	0
Rice-fish culture										10	10	60
Farm assets building		1								5	6	50
Biomass use								4			4	0
Fodder sources				4							4	75
Minimum tillage		4									4	50
Supplementary feeding								4			4	25
Ploughing frequency			2								2	100
Weeding			2								2	0
Biogas								1			1	0
Broadcast sowing			1								1	100
Mobility								1			1	0
Other										1	1	100
Total responses	564	47	147	49	430	82	1,106	17	27	1,548	4,017	

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TABLE 7 Interaction between environmental and other reasons for using agroecological practices.

Reason given for using practice		Percent also using practice for environmental reasons
Better health	No	93.3
	Yes	54.9
Cheaper	No	83.9
	Yes	86.6
Increase yield	No	85.9
	Yes	73.5
Increase income	No	89.6
	Yes	90.2

For each reason for using practices (Better health, Cheaper, Increase yield, Increase income), the percentage of responses that also gave Environment as a reason was calculated for each case. Percentages presented are averages across nine cases.

TABLE 8 Percent of agroecological practices different labour requirements and environmental reasons as discussed in FGDs.

Labour	Environmental reason for use		*N*
	No	Yes	
Low	82.7%	17.3%	179
Moderate	76.1%	23.9%	46
High	62.1%	37.3%	201
Total	309	117	426

N, total number of practices for which these aspects were discussed.

Data from the cost–benefit analysis of agroforestry in Eastern Kenya are shown in more detail as an example (Table 9). Most striking is the large number of factors that are used by farmers when assessing the viability of practices. Many of these are environmental. The design with six sites and two groups per site allows investigation of consistency of assessments and reveals the diversity of both factors mentioned and their importance. After coding during analysis, 29 distinct environmental factors were identified (Table 10). Some were mentioned by many groups and others once only. The commonest was "soil health," as might be expected for agroforestry. Groups use the term "soil health" as well as other articulations that were categorised as soil health, including "trees act as soil cover," "tree leaves provide humus once rotten," "trees provide manure through leaf fall," "soil erosion control" and "soil fertility." The average importance scores (Table 10) highlight that not all environmental factors used by farmers in assessing agroforestry were positive. The negative factors mentioned include both: perceived negative environmental impacts of agroforestry, such as encouraging termites and competition for plant growth resources; and, environmental conditions that mitigate against use of agroforestry, such as drought. Drought is mentioned because it limits the establishment of agroforestry practices.

4 Discussion

4.1 Reflections on methods

The exploration of how environmental factors affect farmers' perceptions about, and use of, agroecological practices reported here were derived from data generated to explore the viability of agroecological practices more generally across Africa. Lessons about the methods used in relation to the overall evaluation of the viability of agroecological practices are discussed in Andrieu et al. (2025) and so we focus here on the opportunities and constraints of using data derived in this way for understanding environmental factors associated with agroecological practices. There is a risk that the focus on environmental factors in this analysis will misrepresent a more integrated assessment that farmers make. However, we have presented results on interactions of environmental with other effects where possible, such as in Tables 5, 7, 9.

Strengths of the methodological approach include the following.

1. The range of environmental effects considered was not set by researchers but was based on the information from farmers and other respondents.
2. The scope of agroecological practices and systems considered was not set by researchers but by respondents.
3. The "viability" framing of the project means the results are consistently based on respondents' perceptions, beliefs and values.
4. The multiple steps and methods of data collection (KIs, farm survey, focus groups and special studies) produced results that are congruent. This provides some validation of results increasing the credibility of overall conclusions.

The key limitations of the method also arise from the same farmer-centred and flexible approach. While allowing respondents to define environmental impacts ensured local relevance, it also introduced variability that complicated cross-site comparisons. The choices made on such things as how practices were grouped and how factors were labelled as being environmental or not, while explicit, are to some extent subjective and alternative choices may have resulted in differences in the detail of results and their interpretation. Use of explicit criteria for identification of practice labels that are synonyms, and classification of environmental dimensions, could be a more transparent approach to adopt in future research. However, the general findings reported here are sufficiently consistent to suggest that they are likely to be robust regardless of different choices about grouping and labelling. The project was based on the concept of "viability of agroecological practices." The term "practice" was used when eliciting responses but "viability" was not. Instead, respondents were asked about reasons for using or not using practices, and advantages and disadvantages of practices. By using such common but open terms, there is a risk that the framing itself may have influenced farmer responses on environmental factors.

