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Land-use change and forestry programmes in low- and middle-income countries

An evidence gap map update

January 2024

Evidence Gap Map Report 29

Agriculture, fishing and forestry

3ie International Initiative for Impact Evaluation

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3ie evidence gap maps

3ie evidence gap maps (EGMs) are thematic collections of information about impact evaluations and systematic reviews that measure the effects of international development policies and programmes. The maps provide a visual display of completed and ongoing systematic reviews and impact evaluations in a sector or sub-sector, structured around a framework of interventions and outcomes. The report provides all supporting documentation for the map, including background information for the theme of the map, the methods applied to systematically search and screen the evidence base, as well as the main results.

About this evidence gap map

This report presents the findings of a systematic search to identify and map the evidence base of impact evaluations and systematic reviews of interventions on land-use change and forestry programmes. With support from the UK's Department for Environment, Food and Rural Affairs (Defra), this work updates the EGM produced by Snilstveit and colleagues (2016) by replicating the scope of interventions used in the original report. The online EGM is available here. All content in this report is the sole responsibility of the authors and does not represent the opinions of Defra and 3ie, including its donors or its Board of Commissioners. Any errors and omissions are also the sole responsibility of the authors. Please direct any comments or queries to the corresponding author, Constanza Gonzalez Parrao cgonzalez@3ieimpact.org.

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Land-use change and forestry programmes in low- and middle-income countries: an evidence gap map update

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Evidence Gap Map Report 29

January 2024

Executive Summary

In the context of global greenhouse gas (GHG) emissions on the rise, the agriculture, forestry and other land-use sector continues to contribute a large proportion of these emissions, driven mainly by deforestation. International coordination and financing efforts persist in setting mitigation and adaptation strategies for climate change. To inform policymaking with the latest evidence of the effects of programmes and policies that address land-use change and forestry, this EGM updated the evidence of a 3ie Evidence Gap Map (EGM) published in 2016. After seven years, the evidence base in this area is suspected to have increased substantially, especially given the boosted investments in the sector and the urgency to find solutions to reduce emissions and decrease deforestation.

By mapping the evidence that has been published since the original EGM, we aimed to identify learnings in the sector's effectiveness, highlight land-use and forestry areas that have stayed or become under-researched, and facilitate critical thinking about the methods of evaluation used in the field. We updated the EGM by replicating the scope of interventions used in the original map, which aimed to identify programmes and policies likely to have an effect on GHG emissions. These interventions are grouped into five categories: area protection and management; law and policies related to forests and other land; incentives; training, education and information to promote sustainable practices and technology; and infrastructure. We focused on intermediate, environmental, and human welfare outcomes reported in these studies.

We conducted the search in February 2023 and identified 176,240 records from seven databases and nine grey literature sources. After using machine learning to prioritise the screening of these records, we ultimately included 557 impact evaluations and 39 systematic reviews. The volume of evidence has grown substantially since the original map: 63% of the studies in the map were identified in the update search, which highlights the interest in understanding land-use and forestry challenges.

The main trends from the original map remain: 85% of the studies are still concentrated in Sub-Saharan Africa, Latin America and the Caribbean, and East Asia and the Pacific. Likewise, there is still a small number of studies evaluating interventions in the Middle East and North Africa region. The countries with the highest number of studies are China, Brazil, Ethiopia, and Indonesia. Protected areas, community/decentralised forest management, payment for environmental services, and agricultural extension and training remain the most common interventions, covering 58% of the evidence. Likewise, forest coverage and income and household expenditure continue to be the most frequently reported measures, accounting for 49% of the outcomes in the map.

The body of evidence remains heavily based on the use of quasi-experimental designs, particularly matching techniques. More than half of the randomised evaluations focused on subsidies, grants and concessions, and agricultural extension and training. A third of the studies relied on the use of geospatial data, which publications are concentrated in the last five years.

