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Providing targeted incentives for trees on farms: A transdisciplinary research methodology applied in Uganda and Peru

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ABSTRACT

Native trees are central elements of sustainable agriculture, providing economic futures to rural populations while safeguarding biodiversity and ecosystem services. We present a diagnostic methodology for (i) identifying 'incentive opportunities' for farmers to plant and manage trees on farms; (ii) proposing targeted packages of incentive and finance instruments; and (iii) describing levers for policy integration to support their implementation. In two case studies from Uganda and Peru, the 'incentive opportunities' consist of providing technical and financial support to farmers for planting and managing trees, generating income sources from native trees and support from the beneficiaries of tree-based ecosystem services, and eliminating incentives for tree removal. Many instruments to promote trees on farms already exist, but implementation is hampered by weak and fragmented institutions, limited funding and low political priority. The proposed methodology can guide the development of incentive instruments as part of implementing policy strategies for integrated biodiversity conservation and sustainable development.

1. Introduction

Agricultural intensification and expansion is one of the major drivers of biodiversity loss (IPBES, 2019). It also drives deforestation and land-use change and is one of the largest sources of carbon emissions in the global South (Pendrill et al., 2019). Agroforestry and other trees on farms can support habitat connectivity and biodiversity conservation (Somarriba et al., 2017; Dawson et al., 2013), greenhouse gas sequestration (HLPE 2019), water management (Lorenz et al., 2014), and other ecosystem services. Trees on farms can also generate new income opportunities to farmers (Kassie 2018; FAO 2005, 2019), improve food security (van Noordwijk 2019; Somarriba et al., 2017), and have cultural significance (Moreno et al., 2018; Torralba et al., 2016). Despite these benefits of trees on farms, they are not yet adequately integrated into good practice guidelines and political support systems (Somarriba et al., 2017). Instead, dominant agricultural schemes continue to prioritise agricultural intensification and pose barriers to the integration of trees in agricultural practices (Zinngrebe et al., 2020). The integration of trees on farms can take different forms, including trees planted in agroforestry systems. In this context, our focus is primarily on the inclusion of native species that will contribute to biodiversity conservation. We will henceforth speak of 'trees on farms' with this priority in mind and also use 'trees on farms' and 'agroforestry' interchangeably.

Changing incentives to promote trees on farms requires a comprehensive understanding of the factors driving current behaviours and practices in the socio-ecological system within which farmers are operating. Certain opportunities for providing incentives are intuitive, such as support for seedlings and tree cultivation. At the same time,

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government support (e.g., subsidies) for intensified monocultures or fast-growing exotic species clearly disincentivise the adoption of less intensified agroforestry systems and the planting of native trees (Angelsen 2010). Other incentives are less intuitive but equally important, as they can be linked to the cultural setting and economic systems within which the farms are embedded (Naito et al., 2022). Community norms and social pressure from peers (Buyinza et al., 2020) along with conceptions of 'progress' and land value linked to the conversion of land (Van Hecken et al., 2015) can be decisive obstacles to agroforestry. In addition, the benefits from trees (e.g., fruits, soil stabilisation, habitat for pollinators) and their role as 'nature-based solutions' may be important incentives for farmers to adopt trees on farms (Bottazzi et al., 2018), but they are sometimes neglected, for instance, when the land is used by settlers who do not appreciate the value of the native vegetation. For biodiversity finance and political support for trees on farms to be effective, an integrated approach to addressing the plurality of incentives influencing agricultural production and land and tree management practices is required (Young and de Castro, 2021; Zinngrebe et al., 2022).

The 2030 agenda of the Convention for Biological Diversity (CBD) includes global targets for promoting sustainable agriculture, reducing the biodiversity impact of value chains, ensuring sustainable levels of consumption, and eliminating harmful subsidies (CBD 2022). Hence, the parties to the CBD need technical guidance on how to adjust their policies in order to support forest conservation and sustainable agriculture. Existing guidance, such as that provided by the Biodiversity Finance Initiative (BioFin), helps identify important finance flows and financing needs (Seidl et al., 2021), but does not cover the multiple ways of providing incentives and finance for conservation (Meyers et al., 2020). In this paper, we propose a diagnostic methodology to address the following research question: Which set of instruments can provide the incentives – financial or otherwise – to support behavioural changes and local strategies to integrate trees on farms?

To answer this question, we adapted the Ecosystem Services Opportunity (ESO) framework (Rode et al., 2016) to identify context-specific incentive and finance instruments for promoting trees on farms. In order to reflect the potential and complementarity of incentive instruments within existing institutional frameworks, we added analytical elements from the Biodiversity Policy Integration (BPI) framework (Zinngrebe et al., 2022; Zinngrebe 2018). The methodology is organised on three levels: (i) identifying entry points or general rationales by which incentives can support trees on farms (henceforth '*incentive opportunities*'); (ii) identifying and selecting suitable incentive and finance instruments ('*instrument packages*'); and (iii) recommendations for integrating these instrument packages into existing sectoral policies ('*levers for policy integration*'). The methodology is transdisciplinary insofar as it is based on a reflexive research approach that integrates knowledge from different sources and involves academics and practitioners for co-designing solutions (Lang et al., 2012; Steger et al., 2021). The broader aim of this approach is to safeguard biodiversity and ecosystem services for the benefit of local livelihoods and the generation of wider socio-economic opportunities.

As part of the *Trees on Farms for Biodiversity* project, we applied the methodology in Uganda and Peru. The Mt. Elgon region in Eastern Uganda is a human-modified, largely deforested area where agroforestry coffee production has strong potential for reintroducing native trees (ICRAF 2020). The Padre Abad province in Peru's Ucayali region includes one of the oldest and strongest deforestation frontiers in the Peruvian Amazon. Significant immigration and land-use conversion processes over the last decade have led to the establishment of agricultural corridors along the main road axes.

The country-specific results from the analysis can inform national policy processes in Uganda and Peru (e.g., National Biodiversity Strategies and Action Plans – NBSAPs, or the agroforestry strategies). More broadly, the case study results can provide lessons for tackling similar challenges in other places. The methodology can navigate inter- and transdisciplinary research teams in processes for co-designing finance and policy options to provide targeted incentives for trees on farms within sustainable agricultural landscapes. It can be used, for example, when developing action or implementation plans within strategic policy processes at national or sub-national levels.

2. Case studies

The case studies have been selected to demonstrate the application of the methodology in two distinct contexts. Whereas the Mount Elgon region in Uganda is characterised by high population density and little remaining forest, the Padre Abad province in Peru remains a highly dynamic deforestation frontier with immigration and land-use change. The two cases thus provide illustrative examples of the challenges and potential found in many tropical developing countries.

2.1. Uganda

In Uganda, the focus of the study was on the Mount Elgon region (see Fig. 1) in eastern Uganda along the Uganda-Kenya border. The area consists of an extinct volcanic mountain (4321 m), a national park (1110 sq. km) and surrounding farming communities (UNEP-WCMC, 2020). There are four major types of vegetation in the Mount Elgon landscape: mixed montane forest (up to 2500 m), bamboo and low canopy montane forest (2400–3000 m), high montane heath (3000–3500 m), and moorland (>3500 m) (Dale, 1940). The local communities practice intensive mixed agriculture dominated by coffee and bananas (Kayiso, 1993). Mount Elgon is recognised for its global biodiversity values (Howard, 1991), hosting 39 endemic higher plant species and many species with limited distribution (IUCN, 2005). Increased harvesting of native trees has resulted in there being almost no remnant forests within 20 km around the park and settlements close to the park boundary (Sassen et al., 2013). However, on the northern, western and southern slopes of the mountain, native trees are part of the agricultural system: they are found in combination with coffee and bananas, around homesteads, and in the valleys planted with eucalyptus woodlots. A few isolated canopy trees of former forests remain scattered among the fields (Sassen et al., 2013).