More fundamental is whether farmers' statements about environmental factors can be taken as reliable evidence. This research, and the results reported here, concern the *viability* of practices and systems, and the viability from a user's perspective is their subjective assessment. Hence the validity of our methods hinges on whether the information was elicited in ways that reveal respondents' true assessments and avoid bias, for example that arising from respondents trying to please researchers or as a result of the use of leading questions. While protocols and training aimed to reduce the likelihood of such problems, the use of independent teams collecting data in different case studies makes it hard to completely eliminate them. The congruence of results from the different steps in data collection, that used different methods,

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TABLE 9 Participatory cost-benefit analysis of agroforestry in E Kenya. Factors that participants use to determine the viability of the system are listed, classified as environmental, economic and social. Number of groups out of 12 that mentioned this factor give in brackets.

Advantage or Disadvantage	Importance	Environmental	Economic	Social
Advantages	Most important	Soil health (8)	Firewood (5)	Firewood (5)
		Attracts rain (7)	Income (10)	Food security (8)
		Clean air (6)	Timber (2)	Fruit (4)
		Shade (6)	Fruit (4)	Fodder (3)
		Land restoration (3)	Fodder (4)	Agrobiodiversity (1)
		Wind break (2)	Pesticidal plants (1)	Dowry (1)
		Reduce evaporation (1)		Product diversity (1)
	Moderately important	Soil health (7)	Firewood (5)	Firewood (4)
		Beauty (3)	Fodder (4)	Fodder (4)
		Shade (3)	Timber (2)	Medicine (5)
		Manure (1)	Honey (2)	Timber (1)
		Microclimate (2)	Income (2)	Boundary markers (1)
		Clean air (1)	Manure (1)	Fencing (1)
		Environmental protection (1)	Animal traction (1)	Labour (1)
		Wind break (1)		security for loans (1)
	Least important	Beauty (4)	Medicine (2)	Medicine (4)
		Shelter for birds and animals (4)	Fodder (2)	Fodder (1)
		Pollination (2)	Honey (3)	Timber (1)
		Clean air (1)	Timber (1)	Wealth value (1)
		Ecological balance (1)	Wealth value (1)	Boundary markers (1)
		Microclimate (1)		Fencing (1)
		Shade (1)		Food while working on farm (1)
		Soil health (1)		Sacred places (1)
				Small land area (1)
				Social prestige (1)

(Continued)

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TABLE 9 (Continued)

Advantage or Disadvantage	Importance	Environmental	Economic	Social
Disadvantages	Least important	Damage to construction (2)	Competition (1)	Damage to construction (5)
		Competition (1)	Market for products (1)	Poisonous trees (5)
		Rodents and snakes (1)	Pests and diseases (1)	Knowledge (2)
		Shading crops (2)		Land area (2)
		Smell (1)		Rodents and snakes (1)
		Destroy the environment (1)		Smell (1)
		Diseases to crops (1)		Conflicts (1)
		Hardpan to soil (1)		
		Limited water (1)		
		Termites (1)		
		Thunder arresters (1)		
		Tree cutting (1)		
	Moderately important	Competition (2)	Competition (4)	Livestock damage (4)
		Pests and diseases (1)	Livestock damage (1)	Destruction by animals (1)
		Destruction by animals (1)	Pests and diseases (2)	Labour (2)
		Rodents and snakes (1)	Establishment costs (2)	Land area (2)
		Termites (1)	Market for tree products (2)	Rodents and snakes (1)
		Depressed rain (1)	Termites (1)	Seedling availability (2)
		Drought (1)	Maintenance costs (1)	Skills (2)
		Smell (1)		Disasters (1)
				Hosts enemies (1)
				Theft (1)
	Most important	Termites (5)	Termites (5)	Conflicts (2)
		Drought (6)	Drought (1)	Destruction by animals (1)
		Competition (3)	Competition (2)	Knowledge (1)
		Tree cutting (1)	Establishment costs (5)	Labour (1)
		Limited water (1)	Pests and diseases (4)	Theft (1)
		Shading crops (1)	Tree cutting (1)	
			Market products (1)	

A factor will appear more than once if different groups gave it different levels of importance or it falls into multiple categories. Totals for a factor may be >12 if two different factors have been given the same code at analysis.