Systematic reviews almost doubled in this period; however, 72% of the reviews were assessed as having low confidence, meaning their findings are likely to have a high risk

of bias. Some of the key learnings from the high or medium confidence reviews include that small and short-term farm field schools can be effective in promoting sustainable management practices but may not be suitable for large-scale contexts; transitioning from long-fallow swidden to other land uses can have negative effects on farmers and ecosystem services; providing land titling to smallholders can increase investment, agricultural productivity and farmers' income, particularly in Latin America and Asia; and protected areas can be effective in preserving tropical forests, but the evidence is insufficient to generalise policy recommendations for other areas.

The lack of high-quality synthesis is one of the major findings of this EGM update. The increasing production of primary evidence needs to be paired with synthesis efforts that follow standards for conducting and reporting reviews. These systematic reviews have stressed the need to incorporate rigorous evaluation at the programme design stage and coordinate efforts to produce high-quality and comparable studies, including testing different versions of the programmes, using common outcome measures, and abiding by reporting standards.

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1. Background

Globally, greenhouse gas (GHG) emissions continue to rise, with average annual rate emissions during 2010–2019 higher than in any previous decade (IPCC, 2022). The agriculture, forestry and other land-use (AFOLU) sector represented 21% of all GHG emissions in 2019 (Nabuurs et al., 2022), a decrease from 24% in 2010 (Smith et al., 2014). AFOLU emissions are mainly driven by changes in land-use and deforestation in particular (Nabuurs et al., 2022). While some countries that home the largest share of forests worldwide have recently been able to curb deforestation rates, such as Russia and China, many other countries, like Brazil and Indonesia, continue to lose forest coverage at an increasing rate (Ritchie & Roser, 2021a). In turn, agriculture is the largest driver of deforestation (Pendrill et al., 2019; Ritchie & Roser, 2021b), with evidence highlighting that around half of land deforested for agriculture across the tropics had a productive agricultural use eventually (Pendrill et al., 2022). Forest loss not only contributes to GHG emissions, but forests themselves act as a carbon sink, with reforestation having the potential to play a significant role in reducing net GHG emissions (Pugh et al., 2019; Raihan et al., 2019).

Recent research has also highlighted issues related to the progress achieved in relation to sustainable land-use. Research has underlined that the impact of flagship programmes, such as reducing emissions from deforestation and forest degradation (REDD+), may have been overestimated (West et al., 2020; Guizar-Coutiño et al., 2022). Not only does the AFOLU sector continue to emit a large proportion of GHG emissions, but previous efforts to tackle this issue may not have been as effective as previously thought.

Despite the efforts of individual countries, the global dimension of climate change requires countries to implement coordinated strategies to meet universal standards and requirements. At the international level, governments of 195 countries adopted the Paris Agreement at the CoP21 in 2015, becoming the first international agreement on climate change legally binding for all countries (Falkner, 2016). Contrary to the 1997 Kyoto Protocol, the Agreement also imposes a reduction of GHG to low and middle-income countries (Horowitz, 2016). Key elements of the Agreement are (i) to keep the global temperature increase under 2°C above pre-industrial levels, (ii) to restrain the temperature raise to 1.5°C above pre-industrial levels, and (iii) for greenhouse gas emissions to peak before 2025 and decline 43% by 2030 to limit global warming to 1.5°C (UNFCCC, March 2023b). It also has the merit of incorporating forest conservation as a strategy for compensating GHG emissions (Federici et al., 2018). Article 5 of the Agreement calls for governments to take action to reduce activities causing deforestation and deterioration of the forests (United Nations, 2015). More recently, the 2020 Glasgow Climate Pact was signed by 200 countries and consists of a range of activities and items needed to reduce GHG emissions to contain global warming and build and improve resilience to climate change (UNFCCC, March 2023a).