Together with national policy partners, the Uganda project team formulated the following targets for the project.

- **Target I**: Integrate 30% of farmer-preferred, ecologically suitable native tree species into sustainably managed coffee-banana agroforestry systems at the landscape scale.
- **Target II**: Increase tree cover at landscape level, without interfering with farming operations, through guided and systematic integration of native trees on farms for better livelihoods
- **Target III**: Develop more diverse woodlot systems with native tree species as alternatives to eucalyptus.

2.2. Peru

In Peru, the project focuses on one of the oldest and most iconic agricultural frontiers in the country, the Ucayali region and specifically Padre Abad province and Campo Verde district, mainly in the Aguaytia watershed (see Fig. 2). Here, where agriculture began to expand and consolidate in the 1940s, we are witnessing a significant process of simplification of the mosaic structure of forest patches. This is intensified by the expansion of oil palm plantations and cocoa cultivation into large monocultures, the reduction or elimination of annual fallow-based cultivation systems and older fallow, and the continuous degradation and lack of pasture management.

Together with national policy partners, the Peru project team had formulated the following targets for the project.

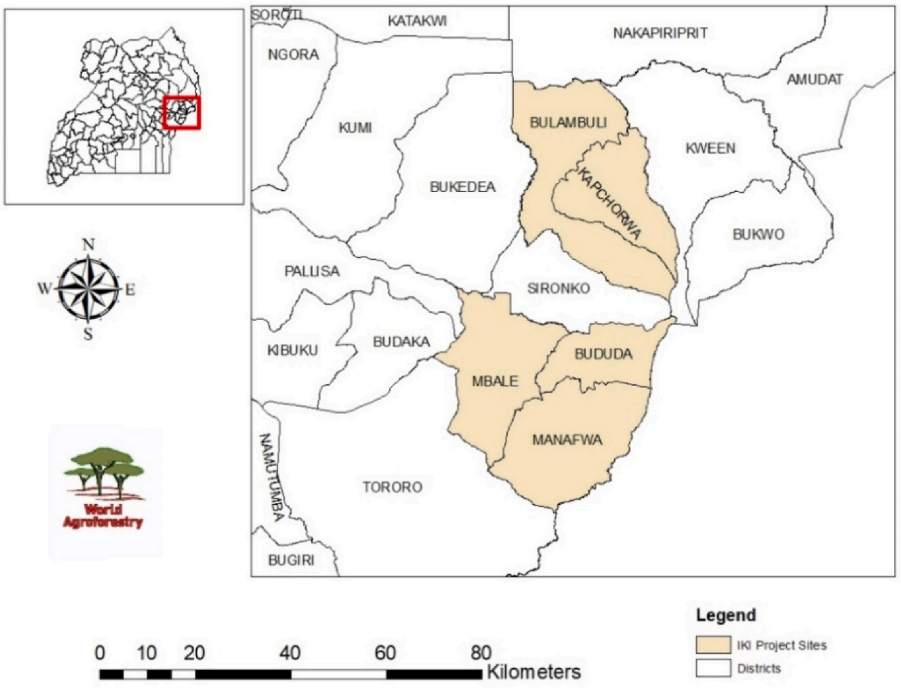


Fig. 1. Location of project sites within the Mt. Elgon region of Uganda (Source: XXX).

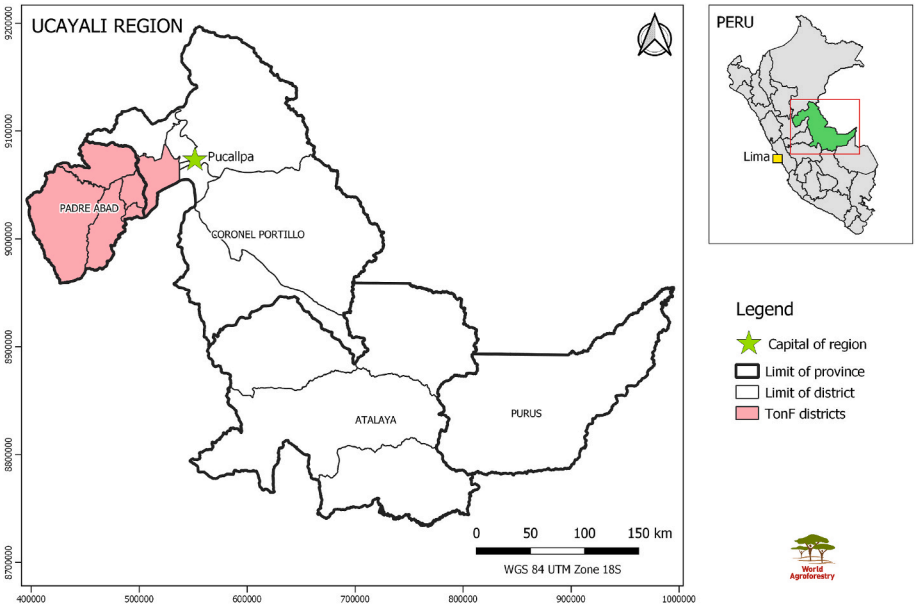


Fig. 2. Location of project sites within the Ucuyali region of Peru (Source: XXX).

- **Target I**: Establish biodiversity-friendly cocoa agroforestry on pasture, degraded fallow or full-sun cocoa to promote restoration of biodiversity and ecosystem services by integrating multi-functional native tree species. Convert an equivalent of the ten percent (10%) of the current cocoa full-sun or monospecific cocoa area into multi-strata cocoa with biodiversity-friendly tree species.
- **Target II**: Pilot biodiversity-friendly small-scale oil palm agroforestry on pasture or degraded young fallow land rather than on old fallow land or secondary, old growth forest and on degraded oil-palm plantations under regeneration, in order to promote the enrichment of small-scale oil palm plantations with biodiversity-friendly species. An equivalent of the five percent (5%) of current monospecific oil palm land is established as multi-strata with biodiversity-friendly tree species. This target is reflected in the Regional Biodiversity Strategy and in other official sub-national planning documents and guidelines.
- **Target III**: Enrich biodiversity-friendly fallow-based systems and other smallholding land-use systems in the agricultural matrix with biodiversity-friendly tree species. In addition, prolong fallow-based rotations and promote conversion into secondary forest. The system integrates the management of natural regeneration with the planting of high value tree species. An equivalent of the ten percent (10%) of fallow is enriched with biodiversity-friendly tree species into multi-strata cocoa.

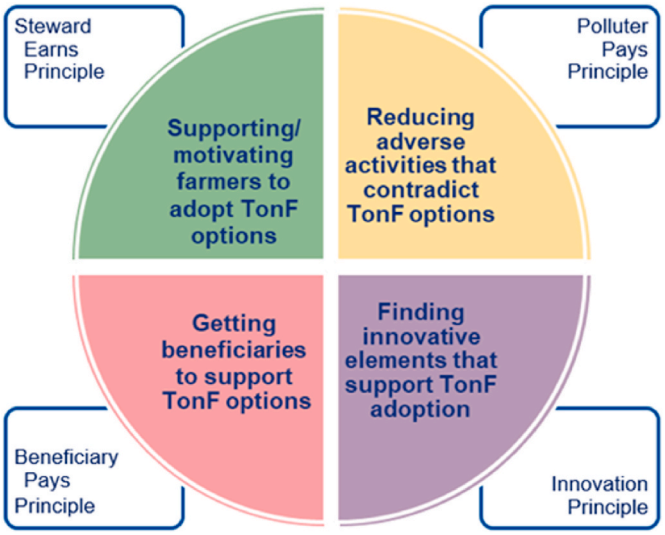


Fig. 3. The four types of incentive opportunities based on the Ecosystem Services Opportunity methodology (Rode et al., 2016).