TABLE 10 Frequency and average score of environmental factors contributing to assessment of agroforestry in E Kenya.

Environmental factor	*N*	Average importance
Soil health	16	2.4
Shade	10	2.5
Clean air	8	2.6
Termites	7	−2.6
Beauty	7	1.4
Drought	7	−2.9
Competition	5	−2.6
Attracts rain	5	3.0
Shelter for birds and animals	4	1.0
Land restoration	3	3.0
Wind break	3	2.7
Microclimate	3	1.7
Shading crops	3	−1.7
Smell	2	−1.5
Damage to construction	2	−1.0
Rainfall	2	3.0
Limited water	2	−2.0
Destruction by animals	1	−2.0
Pollination	1	1.0
Thunder arresters	1	−1.0
Reduce evaporation	1	3.0
Destroy the environment	1	−1.0
Rodents and snakes	1	−1.0
Diseases to crops	1	−1.0
Ecological balance	1	1.0
Tree cutting	1	−3.0
Environmental protection	1	2.0
Depressed rain	1	−2.0
Hardpan to soil	1	−1.0

Scores from −3 to +3 were assigned for categories of importance of disadvantages and advantages. *N* = number of times factor included in assessment by 12 groups.

increases confidence in the overall validity of the findings. More confidence would have been provided by deeper explorations of reasons behind farmer statements, recording these verbatim and conducting an analysis of this raw text data from all case studies in a uniform way. Such an approach might have allowed us to distinguish when farmers' statements about environmental factors were based on their own observations and know-how, and when they were based on information they had received from external sources. The practical scale of this research did not provide resources for that.

The sequence of data collection steps used was determined by a hypothesis of the overall project, that viability of agroecological practices is related to farm structure. The farm survey was designed to generate the data needed for testing this hypothesis, with the following FGDs designed to provide deeper understanding of revealed patterns. However, this sequence was not ideal for generating understanding of environmental factors involved in farmers' decisions on agroecological practices. More appropriate would have been a sequence of scoping followed by discovery and generalisation, an approach consistent with that developed and widely applied to the acquisition of local agroecological knowledge in Africa (Crossland et al., 2018; Kmoch et al., 2018; Walker and Sinclair, 1998). This would have reversed the order of the FGDs and farmer survey so that the survey could be designed to quantify patterns suggested by the FGDs.

4.2 Environmental factors

The overall dominance of environmental factors as reasons for using agroecological practices is striking and the results in Table 5 seem to contradict the often-made assumption that economic factors dominate farmer decision making. Even if the three economic reasons in Table 2 (increase yield, cheaper, increase income) are combined, 63.5% of responses are economic, compared with 84.2% being environmental. However, these rates are for practices described as agroecological, not all practices. Many promoters of agroecology do so on the basis of environmental sustainability, so that farmers may also associate these practices with environmental factors (Bellwood-Howard and Ripoll, 2020). The more expected situation, where environmental factors rank third in importance after social and economic factors, was found in the case study in western Burkina Faso where the assessment was of types of whole farm systems rather than individual practices (Orounladji et al., 2024).

Soil related factors were the most cited environmental reasons for using agroecological practices in the farm survey. This is consistent with previous evidence from farmers in different contexts across Africa having detailed knowledge about indicators of soil health (Kuria et al., 2019) and of soil attributes that determine crop productivity (Joshi et al., 2004). It is notable that only 40% of the cases that gave some aspect of soil health as a reason for using an agroecological practice in this study also gave production (increased income, increased yield or cheaper) as a reason. This suggests that some of these effects on soil are either anticipated effects not yet observed, or that soil health is valued for its own sake, or in relation to sustainable productivity in the long-term, rather than only for its instrumental role in current production.

Farmers and KIs refer to a very broad range of environmental factors as contributing to the viability of agroecology. When coding the data from the participatory cost–benefit analysis (Tables 3, 9, 10), a factor that was directly implicated in current production by the respondent was not classified as environmental, and farmers' own reasons for valuing an environmental factor were generally not explored. Values associated with nature, coming from a nature conservation perspective, have been described as falling into three overlapping categories (Himes et al., 2024): instrumental (achieving human ends or satisfying human preferences), intrinsic (innate and independent of value to humans) and most recently, relational (covering social and cultural aspects often related to particular people or places). The environmental factors articulated by farmers and KIs about agroecological practices were predominantly instrumental, as might be expected since farming is all about instrumentalising nature for human ends, but there were sometimes social and cultural dimensions either articulated separately or together with predominantly instrumental reasons. Often, instrumental value has been equated with financial value but here farmers expressed preferences for non-financial aesthetic, social and cultural aspects of agroecological practices that are clearly meeting human preferences. These were sometimes delivered together with financial instrumental value as, for example, in the case of trees in agroforestry practices. This suggests that coming from an agroecological perspective, there is a broad overlap of instrumental and relational values, indicating the need to consider qualitative social, cultural and spiritual values alongside the more easily quantified financial costs and benefits related to agroecological practices.