These coordination efforts have been paired with funding for mitigation and adaptation to climate change (“climate finance”), which has accumulated USD 4.8 trillion between 2011-2020. In 2021, it was estimated that climate finance amounted to USD 850 billion (Climate Policy Initiative, 2022a). However, the AFOLU sector has attracted only 2.5% of total climate finance between 2013 and 2020 despite causing 13-21% of global

emissions over the same period. Most of this funding in 2019 and 2020 (USD 8.5 billion) was aimed at climate mitigation strategies, particularly in East Asia and Pacific and Sub-Saharan Africa, which received 37 and 23%, respectively. This funding is commonly provided by public actors, notably development financial institutions (Climate Policy Initiative, 2022b).

This EGM updated the evidence of a previous map on land-use change and forestry programmes (Snilstveit, Stevenson, et al., 2016), in which the authors identified 241 relevant impact evaluations and 11 systematic reviews. After seven years, the evidence base in this area is suspected to have increased substantially, especially given the boosted investments in the sector and the urgency to find solutions to reduce emissions and decrease deforestation.

By identifying and mapping the evidence that has been published since the original EGM, we aimed to highlight land-use and forestry areas that have stayed or become under-researched, and to facilitate critical thinking about the methods of evaluation used in the field. This EGM can help stakeholders make evidence-informed decisions on programming and future allocation of resources towards primary and synthesis research for areas within forestry and land-use programmes. Appendix A presents an additional description on how to interpret and interact with the online map.

2. Interventions and outcomes framework

An EGM is a thematic collection of evidence on the effects of development policies and programmes in a particular sector or thematic area (Snilstveit et al., 2017), which is structured around a framework of interventions and outcomes. This section describes the interventions and outcomes of interest covered in this map.

2.1 Land-use and forestry interventions

We replicated the scope of interventions used in the original EGM, where “studies had to assess forestry and land-use programmes or policies likely to have an effect on GHG emissions” (Snilstveit, Stevenson et al., 2016, p.4). Relevant interventions are grouped into five categories (Table 1; full definitions are presented in Appendix B).

Table 1: Interventions categories covered in EGM

Category	Intervention
Area protection and management	Interventions in this category involve actions to establish or expand parks, reserves or other legally protected areas (PAs) in which land or resource use is either fully restricted or regulated. They also include programmes with changes to the management regime of a particular area or jurisdiction.
Law and policies related to forests and other land	This category comprise actions to develop, change and implement formal legislation, regulations and voluntary standards related to forestry and other land.
Incentives	This category includes different interventions that use economic and other in-kind incentives provided to

	individuals or communities to influence land management behaviour.
Training, education and information to promote sustainable practices and technology	Interventions in this category are developed to promote sustainable practices and technology.
Infrastructure	This category includes selected infrastructure interventions (roads, dams) which were included because they could have large effects on land-use and be drivers of emissions.

2.2 Outcomes of Interest

The outcomes of interest also followed the original EGM. Table 2 shows these outcomes according to three dimensions where interventions could have an effect. These categories aimed to capture direct and spillover measures of changes due to the interventions of interest. We included intermediate (e.g., productivity of land) and environmental outcomes (e.g., changes in forest cover or condition), as well as additional outcome measures related to human welfare. For example, income and expenditure indicators may be affected by forest management interventions. Full definitions of the outcomes of interest are presented in Appendix C.

Table 2: Outcome groups covered in EGM

Category	Outcomes
Intermediate outcomes	Outcomes measuring the uptake of agricultural practices, land-use management or forest management.
Environmental outcomes	Outcomes related to GHG emissions, including proxies such as forest condition and coverage, as well as more direct measures of emissions.
Human welfare outcomes	Outcomes related to welfare measures for populations living in areas where interventions are implemented and/or programme beneficiaries.

3. Research methods

We used common standards and methods for creating an Evidence Gap Map (Snilstveit, Vojtkova, et al., 2016; Snilstveit et al., 2017). We produced a protocol for the implementation of the EGM update and also followed the original EGM's approach for searching, screening, and coding relevant literature. This section summarises the key aspects of the inclusion criteria and presents the results of the evidence search.