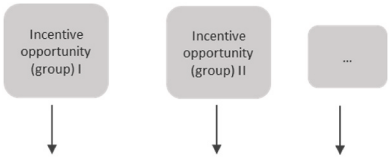
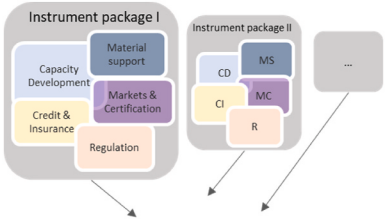
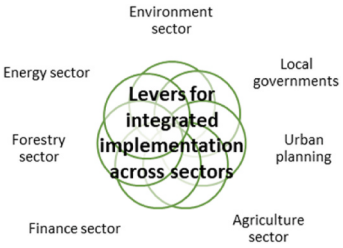
3. Method

The analytical framework of the study, which we henceforth refer to as 'the methodology', is based on the step-by-step Ecosystem Services Opportunities (ESO) guidelines (Rode et al., 2016, www.es-opportunities.net), adapted to the task of promoting trees on farms. The methodology was enriched with elements of the Biodiversity Policy Integration (BPI) framework (Zinngrebe 2018).

The methodology consists of three interlinked levels, reflecting an integrated perspective on incentives for supporting trees on farms: (1) entry points or general rationales by which incentives can be used to motivate actors to promote trees (*incentive opportunities);* (2) the combination of incentive and finance instruments that can support the planting and maintenance of trees *(instrument packages);* and (3) the broader enabling conditions across sectors required to effectively implement the instrument packages *(levers for policy integration)*. For each level, the following sub-sections present a conceptual rationale and background and the procedure for data collection and analysis applied to the case studies. Fig. 3 is a graphical summary of the research process.

In line with the conceptual model of transdisciplinary sustainability research proposed by Lang et al. (2012), the methodology describes Phase B, the process of actually *doing* transdisciplinary research in terms of "co-creation of solution-oriented and transferable knowledge through collaborative research". Table 1 shows how the three levels incorporate the transdisciplinary design principles of this phase B as proposed by Lang et al. (2012), namely, to assign appropriate roles for practitioners

Table 1
Overview of the methodology, situated within Lang et al.'s (2012) three-phase conceptual model of transdisciplinary sustainability research.

Phase A: Collaborative problem framing and building a collaborative research team	
• The ICRAF country teams in Uganda and Peru defined the respective trees on farm "targets" (see section 2) together with experts from research and national policy partners • Building the interdisciplinary research teams • Designing the methodological framework for collaborative knowledge production	
Phase B: Co-creation of solution-oriented and transferable knowledge through collaborative research	
Level 1 – Identifying incentive opportunities 	**Consultations** with external experts to assess how human activities and actors relate to ecosystem services from trees on farms (see SM 1.1) *Uganda*: local experts from national research institutions (4) *Peru*: local experts from national research institutions (3)
Level 2 – Identifying instrument packages 	**Consultations** with national experts to build the initial comprehensive list of existing incentive and finance instruments *Uganda*: local experts from national research institutions (4) *Peru*: local experts from national research institutions (4)
Level 3 – Identifying policy levers 	**Workshops** with experts and stakeholders as participants to validate, complement, and prioritise incentive and finance instruments and to specify enabling conditions for their implementation. *Uganda*: government authorities (7), civil society organisations (7), research institutions (7), farmers' associations (2), international organisations (1).$*Peru*: government authorities (7), civil society organisations (1), research institutions (5), international organisations (1). **Follow-up interviews** to elicit additional information on the selected instrument packages and the enabling conditions for their implementation *Uganda*: research institutions (1), government authorities (3), farmer associations (1), international organisations (1). *Peru:* government authorities (4)
Phase C: (Re-)integrating and applying the co-created knowledge	
• Integration of the instrument packages and enabling policy conditions into the formulation of national policy strategy processes and action plans (societal impact) • Synthesis of the methodology and the lessons learned from its applications within the present article (academic impact)	

and researchers, and to apply integrative research methods and transdisciplinary settings from knowledge generation and integration. The table also shows how the preceding Phase A (Collaborative problem framing and building a collaborative research team) and the final Phase C (Integrating and applying the co-created knowledge) were considered in the overall research process. Although they were not explicitly part of the methodology as presented here with the three levels, they were nonetheless part of a more comprehensive step-by-step guidelines document drawn up as part of the project (Rode et al., 2022). Specifically, the elements of Phase A were the participatory process for setting the trees on farm "targets" (see section 2), the creation of the interdisciplinary research teams in Uganda and Peru (i.e., the co-authors of this article), and the design of this methodological framework for collaborative knowledge production. The main elements of Phase C are the envisioned integration of the instrument packages and enabling policy conditions into the formulation of national policy strategy processes and action plans (societal impact) as well as the synthesis of the methodological approach and lessons learned from its applications within the present article (academic impact).

3.1. Level 1: Incentive opportunities

3.1.1. Conceptual rationale

The first level of an integrated perspective on incentives takes a broad view of land users' motivations for planting trees and managing natural regeneration on farms or, as the case may be, their motivations for not doing so or even for removing trees from their land. A prerequisite for the analysis is a thorough understanding of the stakeholders, the local ecological and socio-economic conditions, and the ecosystem services provided by trees on farms. To this end, the ESO methodology (Rode et al., 2016) proposes to explicitly specify how different human activities and actors relate to trees on farms. These are the activities or behaviours by which actors (i) are currently promoting trees on farms (stewardship role); (ii) are currently benefiting from the ecosystem services provided by trees on farms (beneficiary role); and (iii) are harming trees on farms (degrader role). Based on these relationships, the entry points for incentives – *incentive opportunities* – are identified by applying four economic principles (see Fig. 3). [1] Three of the principles directly build on the three types of actor relationships: 'steward earns', 'beneficiary pays', 'polluter (degrader) pays'. A fourth economic principle of 'innovation' captures opportunities from, for example, new products or technologies, efficiency measures, or new modes of stakeholder organization and association. The incentive opportunities not only reflect the economic perspective of creating incentives, but also pertain to ethical issues, most notably considerations of distributive justice. For instance, the purpose of the Polluter Pays Principle is to prevent people from profiting at the expense of others. Similarly, having ecosystem service beneficiaries contribute to the costs of natural resource management is essentially a dictate of fairness when, for instance, a poor local farmer or a cash-strapped government department effectively subsidize the provision of ecosystem services to wealthier urban populations or profit-making industries. By tackling imbalances in who benefits from trees on farms and who bears the costs of planting and maintaining them, incentive opportunities represent ways of re-allocating and enabling a fairer distribution of resources.

3.1.2. Procedure for data collection and analysis

Using data from the literature and consultations with national experts, the research team specified how different human activities and actors relate to trees on farms, sorting them along the three types of roles (stewardship, beneficiary, degrader). Based on this information, the following questions were answered to identify the incentive opportunities.

- *Steward Earns Principle (SEP)*: How can those who promote trees on farms be supported and motivated to continue or enhance their stewardship activities?
- *Beneficiary Pays Principle (BPP):* How can the beneficiaries of the ecosystem services from trees on farms be motivated to support trees on farms?
- *Polluter Pays Principle (PPP)*: How can those who harm trees (within or outside the farm) be held liable and be motivated to reduce or stop the harm?
- *Innovation Principle (IP)*: Which innovative elements could further support trees on farms?