Some ambiguity remains about intrinsic value. KIs described agroecology as “farming without conflicts with nature,” “maintaining the value of nature” and “trying to mimic nature,” they also referred to ecosystems, rather than environmental factors, more frequently than farmers, perhaps reflecting training in ecology and in describing or evaluating systems. Concepts like maintaining soil health could either be entirely instrumental or include notions of stewardship (Schnyder, 2022), that, like the general aim of agroecology to farm in harmony with nature, may imply recognition of some intrinsic value of nature that might be critical in people’s motivation to pursue environmentally benign practices (Batavia and Nelson, 2017). More research is merited on the extent to which intrinsic environmental value influences farmers’ motivation to adopt agroecological practices because this could usefully inform engagement strategies to promote their uptake.

Most of the responses from KIs, the farmer survey and FGDs focus on technologies or practices, rather than farm systems or ecosystems, in line with the initial focus of the research. This might be one reason why the environmental aspects mentioned are mostly instrumental services. Practices are mainly developed or promoted because they impact production. When the production connection is not direct, then environmental factors identified mostly focus on the local environment and its interaction with humans. For example, trees are valued for providing beneficial shade. Their contribution to mitigating warming more generally was not mentioned. Supporting pollinators came up in multiple cases but there were fewer references to broader biodiversity protection although resting rangelands was identified as being “good for biodiversity” and managing fodder as allowing “some species to still exist.” It is possible that more examples of concern or awareness of broader environmental considerations by farmers would be forthcoming if data collection procedures included a broader systems focus rather than being structured around agroecological practices. A general need to consider downstream impacts of agroecological practices on aquatic and marine resources was recently identified as important for informing the design and implementation of agroecological transitions globally (Freed et al., 2025).

Environmental factors that farmers and KIs associated with the viability of practices were not all positive. Those in Table 9 include increases in some organisms that have negative consequences and competitive effects of trees shading of crops, although providing shade was also sometimes seen as positive. This highlights both the context specificity and the individuality in assessment of an agroecological system or practice. In the case of shade, assessment of its value may also depend on the season and the use of management practices such as tree pruning. In many contexts, farmers in Africa practising agroforestry have been found to have sophisticated and generalisable local understanding of shade cast by different tree species and context-specific management practices to control competition with crops (Dumont et al., 2019; Lamond et al., 2019).

Environmental factors that are seen as negative because they limit or constrain use of a practice are also evident in Table 9. These include soil hardpans restricting growth, limited water for raising seedlings and termites destroying seedlings. Agroforestry, as experienced by these farmers, is not suited to all farmers or contexts. This highlights the importance of incorporating methodological procedures to distinguish between environmental factors that constrain or facilitate practices and those that are outcomes from having adopted the practices. However, that distinction is not always clear and is confounded with understanding of dynamic processes through time and feedbacks, which were beyond the scope of this study. Co-learning and co-creation through participatory action research are core elements of agroecology (Méndez et al., 2017). Agroecological practices, systems, their properties and farmers’ valuations of them and knowledge about them will all change through the dynamic feedback processes involved, indicating the importance of taking an options by context (OxC) approach in supporting local innovation (Sinclair and Coe, 2019) that explicitly incorporates co-learning (Coe et al., 2014).

4.3 Observation and knowledge

Many of the environmental factors that farmers use in assessing viability align with scientific knowledge. Scientific knowledge also shows that some practices have, or are expected to have, environmental effects that were not mentioned by respondents. For an effect to be mentioned by respondents based on their own experience, it must be:

- o Manifest
- o Observed or understood
- o Valued
- o Captured by the data collection method

Alternatively, an environmental effect could be mentioned because respondents have been told that the effect will happen. It is generally not possible to distinguish these in our data. In addition, there are interactions between what is observed and what is learnt by other routes. For example, if a farmer has learnt during training that a practice will have an environmental effect, they could both pay more attention to observing the effect and be more likely to attribute an observation to the practice.