3.1 Inclusion criteria

Table 3 summarises the criteria to select studies for the EGM following the PICOS framework and additional categories such as language, publication date and status.

Table 3: Summary of inclusion criteria

Criteria	Description
Population	We included studies that focused on any population from L&MICs, as defined by the World Bank, for the first year of implementation. We included studies that targeted populations in an L&MIC and a high-income country if the results for the L&MIC population were analysed and reported separately (i.e., with unique intervention and comparison groups from the L&MIC).
Intervention	We included the same intervention categories used in the original EGM (see Appendix B for full definitions).
Comparator	We included studies with any comparator (e.g. business as usual, waitlist). Non-comparative studies and observational studies with no control were excluded.
Outcomes	We included the same intermediate, environmental and human welfare outcomes used in the original EGM (see Appendix C for full definitions).
Study designs	We included impact evaluations (randomised and quasi-experimental evaluations) and systematic reviews that measured the effects of a relevant intervention on outcomes of interest. The specific research designs used are presented in Appendix D, which are widely used to evaluate intervention effectiveness (Aloe et al., 2017; Reeves et al., 2017).
Language	We included studies published in any language, although the search terms used were in English.
Publication date	The search in the original EGM covered up to part of 2016; hence, we included studies published from 2016 onwards.
Study status	We included peer-reviewed studies and 'grey literature', ongoing and completed impact evaluations and systematic reviews.

3.2 Searching for the evidence

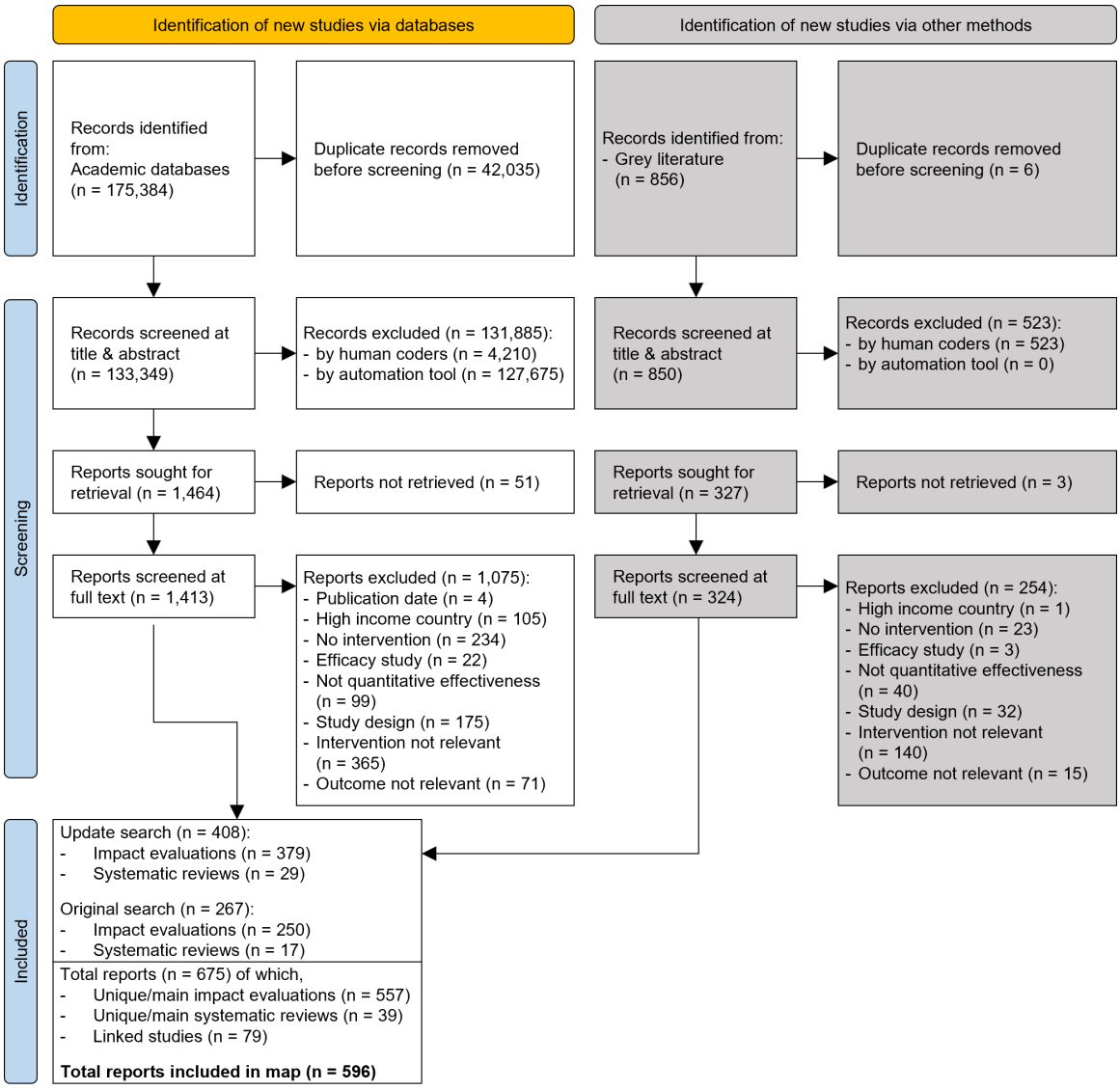
We adopted a systematic search strategy following guidelines for systematic literature searching (Kugley et al., 2017). Based on the strategy used in the original map, the search was designed to address potential publication bias issues by systematically searching academic bibliographic databases and implementing additional searches for grey literature in specialist organisational websites, websites of bilateral and multilateral agencies and repositories of research in international development.