Formulating an 'incentive opportunity' involves specifying which actor would be motivated to engage in which behaviour. In order to work with a feasible number of opportunities, we grouped the resulting elements of incentive opportunities. In some instances, this meant grouping elements initially identified according to different principles.

3.2. Level 2: Instrument packages

3.2.1. Conceptual rationale

The multiple types of incentive opportunities already indicate that no single instrument will provide all the necessary incentives for trees on farms. Therefore, the second level for an integrated perspective identifies an appropriate mix of complementary incentive instruments (Ring and Barton 2015). The selection of a suitable instrument package requires a comprehensive understanding of existing policies and interventions and how they currently affect land users' behaviours. The diversity of instruments can be structured in many ways, and it is important that these categories resonate with the users of the analysis. In line with this context sensitivity, we grouped the instruments into the following categories.

- **Capacity Development:** Instruments that improve stakeholders' (long-term) ability to implement the management practices related to trees on farms (e.g., targeted skills training, educational programmes);
- **Material Support**(financial, non-financial): Instruments that support the farmer materially to facilitate and motivate investments in or to compensate for any opportunity costs arising from trees on farms (e.g., technology transfer, payments, seedlings);
- **Credit and Insurance:** Instruments that provide credit for required investments to support tree management practices, and insurance schemes that reduce the risks of adopting trees on farms and provide compensation for costs or damages;
- **Markets and Certification**: Instruments that generate new income streams or added value based on goods and services related to trees on farms (e.g., shade coffee certification);
- **Regulation**: Legal and institutional arrangements (rules, standards, tenure rights) that allocate enforceable rights and responsibilities to support the sustainable use and management of land and natural resources.

3.2.2. Procedure for data collection and analysis

The analysis for this level consisted of reviewing existing instruments for each country and associating them with the respective incentive opportunity groups formulated in level 1. The members of the respective national research teams suggested relevant policy documents with information on incentive and finance instruments already in operation (e.g., policy reports, scientific articles, and websites) and consulted national experts on agricultural policy and farming. The research team also conducted an online search for documents with relevant information and, based on all these sources, compiled a comprehensive list of

[1] In the original methodology the incentive opportunities were labelled 'ecosystem service opportunities' (ESO) (c.f. Tasks 2–5 in Rode et al., 2016 and Step 3 in www.es-opportunities.net).

existing incentive and finance instruments. The list included information on where and how the instruments operate and on obstacles to their implementation or effective functioning. The above-mentioned instrument categorisations were used to structure the list.

This list of existing instruments was the main input for a broader participatory process where stakeholders and experts selected the final instrument packages. Workshops with stakeholders and experts on the design and implementation of agricultural policies were hosted in both Uganda and Peru. Participants represented government authorities for the environment, agriculture and forestry sectors, civil society organisations, research institutions and farmers' associations. Workshop participants were first familiarised with the background and aims of the project, its methodology, and the objectives of the participatory process. The research team also presented the groups of incentive opportunities and the respective lists of existing instruments. The experts then worked in teams for each incentive opportunity group. In each team, a facilitator asked them to extend the list by identifying additional existing instruments and proposing new instruments (e.g., based on experiences from other countries). For each instrument, experts explained why they thought it was useful – or limited in its potential – to promote trees on farms, and suggested possible adaptations to its current form to make it more effective. Participants also specified enabling conditions for implementing the instruments (e.g., funding, institutional capacities, training, institutional coordination, transparent balanced management of stakeholder interests, political support and leadership) and actors who could take a key role in implementation. To prioritise and select instruments, the team members voted on which instruments should be part of the final instrument package. In doing so, they considered the criteria of expected impact for promoting trees on farms and desirability and feasibility for the local socio-cultural context. In both countries, follow-up interviews were conducted with experts who were particularly knowledgeable regarding the selected instruments (five in Uganda, four in Peru).[2] The interviewees included at least one expert from each of the teams at the workshops.

3.3. Level 3: Identifying levers for policy integration

3.3.1. Conceptual rationale

Based on the conceptual approach of Biodiversity Policy Integration (BPI) (Zinngrebe 2018; Zinngrebe et al., 2022), the third level of an integrated perspective on incentives assesses the extent to which trees on farms are coherently reflected in relevant sector policies and related governance processes. This involves the following three dimensions.

- **Linking activities with the existing regulatory framework**: The extent to which sector policies explicitly address and conceptualise trees on farms in legal documents and strategy papers, and whether there is coherence in these political perspectives across the targets and legislation of other relevant sectors.
- **Political support and capacities for implementation:** The degree to which sectors provide technical and financial means for the implementation of trees on farms initiatives to reflect the political significance (priority) of trees on farms in the political arena.
- **Collaborative structures and leadership**: How leadership and responsibilities are distributed among actors and the degree to which actors collaborate and harness synergies in a political arena influences their ability to solve a problem.

3.3.2. Procedure for data collection and analysis

In a document analysis, specific passages from national sector strategies and legal texts were extracted to understand the definition, role and political importance of trees on farms in sector policies. Workshop discussions and follow-up expert interviews were then used to understand how to design and implement the prioritised policy packages in existing institutional settings. The experts were asked the following questions.

- What do you know about the implementation of the instrument? What experiences or examples could you mention?
- What changes are necessary for implementation to be effective to support the incentive opportunity?
- Is there a regulatory and financial framework to implement the instrument? What else is missing for it to be implemented effectively?
- Which specific institutions or actors should be addressed? Who needs to take action or assume leadership? How does doing so relate to their own objectives? (e.g., do they have an interest in advancing or slowing down implementation? Which of the actor's objectives are linked to implementation of the instrument?).

In Peru, the analysis also used data from a previous network analysis and interviews with local expert practitioners (Zinngrebe et al., 2020). For each sector, we synthesised the information according to the three BPI dimensions introduced above.

4. Results

4.1. Level 1: Incentive opportunity groups

The groups of incentive opportunities identified are shown in Table 2 for Uganda, and Table 3 for Peru. The columns on the right illustrate the economic principles upon which each of the opportunities are based (Steward Earns Principle – SEP, Beneficiary Pays Principle – BPP, Polluter Pays Principle – PPP, Innovation Principle – IP). Due to the bundling of the incentive opportunities, some groups are associated with more than one principle. The supplementary material contains the list of how different human activities and actors relate to trees on farms (SM 1.1) as well as the complete set of incentive opportunities identified, based on the four economic principles (SM 1.2).

There was a strong alignment between groups of incentive opportunities across the two countries. Both countries identified incentive opportunity groups based on the Steward Earns Principle (group 4 for Uganda and group 1 for Peru). According to this principle, farmers willing to plant trees on farms (a stewardship activity) could be supported with training activities, provision of tree seedlings and access to loans. In both countries, channelling resources from beneficiaries of ecosystem services from trees on farms were identified, associated with the Beneficiary Pays Principle (group 2 for both countries). Public entities interested in reducing landslide risks and downstream beneficiaries of water-related ecosystem services were identified as potential supporters of trees on farms by paying compensation to upstream farmers. In line with the Steward Earns and Innovation Principles, both countries also identified opportunities for generating new income sources and added value from products based on native trees and from product certification (group 5 for coffee producers in Uganda, group 3 for palm oil producers in Peru). Finally, both countries had similar incentive opportunities related to the Polluter Pays Principles (group 3 in Uganda, group 4 in Peru) related to holding vendors liable for illegal timber extraction and applying sanction mechanisms in order to halt deforestation. In addition, these groups highlighted the importance of understanding and tackling the reasons for noncompliance. Consequently, related to the Steward Earns and Innovation Principles, there were proposals to gear activities toward supporting farmers with simpler and clearer processes for selling legal timber (Peru) and to promote alternative energy supply (Uganda).