4.4 Integration and systems perspectives

In this research we have attempted to look at the role of environmental factors in the viability of agroecological practices. Both these concepts can be questioned because of interactions, including both interactions between multiple practices and system components, and interactions between perceptions of environmental effects and other effects.

The research was predicated on the notion that some practices are agroecological, and the concept of the existence of “agroecological practices” was used to frame the initial data collection, though it became clear that such a focus had consequences. The definition of an “agroecological practice” that was initially used, could be more accurately seen as referring to “practices that contribute to agroecology.” This distinction was unlikely to have affected how respondents answered questions because each case study had developed their own, locally appropriate, way of discussing agroecology with farmers and other food system actors. More importantly, practices are not used and understood individually but in relation to how they fit into the farming system. Later steps in the research focussed more on systems rather than practice-based assessments of viability. For example, the team of the Crop-livestock-tree systems case study in Burkina Faso show that the global benefits of agroecology in those systems come from the implementation and integration of 15 agricultural practices (Vall et al., 2023). Nevertheless, it is clear from responses that farmers do associate environmental factors with specific practices. It is also clear from the examples they listed that many see agroecological practices as “bundles of technologies” used within a system with which they are familiar, rather than considering their contribution to transitioning farm systems to become more agroecological.

It is not always clear what constitutes an “environmental” aspect, concern, dimension, factor, value, reason, role, impact or effect. For example, is it appropriate to classify “erosion” or “soil health” as environmental concerns? The answer is yes, if they are considered in the context of the natural resource base but no, if they are only considered in relation to current production. Similar ambiguity is found in any attempt to categorise indicators that contribute to assessment of systems. Is yield considered an environmental or economic indicator? Yield over time, and particularly its stability and resilience can be an indicator of healthy soil which is environmental, but yield can also be used as an economic indicator of current production. Other aspects could be classified as being either more environmental or social, such as human health. This paper clarifies how farmers understand some of the environmental dimensions of agroecology, and reveals causal chains from environmental concerns through agroecological practices to environmental effects, that influence how African farmers’ use agroecological practices within their farming systems.

To these ambiguities of definition are added the realities of interactions between social, economic and environmental factors, with changes in one both causing and being caused by changes in others. Understanding such dynamic properties requires tracking data over time and cannot be adequately assessed with cross-sectional methods (Andrieu et al., 2025). In this paper we have not tried to understand interactions between environmental and other factors. For example, when farmers describe a benefit as improving soil health, do they also link this to improving yield, income and nutrition or are those associated with social and welfare benefits? Some farmers also referred to the interactions between practices on their farm and the wider territory. For example, in Tunisia changing grazing management and use of crop residues within farms was seen as increasing pressure on common grazing land. The interactions between on-farm practices and grazing management also appeared in Burkina Faso, to the extent that the political dimension, based on the governance of common grazing lands, was integrated into the assessment of the viability of agro-sylvo-pastoral systems (Orounladji et al., 2024).

At the outset of the research there was an interest in deriving objective valuations of the environmental services influenced by agroecological practices, with the hope that such values might be used to inform some form of true cost accounting (Müller and Sukhdev, 2018) or development of payment for environmental service mechanisms (Namirembe et al., 2018). Limitations to doing this became apparent when considering the details. There are many methods for valuation via estimating willingness to pay for a product or service and some of these could be applied to an agroecological practice (Breidert et al., 2006). However, we are not trying to value the practice but its environmental costs and benefits. Any scheme to put an objective value on the environmental benefits (or costs) of a practice or system change, requires separating those benefits from other properties of the practice, yet that is rarely possible. For example, using organic manure rather than mineral fertiliser may have environmental values to a farmer, perhaps because they are aware of long-term degradation of soil fertilized only by mineral fertiliser, or they have experienced pollution from run-off. It is not easy to put a monetary value on these perceived environmental benefits, either in principle by using contingent valuation (asking people how much they would be willing to pay for them or would need to be compensated to forgo them) or in practice (by observing costs of avoided damage, replacement or substitution), that requires comparison of using organic fertiliser with an alternative practice that has different environmental effects but is otherwise the same. Such alternatives rarely exist. In the case of farm-produced organic fertiliser, farmers are also influenced by considerations of labour, quality assurance, self-reliance, risk, and availability. The overall assessment or viability of using organic rather than mineral fertiliser depends on the integrated assessment of all these factors. We have seen that farmers can identify environmental factors as important, but we do not have a general approach to putting a monetary value on that. The participatory cost–benefit analysis that we used (Tables 3, 9, 10) is effective for eliciting the environmental advantages and disadvantages but does not attempt to quantify them. It would appear to be more practical to state environmental values associated with agroecological practices, and their importance, qualitatively and consider them alongside financial profitability, rather than forcing them into a financial modality that is unlikely to accurately reflect their actual value to people and hence how they might influence decisions about agroecological practice.