We conducted the search in February 2023 based on seven databases and nine grey literature sources. The full list of sources used in the search for evidence, as well as an example of the search strings employed, are presented in Appendix E. The precise strings and logic (e.g., index terms and truncation operators) were adapted for each database and platform. Due to time restrictions, we did not conduct forward or backward citation tracking.

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021), Figure 1 presents the EGM flowchart detailing the results of the search and screening processes. This implementation stage was managed using

EPPI-Reviewer (Thomas et al., 2020). We identified a total of 175,384 records from academic databases and 856 records from grey literature sources. A quarter of these (n = 42,041) were duplicate records.

Figure 1: PRISMA flowchart



We used EPPI-Reviewer's machine-learning algorithm, particularly the 'classifier' functionality, to prioritise studies for screening according to their likelihood of inclusion. The classifiers were based on two sources: first, we used a model based on 3ie's Development Evidence Portal (3ie, July 2023) to identify studies with eligible study designs and country focus. Second, we built a classifier model based on data from the original map to subject-relevant studies. We screened all studies categorised with at least 15% likelihood of being included. Records with less than 15% likelihood were auto excluded. A small random set of studies was screened to provide screening training material to the team. During this stage, inclusion decisions were discussed among the team, clarifying the inclusion criteria as needed. After the training stage, the review team proceeded with a single screening approach, where each title and abstract was screened by one coder with the possibility of flagging the study to another reviewer if unsure.

We aimed to retrieve the full text of all studies that met the inclusion criteria; however, a small number of studies was not retrievable (n = 54). Two reviewers independently screened around half of the 1,737 studies screened at full text, and in cases where discrepancies remained after discussion, a third senior reviewer was involved in the final inclusion decision. For the second half of these records, the team transitioned to single screening with the option of raising the study for an additional opinion. At the end of this process, we identified 406 new studies to be added to the map.