Some context-specific differences in the incentive opportunities could be observed. In Uganda, promoting alternative energy sources was deemed crucial to reduce deforestation and carbon emissions from

[2] The follow-up was necessary because, due to the COVID-19 situation, workshops had to be conducted online and with a relatively short duration of 2.5 h. The interviews lasted between 30 and 150 min.

Table 2
Incentive opportunity groups identified in Uganda (Mt Elgon).

Incentive opportunity groups	SEP[a]	BPP	PPP	IP
1. Reduce ("harmful") incentives with negative effects on native trees			X	
Rethink subsidies for land conversion				
Tackle negative impacts of shifting cultivations				
Reduce current support for intensification and deforestation, including advantages for tenure				
Reduce attractiveness of planting fast growing non-native species such as eucalyptus				
2. Generate support from beneficiaries of the ecosystem services provided by trees on farms	X	X		
Use of fodder from agroforestry by dairy farmers				
Tourism industry of Mt. Elgon National Park				
Uganda conservation authorities want to support on-farm habitat				
Commercial and public water users benefit from stable water supply				
Local governments want to reduce landslide risks				
3. Reduce use of wood for household level energy supply and charcoal	X		X	X
Promote alternative energy supply (e.g. solar) and energy efficient stoves				
Control and mitigate (illegal) deforestation on household level for timber and firewood				
Strengthen the formal market for charcoal and value chain development				
4. Financial and non-financial support for (coffee/banana) farmers who plant native trees in agroforestry systems and/or woodlots and do not convert forest land	X			
Increase knowledge on the benefits of companion trees: additional income and subsistence use of fruit, fodder, water storage, pollination etc.				
Provide tree seedlings				
Training/skills for agro-forestry practices (e.g. how to pick red cherries for high-quality coffee)				
Empowering youth and women				
Access to credit/microfinance				
5. Create or strengthen markets for high-quality agroforestry coffee with native trees (in collaboration with intl. coffee industry)	X	X		X
Generate added value and market access for farmers				
Work along the supply chain and connect coffee farmers with private sector actors				
Include native tree cover in criteria for certification schemes				

[a] **SEP**: Steward Earns Principle, **BPP**: Beneficiary Pays Principle, **PPP**: Polluter Pays Principle, **IP**: Innovation Principle.

Table 3
Incentive opportunity groups identified in Peru (Ucayali).

Incentive opportunity groups	SEP[a]	BPP	PPP	IP
1. Support with inputs, information and technical assistance to producer families to promote the adoption of trees on farms	X			
Information and seedlings for tree species that attract pollinators, fix nitrogen, and improve soil fertility, provide shade				
Training on how to improve soil fertility and cacao productivity to reduce the need for expansion into secondary forest				
Input for fertilizer and credit mechanisms for their purchase				
2. Channelling the contribution of the beneficiaries of ecosystem services to those who grow/manage trees on farms	X	X		
Clear information to farmers about compensation mechanisms (e.g., MERESE)				
Support/compensation (monetary or non-monetary) for protection of water sources and conservation of tree species through natural regeneration				
Increase public investment projects for landscape restoration and for protection of water sources				
Contribution of downstream water users for the establishment or maintenance of trees to protect water sources within their respective supplying basins: Inhabitants of Shambillo and of the city of Aguaytía, rice producers.				
Upscale the opportunities identified above with support from the National Water Authority by coordinating efforts between key stakeholders of integrated watershed management in order to support the establishment or conservation of trees on farms.				
Promotion of trees on farms as part of disaster risk reduction (landslides and floods) with public investment projects				
3. Diversification of production (certification and innovation)	X			X
Support development of income opportunities from ecotourism, incl. bird watching				
Promote biodiversity-based products (e.g. resin, seeds, fibre, medicinal plants, honey)				
Support certification of sustainable palm oil (RSPO)				
4. Information and facilitation for timber commercialisation	X		X	X
Provision of information on how to register plantations and which fees small holders have to pay to allow legal sale of timber.				
Support farmers with simpler and clearer process to sell legal timber				
Improvements of the Regional Government on granting agroforestry concessions.				
Strengthening coordination and intersectoral control between different authorities at all levels, to raise awareness on the benefits of trees on farms and to monitor compliance				

[a] **SEP**: Steward Earns Principle, **BPP**: Beneficiary Pays Principle, **PPP**: Polluter Pays Principle, **IP**: Innovation Principle.

burning or selling wood and charcoal (see opportunity group 3). Moreover, Uganda focused on reducing incentives with negative effects on trees on farms (group 1). This aspect was not covered in Peru, where the issues of land titles, forestry concessions and forest registration reflected specific contextual conditions (see group 4).

4.2. Level 2: Instrument packages

The results of the level 2 analysis are instrument packages for each group of incentive opportunities. The complete instrument packages are available in the supplementary material (SM2). Table 4 and Table 5 provide a selective overview of the instrument packages for each country. They showcase at least one instrument for each incentive opportunity group, such that all instrument types are represented, and include short explanations of the instrument and summaries of changes and enabling conditions identified by the experts. Fig. 4 presents for the example of Uganda the different elements which can motivate and support farmers in planting and managing native trees on farms.

We find that both countries have a broad regulatory framework with instruments in place that can support the adoption and maintenance of trees on farms. However, the instruments are in different states of advancement, with some already implemented in other regions of the countries (from which lessons can be drawn) and others that are formulated on paper but not yet implemented. Many of them would require modifications in order to be applicable to agroforestry activities.

Among the enabling conditions for the implementation of

Table 4
Overview of one instrument package (Uganda) for the incentive opportunity "Reduce ("harmful") incentives with negative effects on native trees". The columns on the left indicate the instrument types, that is, whether a particular instrument provides Capacity Development (CD), Material Support (MS), Credit & Insurance (CI), Markets & Certification (MC), or Regulation (R).

Type of Instrument					Instrument	Proposed Changes and Enabling Conditions for Implementation
CD	MS	CI	MC	R		
					1. Reduce ("harmful") incentives with negative effects on native trees	
X					**National Agricultural Advisory Services**: government programme which provides extension services (advice and inputs) to farmers in very remote areas	• joint development of support packages between forestry, agriculture, finance and local government ministries and other extension services stakeholders (e.g., myoga – farmer associations) which support long-term adoption and maintenance of agroforestry systems
					2. Reduce use of wood for household level energy supply and charcoal	
	X				**Rural Electrification Fund**: extends electrification to rural areas by erecting electricity poles and providing free connection to the grid	• Further incentivise grid connection by subsidising cost of or reducing tariff for electricity • Supplement with efforts to scale energy efficient technologies (energy saving stoves, charcoal briquettes) and renewable energy (solar cooking stoves) • Establish multi-stakeholder roundtable for communities and policy makers to devise solutions
					3. Generate support from beneficiaries of the ecosystem services provided by trees on farms	
	X				**Uganda Biodiversity Trust Fund:** Mobilises and manages financing for projects related to biodiversity offsets, biodiversity enhancement, protected areas and national parks, etc. which meet national environmental management standards.	• Expand funding sources to upscale programme (e.g., from UN, EU, bilateral agreements Germany & Sweden) • Expand scope to support competitive trees-on-farms innovations; focus on particular species and land uses • Further legitimise fund by (1) emphasising agrobiodiversity in Forestry Policy & Tree Planning Act; (2) using National Environment Act as basis for implementation & monitoring of private developers in protected areas.
					4. Support for (coffee/banana) farmers who plant native trees in agroforestry systems and/or woodlots and do not convert forest land	
	X	X			**Community Environment Conservation Fund**: pro-poor mechanism for benefit-sharing; incentivises forest landscape restoration for integrated water resources management.	• Include 'native tree species' clause in Catchment Management Guidelines of the Uganda Water Act (CPA 152) • Revise National Forestry and Tree Planting Act: include clauses on use of native tree species • Focus on supporting tree initiatives at community level
					5. Create or strengthen markets for high-quality agroforestry coffee with native trees	
			X		**Rainforest Alliance Certification Programme:** Promotes agroforestry practices for biodiversity conservation.	• Implement national natural capital accounting to incentivise tree farmers to participate in the programme • Focus on use of native trees so that programme can occupy growing global markets for specialised/niche products