5 Conclusion

This research has documented environmental factors that contribute to farmers’ assessments of viability of agroecology across diverse contexts in Africa. These have implications for the way agroecology is described and assessed.

The results of this study show that farmers in Africa use a very wide range of agroecological practices within different farming systems. They consider a diverse set of environmental factors when assessing the viability of agroecological practices and making choices about using them. The environmental factors that influence decisions to use the agroecological practices include social and cultural aspects but the major environmental considerations are instrumental, concerning the local farm environment and the way it supports farming and the livelihoods of farmers and other food system actors. These include aspects of soils, water, microclimate, pests and diseases, other animals, and vegetation. While individual farmers generally have a few environmental aspects that they consider as priorities, collectively, groups of apparently similar farmers in the same context, are aware of and care about a very wide range of environmental factors. The set of environmental aspects that is important to farmers depend on the wider context within which their farm is situated.

When farmers make assessments and choices, environmental factors are considered along with a similarly wide range of other social and economic factors. Contrary to common assumptions, economic factors such as profitability do not always dominate farmers' assessments of viability of a practice.

These findings have important consequences for the way agroecology is studied and promoted.

1. Data on the environmental impacts of agroecological practices are inherently complex because so many different factors are considered important by farmers in different contexts. While people trying to understand or influence farmer decisions about agroecology may choose to focus on frequently occurring factors of global interest, such as soil health or biodiversity, these will not necessarily be good predictors of farmers' evaluations of practices or of their likely uptake of them. This means that attempts to understand environmental concerns of farmers and other food system actors, in addition to any external framing, require use of sequential, context-specific methods involving distinct stages of scoping, discovery and generalisation that can elicit locally relevant information about how environmental factors affect decisions about agroecological practice.
2. The viability of an agroecological practice, or a group of practices embedded in a farming system and wider agroecosystem, is not a property of the practice alone. It is rather, a property of the practice along with the context within which it is being considered and the individuals making the assessment. Thus, a demand for evidence that "practice X is viable" is not realistic and attempts to provide such evidence will inevitably fall short. Instead, it is important to understand the motivations and mechanisms by which farmers learn about practices, make choices, and the consequences of those choices. This will facilitate evaluation of what bundles of practices and other enabling interventions (e.g., subsidies, loans, environmental service payments), might represent viable agroecological options for farmers and other food system actors in specific contexts.
3. Assessments of changes associated with agroecological transitions or impact analyses of agroecological interventions need to include assessment of the environmental factors that farmers care about. These are context specific and are likely to include factors not commonly considered at present.
4. Messages about agroecology, for example, to policy makers or funders, need to go beyond describing broad claims of economic, social and environmental aims and benefits of agroecology with each represented by a few indicators. The benefits of the complexity, nuance and diversity of reasons for supporting agroecology need to be incorporated, explicitly and in simple language, in these messages.

Overall, it is clear that environmental factors are a critical element in farmers' understanding and assessment of the usefulness of agroecological practices and their impact on farming systems and wider agroecosystems. Using systematically acquired, explicit but qualitative statements about the nature and importance of environmental concerns, alongside the financial profitability of agroecological practices, is likely to be more useful in understanding and promoting them, than attempting to reduce environmental aspects to numerical cash values.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by CIFOR-ICRAF Research Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. It was confirmed that the study was low risk and verbal consent to data collection was appropriate, as described in the protocols.

Author contributions

RC: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. NA: Conceptualization, Methodology, Project administration, Writing – original draft, Writing – review & editing. VA: Writing – review & editing. CK-D: Writing – review & editing. CM: Writing – original draft. BO: Writing – original draft. EV: Writing – original draft. FS: Funding acquisition, Project administration, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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