Among studies from the original map (n = 267) and those newly identified (n = 408), 79 records were linked papers, that is, different versions of the same study. Ultimately, the EGM update includes a total of 596 main studies, of which 63% (n = 374) were identified in the update search. Of the evidence shown in the map, 93% (n = 557) are primary impact evaluations, and 7% (n = 39) are systematic reviews. Likewise, almost all of these studies have been completed (n = 587, compared to 9 ongoing studies). The full list of included studies, both main and linked papers, is presented in Appendix F.

3.3 Coding of included studies

We systematically extracted data from all newly included studies in a shared spreadsheet, and data was then inputted into 3ie's Development Evidence Portal platform. These data covered information about the study (e.g., title, year of publication), programme and context (e.g., country, programmer funder), evaluation methods (e.g., study design, use of big data), and intervention and outcomes evaluated. For intervention categories, we coded studies that evaluated together packages of relevant activities as multicomponent, while we coded studies that evaluated separately relevant activities as multiarm. In cases where studies evaluated different interventions independently and jointly (e.g., effect of intervention A, effect of intervention B, and effect of intervention A+B), we coded studies with the individual intervention categories as well as multiarm. We based the coding of information on main and linked papers to have a complete picture of the evaluation. After coding all studies once, a second coder checked the intervention and outcome categories for all studies as a quality-assurance procedure. The data extraction template used is available in Appendix G.

Newly included SRs were critically appraised following the practices suggested by Lewin and colleagues (2009). The appraisal assessed SRs according to criteria relating to the search, screening, data extraction, and synthesis activities conducted, and covered the most common areas where biases are introduced. SRs were single coded and reviewed by a methods expert in cases of doubt. Each SR was rated as low, medium, or high confidence drawing on guidance provided by Snilstveit and colleagues (2017). The critical appraisal tool used is presented in Appendix H. We did not critically appraise impact evaluations, as this is typically beyond the scope of EGMs.

4. Analysis of the evidence

In this section, we examine the characteristics of the 596 studies that evaluated the effects of land-use change and forestry interventions on the outcomes of interest. We summarise the main findings and then describe some of the observations and notable findings about the methods in the impact evaluations. We also chart the growth, change in focus, geographical coverage and trends from the original EGM (Snilstveit, Stevenson et al., 2016) to this EGM update.

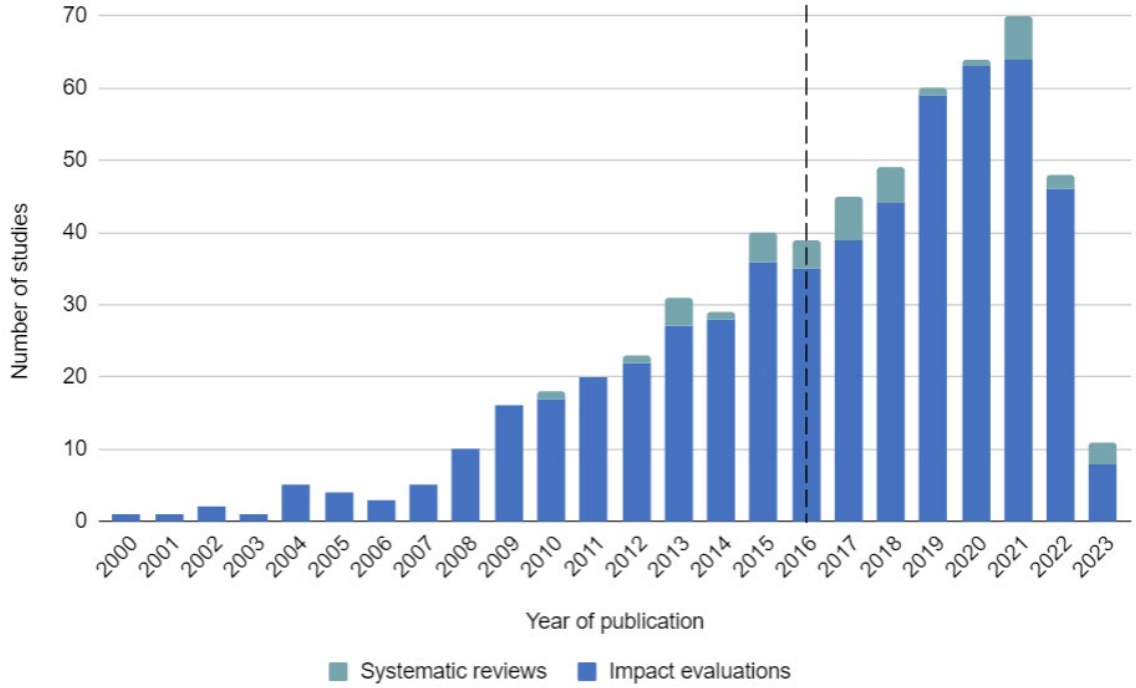
4.1 Characteristics of the body of evidence