instruments identified in both countries are the need for strengthening capacities and coordination, scaling up positive experiences from other projects, and extending the funding of forestry and agricultural activities to include agroforestry. Further, instrument implementation at the local level faces the challenge of a lack of coordination among the multiple levels of governance (national to local) and among the different sectors related to agroforestry. For both countries, this has to do primarily with the alignment of the extension services across the forestry, agricultural and environmental sectors. The information on enabling conditions for the instruments feeds into the analysis of level 3, where various levers are presented to indicate how different political sectors and stakeholders can contribute toward implementation.

4.3. Level 3: Levers for policy integration

The analysis of the instrument packages revealed a set of challenges and enabling conditions for their implementation. Together with the analysis of policy documents, network data and the information collected in the expert workshop and interviews, we identified various levers for how the different political sectors and stakeholders can contribute toward the implementation of the incentive instruments. Despite the contextual differences in Peru and Uganda, common levers apply in both countries. Table 6 summarises the key elements along the three dimensions (see SM 3.1 and SM 3.2 for detailed results).

4.3.1. Linking activities to the existing regulatory framework

A crucial factor for inter-institutional coordination is the standardisation of a definition of 'agroforestry' and the concept of 'trees on farms' (outside agroforestry systems) across legal definitions in different sectors. It is also crucial to ensure that strategies, policies, and programmes consistently reflect targets for trees on farms. Existing legal requirements for incentive schemes, finance opportunities, or "best practice" rules in agriculture, forestry or urban development often do not include tree management or agroforestry. Amending such schemes, opportunities and rules would make it easier to coordinate project budgets aimed at supporting farming families in tree management, which requires long-term programmes in order to realise the multiple benefits from trees on farms.

According to the local experts, Peru recently adopted a general definition of agroforestry that encompasses the agricultural and forest sector. Sectoral instruments exist within the forest sector that can support the development of agroforestry and the establishment and maintenance of native trees on farms in forest landscapes. Beyond creating new laws and instruments, it is important to review and align existing instruments, including incentive and finance schemes, in order, for example, to improve their effectiveness and expand their scope across sectors, land-use systems, and land categories. For some of the instruments within the portfolio, the proposal is to extend existing agroforestry programmes or expand certain programmes so that they include an agroforestry component.

In Uganda, a crucial process for embedding trees on farms in policies is the current drafting of a National Agroforestry Strategy. Its implementation, however, will depend on explicit provisions for the promotion of native trees within existing policies, such as the National Forestry and Tree Planting Act and the National Environmental Act. The agro-industrialisation programme of the National Development Plan III, the Sawlog Production Grant Scheme and urban development regulations could include safeguards against the removal of native trees. Moreover, the payment for ecosystem services provision within the National Environment Act could be used to compensate farmers for preserving

Table 5
Overview of one instrument package (Peru) for the incentive opportunity "Support farmers with inputs, information and technical assistance". As above, the columns on the left indicate the instrument types, that is, whether a particular instrument provides Capacity Development (CD), Material Support (MS), Credit & Insurance (CI), Markets & Certification (MC), or Regulation (R).

Type of Instrument					Instrument	Proposed Changes and Enabling Conditions for Implementation
CD	MS	CI	MC	R		
					1. Support farmers with inputs, information and technical assistance.	
X					**Budget Programmes 072, 121 and 130**	• Mapping technical assistance and assistants to coordinate activities and create synergies among different institutions in charge of this function
X					**Public investment projects (PIP)** for cocoa and oil palm farmers **for technical assistance and capacity building.•**	• Coordinate/create a data base for adapting technical assistance to regional conditions, and work with local and regional governments (e.g. central region farmers associate agroforestry with cacao with bolaina, but in other regions they prefer capirona)
X					Service provision mechanisms, extension services and training for professionals and technicians within **Budget Programmes 072, 130 and 121.•**	• Standardise language with all public-private entities to be able to reach producer families regarding the benefits of having trees on their farms • Training for producers on agroforestry principles • Join efforts with cooperatives and foundations that are already providing training on agroforestry systems with fast and slow growing native species (e.g. Oroverde, Fundación Amazonía Viva, among others).
					2. Channelling the contribution of the beneficiaries of ecosystem services to those who grow/manage trees on farms	
	X				**Funds from regional fiscal transfers** for investment projects to leverage and diversify productive activities and ecosystem services.	• Operationalizing these funds requires work among numerous sectors and should be led by the PCM, because it has within its scope the CEPLAN (which is in charge of territorial planning); should be included within the framework of the territorial planning law. • It implies modifying a law (could take more than 5 years) • Consider again aspects of the decentralisation that took place 15–20 years ago. • Strengthen regional governments (training, awareness, technical issues and financial capacities). • Political will
				X	Clarification of **property rights** in order to **identify the contributors to MERESE projects**.	• Agroforestry concessions, promoted by ICRAF through the AGROFOR project. • According to AGROFOR it could be changed in 1.5–2 years • A change in the type of concessions that are being granted by the state is required so that the producer gets recognition for the forests that farmers have already conserved or established in the past and that they continue to manage, even for the forest surrounding his/her land.
					3. Diversification of production (certification and innovation)	
			X		AGROIDEAS and PROCOMPITE	• Elaborate a rapid density improvement analysis that includes information on o What densities should the farm have to determine the number of cocoa trees, o The numbers of timber and non-timber forest species, • Understand the global context of fertilizer production, other than to be able to manage the farm in an integrated way.
					4. Information and facilitation for timber commercialisation	
		X			Direct Financing Programme for Forest Plantations	• Align financing programmes with forestry issues and not only with agricultural extension. • Link more public funds to forest plantations (public-private partnerships).

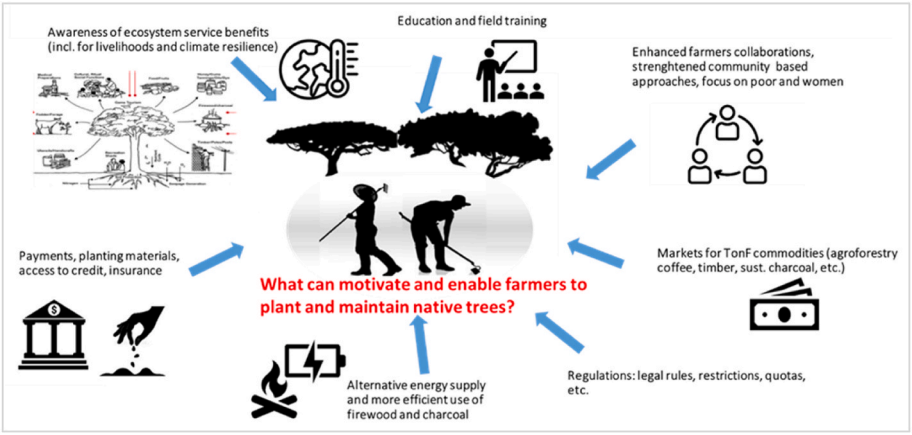


Fig. 4. Overview of elements which can motivate and support Ugandan farmers in planting and managing trees on farms.

native trees and their ecosystem services, with funding for the mechanism provided by private and public conservation funds (e.g., Uganda Biodiversity Trust Fund, Community Environment Conservation Fund). Afforestation and restoration schemes, which are part of Uganda's Nationally Determined Contribution to the UNFCCC, could require the use of native trees.