4.1.1 Growth of the evidence

The original EGM identified 222 studies, of which 210 and 12 were impact evaluations and systematic reviews, respectively. Compared to 2016, this EGM update contains 374 new studies: 347 impact evaluations and 27 systematic reviews. There has been an increase in the production of relevant evidence between the two searches for literature. Of the 557 impact evaluations in the map, 62% came from the updated search compared to 38% from the original. Similarly, 69% of the SRs in the map were identified in the update search.[1]

Figure 2 presents the distribution of studies identified by the year they were published. It shows an upward trend each year and an accelerated growth after 2016. A peak in the number of studies can be seen in 2021 with 64 impact evaluations and six systematic reviews included in line with our criteria. Half of the evidence in the map was published between 2018 and 2023.

Figure 2: Distribution of studies by year of publication



Note: the dashed vertical line reflects the cut-off for the original and update search. The update search was conducted in Feb 2023, hence the lower number of studies this year.

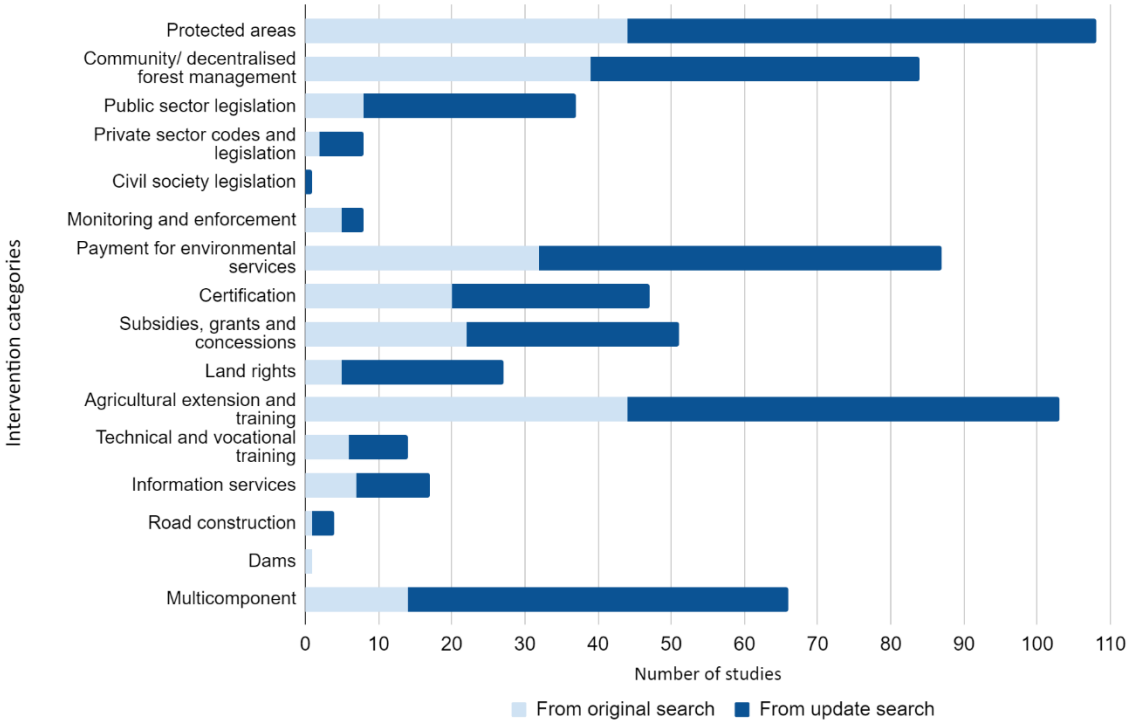
4.1.2 Intervention and outcome coverage

Of the total 596 studies in the EGM, 86% (n = 510) analysed a single intervention, while 14% (n = 86) evaluated packages of multiple activities (i.e., multicomponent) and/or compared different treatment arms within the same study (i.e., multiarm). More than half of the studies evaluating more than one intervention category are multicomponent (n = 47).

[1] We identified final reports for five SR protocols in 2016 (Dressler et al., 2017; Gutiérrez Rodríguez et al., 2016; Hajjar et al., 2021; Ojanen et al., 2017; and Oya et al., 2017). Appendix I presents studies identified that cited other of the 2016 protocols, but which were not included as SRs in this map.

This body of evidence is concentrated under three intervention groups: *incentives* (32%, n = 212), *area protection and management* (29%, n = 192) and *training, education, and provision of information to promote sustainable practices and technology* (20%, n = 134). As presented in Figure 3, the intervention categories most commonly evaluated by studies remain the same as in the original map, with *protected areas* (n = 108), *community/ decentralised forest management* (C/DFM; n = 84), *payment for environmental services* (PES; n = 87) and *agricultural extension and training* (n = 103) covering 58% of the evidence in the map.