4.3.2. *Policy support and capacities for implementation*

The current technical and financial support provided for agricultural and forestry systems does not adequately consider trees on farms. In both countries, experts see great potential for redirecting existing funding for conservation initiatives, value chains and green investments toward supporting trees on farms. Likewise, extension services, forestry

Table 6
Levers for policy integration to support trees on farms. General findings and examples from the case studies in Uganda and Peru.

	Linking activities with the existing regulatory framework	Political support and capacities for implementation	Collaborative structures and leadership
Environmental sector (including climate policy)	Strengthen definition and targets for trees on farms in related strategies to highlight their role in contributing to biodiversity conservation	Redirect conservation funding to support trees on farms	Foster collaborative arrangements for synergistic policies and technical support
	Target incentives and payment schemes toward ecosystem services provided by trees on farms	Provide technical support for local implementation	Coordinate coherent institutional planning and implementation across sectors and political levels
	Use emerging finance opportunities from climate change and no-deforestation policies	Provide technical support and facilitate finance for local implementation	Convene joint processes to strengthen synergies between climate finance and trees on farms
Forest sector	Clearly indicate the role of native trees in forestry sector support schemes	Build capacities for forestry services to integrate and support native trees; strengthen land title process and enforcement	Engage with actors to support them in technical capacity and access to sustainable value chains
Agricultural sector	Position trees on farms in agricultural legislation and plans for rural development	Mainstream trees on farms into the best practice elements of agricultural extension services	Build stronger ties with agricultural agents, finance agents and local implementing agents to facilitate coherent implementation
Economic and finance sector	Adjust the criteria for the distribution of finance instruments to enable and assure support for native trees	Strengthen capacities to apply for and implement funding linked to agroforestry and trees and develop value chains linked to native trees	Coordinate technical assistance for budgeting native tree finance and build networks for value chain development involving the private sector
Energy sector (Uganda)	Adjust energy legislation and initiatives to be sensitive to native trees	Adjust prices and subsidy schemes to reduce pressure on fuel wood	Establish fora discussing safeguards for trees in energy solutions
Urban planning sector (Uganda)	Adjust guidelines for development and management of cities	Regulate tree clearance in urban areas	Build fora to find "nature-based solutions" for the urban context
Local governments	Include trees in local development plans	Redirect investments and conditions for investments for green infrastructure in cities	Strengthen targeted initiatives between local governments and national authorities

services and other technical support can recommend the use of native trees and give technical advice on how to integrate them in productive landscapes. At the same time, the elimination of negative incentives that currently support the removal of trees can be powerful levers to (re) introduce native trees. Currently, for example, such negative incentives support the use of trees for fuel wood, tree clearance in urban areas, or work indirectly by prioritising land titles for land already cleared.

In Peru, there are several initiatives that highlight the need to promote agroforestry (e.g., the National Forest Conservation Programme) but are not yet reflected in supporting policies. One main challenge seems to be the transfer of budgets to regional and local governments to support and finance tree-related projects. Capacities for technical assistance at regional and local levels are particularly weak; they are not supported by a technical data base and lack effective monitoring of land trafficking and land invasion. Another major problem is that the lack of land categorisation along with administrative hurdles in registering property undermine legal production. While both regional and local governments clearly have the potential to support tree practices and initiatives, institutional capacities and communication across levels remain weak.

In Uganda, the National Agriculture Advisory Services (NAADS) is a key support institution, which could incorporate native trees on farms more proactively into its extension services and best practice manuals. Its counterpart, the District Forestry Services, can be strengthened in their capacity to train farmers on how to integrate native trees into their production systems. In the local experts' view, these two extension programmes should provide holistic support packages suited to the particular material and technical requirements of agroforestry systems (complementary seedlings, specialised knowledge of tree-crop interactions, etc.). The experts also recommend improving the efficiency of extension services by implementing more demand-driven mechanisms that provide services according to local readiness (capacities) and potential for agroforestry. There are also various funding sources which do not yet combine tree conservation with local development: in conservation (e.g., Uganda Biodiversity Trust Fund, Community Environmental Conservation Fund), in climate policy (e.g., Get Invest, Green Climate Fund), in forestry (e.g., Sawlog Production Grant Scheme), and in rural development (e.g., Farm Income Enhancement and Forestry Conservation).

Strategies to involve the private sector are required in both countries. There are companies that profit from environmentally unsustainable practices and thus (successfully) compete against plans for ecosystem conservation and restoration. Opportunities to implement deforestation-free value chains and bio-business initiatives through regulations or incentives (e.g., green production certification, corporate social responsibility schemes, etc.) should be explored.

4.3.3. Collaborative structures and leadership

Greater inter-institutional coordination is a key factor in efficiently dovetailing resources from different sources in order to promote native trees on farms and to avoid inefficient parallel efforts or even mutually conflicting support schemes. Coherent institutional planning, coordinated technical assistance and synergistic approaches to agroforestry, sustainable energy and "nature-based solutions" can enable 'joined-up' support for sustainable rural development. Linking climate finance and value chain development to trees on farms could unleash considerable economic potential for supporting trees on farms. Working groups that facilitate exchange across sectors and political levels (involving innovative local governments) could foster more effective leadership and induce context-specific innovation.

In Peru, the experts interviewed emphasised the importance of continuity in policies and support systems in terms of programmes, reliable back-up structures, and personnel. Resources are currently lost frequently due to a high turnover of technical staff at all levels of government. Improved continuity would improve farmers' confidence and level of participation and avoid confusion among farmers from frequently changing priorities. Participatory consultation and collaborative processes that include representatives of production systems (producer associations, NGOs) and international projects would enable value chains to better account for local needs and all potential avenues of support.

In Uganda, experts mentioned that the ministries and agencies responsible for the environment, agriculture, forestry and local government need a coordination mechanism to develop and deliver specialised extension services for agroforestry systems. The current Memorandum of Understanding between the Ministry of Agriculture and the Ministry of Water and Environment on cooperation within the Sustainable Land Management Framework could be updated to further

expand and clarify collaboration topics, roles and responsibilities.

Local governments play a key role in communicating local needs (e.g., via budget requests, monitoring and evaluation reports) with the aim of attracting more targeted national support. The establishment of multi-stakeholder roundtables, in which programme beneficiaries can share experiences and issues with government actors, can also provide a mechanism for monitoring, evaluation and learning that can enhance programme design and delivery.

5. Discussion

Our findings in the two case studies in Uganda and Peru identify a broad range of options for strengthening policy support for trees on farms and thus enhancing biodiversity conservation and rural development. Our methodology of combining the 'ecosystem services opportunities' and 'biodiversity policy integration' frameworks involved applying an integrative perspective on incentives at three levels. In line with the idea of transdisciplinarity in sustainability research (Lang et al., 2012) and agroecology (Francis et al., 2013; Méndez et al., 2015; Plieninger et al., 2020), our approach assumes that including and reflecting different knowledge systems and perspectives of multiple stakeholders (scientists, practitioners, policy makers) with local knowledge in the evaluation and design of incentive systems is key to developing strategies for achieving sustainability targets and inducing ownership of their implementation. In this way our approach helps in identifying specific finance and incentive instruments for promoting trees on farms and in revealing the core challenges facing their implementation, which are linked to the wider socio-economic context (e.g., political framework conditions, market opportunities).

Overall, we find that in both countries current policies in agriculture, forestry and local development already include a strong basis for promoting tree planting and management in agroforestry and other tree-related forms of production. Policy support for trees on farms can build on an impressively wide suite of existing instruments – only a handful of new instruments are needed to fill the gaps in points of intervention. This confirms the observation by Schweizer et al. (2021) that for Latin America there is no lack of legal instruments but rather a need to implement and provide suitable finance and incentive instruments. We observe that the impact of existing instruments is currently undermined by fragmented policies and incoherent implementation processes across political sectors and levels (Ashley et al., 2006; Place et al., 2022), which strongly influences farmers' decisions as well as market-related and development initiatives. Moreover, many features of these policies are not yet well matched to the characteristics of tree-related production systems on farms. For example, environmental policies lack elaborate tools to compensate rural householders for their contributions to the provision of ecosystem services by native trees. In addition, while agroforestry systems have characteristics of both forestry and agricultural systems, they do not fully fit into the technical and policy support systems of either sector, due partly to challenges associated with land tenure, concession requirements, and administration. Moreover, financial mechanisms in governmental schemes and the private sector currently create obstacles for actors seeking to invest in agroforestry systems. A harmonisation of policies across sectors and political levels is needed, as well as the empowerment of actors seeking to support trees in sustainable production systems.

At the first level of our analysis, an integrated view of the farming context revealed a wider range of complementary incentive opportunities, some of which may, at first sight, not seem connected to trees on farms or agroforestry. For instance, farmers in Uganda cut down trees for fuelwood and are therefore in need of an alternative energy supply: the connection to required interventions in climate and energy policies is clear here. In the context of illegal timber extraction, farmers in Peru face severe challenges to formalising property ownership and registering trees in order to sell them legally, indicating a connection to the need for interventions in land and resource rights. In contrast to several green finance initiatives (e.g., Seidl et al., 2021), we show that it is necessary to draw on local expert knowledge of contextual factors and farm realities in order to reveal these connections and nuances across issues, sectors, institutions and actors and to devise an impactful package of instruments.

At the second level, an integrated view of policy and finance instruments has made it possible to identify a broad range of incentives to motivate farmers and primary resource users to plant and manage native trees on farms. Depending on the function of native trees and their relation to the beneficiaries of the ecosystem services provided, farmers and other primary resource users can either be paid for providing a societal benefit or be given more ready access to markets for tree-related products; they can receive appropriate technical extension services for tree-related production systems or be supported by means of a regulatory framework that guarantees property rights and ensures legal access to the (sustainable) use of their resources. Concurrently, incentives which discourage planting or managing trees on farms need to be phased out (Zinngrebe et al., 2020).

Finally, at the third level, integrating instruments and interventions into existing institutional settings is a precondition for effective implementation. Native trees frequently remain invisible to legislation (Somarriba et al., 2017). Our analysis shows not only that biodiversity policy in Uganda and Peru is blind to the potential of native trees on farms to provide ecosystem services (e.g., wildlife habitat structures) but also that forestry and agricultural policies continue to support practices that are harmful to trees. Embedding sustainable agroforestry in both forestry and agricultural policies and integrating policy frameworks for coherent incentives can increase effectiveness (Mbow et al., 2014; Schweizer et al., 2021). Moreover, in both countries, significant technical and legal barriers still prevent farmers, governmental agencies and businesses from accessing loans and support schemes.

Certainly, some policy processes promoting native trees on farms have been initiated, and the Peruvian Ministry for Finance, for instance, is developing procedures to facilitate access to funding for biodiversity projects. However, these efforts are compromised by low political priority and weak implementation for three key reasons. First, many initiatives are carried out in a project format that only lasts for a short funding period and is not sufficiently extensive to change overall institutional settings. Second, large shares of funding and technical support still predominantly favour conventional intensified (monocrop) agriculture rather than sustainable agricultural systems. And finally, there is insufficient political will to make sustainable rural development, multifunctional agriculture and the conservation of functional ecosystems a priority. Actors who seek to leverage the mechanisms identified so far lack sufficient political power to implement them in their respective arena. Overcoming the contradictions and incoherence between development and conservation policies could serve to demonstrate the overarching political importance of biodiversity and trees on farms (Singh et al., 2021)

While our methodology has sought to integrate knowledge from many disciplinary angles, it is a relatively rapid diagnostic that cannot go into detail on all facets of the social-ecological system relevant to this issue. For instance, farmers' motivations and behaviours can be studied using methods from the behavioural sciences (e.g., Pak and Castillo Brieva 2010; Ihli et al., 2022). The local farming context needs to be assessed in order to understand the specific ecosystem services and benefits deriving from different tree species. An extended interview process and a closer engagement with stakeholders could be used to understand vested interests and structural barriers undermining political will. Additionally, a review of government spending on plans and programmes relevant to trees on farms would be an interesting component in terms of understanding political priorities (an element we planned but could not achieve due to limited resources and COVID-19 regulations). For the design of similar studies in the future we invite others to adapt our proposed methodology to include approaches and tools which suit the aims and resources. However, we recommend that

all three levels of analysis – incentive opportunities, instrument packages, and policy integration – should be covered in the analysis.

6. Conclusions

In this study, we adopt an integrated perspective on incentives in order to identify a comprehensive set of policy and finance options that promote trees on farms for sustainable agricultural landscapes. For this purpose, we present a diagnostic methodology that works at three consecutive levels: (i) identifying 'incentive opportunities' as the entry points or general rationales by which incentives can support trees on farms; (ii) translating them into suitable packages of incentive and finance instruments; and (iii) developing recommendations for integrating these instrument packages into existing sectoral policies. Our methodology is implemented using a transdisciplinary approach that harnesses expert and stakeholder knowledge in order to identify existing (though reconfigured) instruments and new ones in line with context-specific farming realities and governance structures. Instead of relying on single instruments, the methodology serves to identify a suite of complementary instruments. It also identifies clear roles for actors and their potential contributions.

We applied the methodology in two case studies, in Uganda and Peru. While we cannot claim completeness for the instruments and enabling conditions identified in the two case study contexts, we argue that the analysis synthesised actionable knowledge useful for devising integrated incentives that take account of local needs and institutional structures. The methodology can be deployed by a wide range of actors interested in promoting trees on farms. In light of the 2030 Global Biodiversity Framework (GBF), the Paris Agreement for halting climate change and deforestation, and other commitments for sustainable land use, our methodology is particularly suited to guide the formulation of development action or implementation plans harnessing the potential of trees on farms. The GBF requires parties to update their National Biodiversity Strategies and Action Plans (NBSAPs) and develop national responses to each of the 23 targets (CBD 2022), many of which will require developing and adjusting incentive and finance instruments. We believe that our methodology and the case study experiences can help with this challenge and inspire others to conduct similar analyses in other contexts.

Finally, our results from the case studies in Uganda and Peru highlighted the fact that, to turn the vicious cycle of fragmentation of local incentive systems into a virtuous cycle for sustainable development, the shift towards integration needs to begin at higher political levels. Phasing out harmful incentives and coordinating previously fragmented government institutions will both reduce costs for conservation and provide more leeway for sustainable opportunities to take root and become more widespread. In many settings, local fragmented structures will then need to be redesigned to accommodate such integration and to respond to the implementation of policies in a concerted and coordinated manner. However, as long as the international community and national governments see rural development, climate change, value chains and biodiversity conservation as separate policy arenas, it will be difficult for local structures to change, given their dependence on funding and support from these higher political levels.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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