Figure 3: Number of studies per intervention category, by original vs update search



Seven intervention categories have less than 20 studies, and hence were the least evaluated. These include codes and legislation in the *private sector* (n = 8) and within *civil society* (n = 1), interventions related to *monitoring and enforcement* strategies (n = 8), the provision of formal *technical and vocational training* (n = 14) and *information services* (n = 17) to promote sustainable practices and technology, and interventions related to *infrastructure* (n = 4 for roads and n = 1 for dams).

Three intervention categories show a sharp rise compared to the original map. There is more than a threefold increase in studies evaluating interventions on *public sector legislation* (n = 37 in total, of which 29 were identified in the update search), including forest or soy moratoria (e.g., Heilmayr et al., 2020; Leijten et al., 2021), forest codes (e.g., Albuquerque Sant'Anna & Costa, 2021), and state-owned forest farms (e.g., Chen et al., 2020). We also identified four times more studies on *land rights* interventions than in 2016 (n = 27 in total, 22 of which were captured in the update search). These commonly relate to land titling (e.g., Holland et al., 2017) and collective property rights (e.g., Baragwanath & Bayi, 2020). Finally, the evaluation of *multicomponent* interventions has also increased considerably, including more than three times more studies than in

the original map (n = 66 in total, of which 52 were identified in the update search). Examples of these intervention packages include the evaluation of Brazil's Action Plan for the Prevention and Control of Deforestation in the Legal Amazon, which comprised land planning, monitoring and enforcement, and the promotion of sustainable productive activities (Simorangkir, 2018). Similarly, this includes evaluations of projects under REDD+, which can cover a range of planning, (conditional) payments, capacity-building, and other activities (e.g., Špirić et al., 2023; Duchelle et al., 2017).

Similarly, the most common outcomes reported by studies in the original map remain, with *forest coverage* (n= 248) and *income and household expenditure* measures (n= 225) accounting for 49% of the outcomes in the EGM. However, Figure 4 also shows an increase in measuring other environmental outcomes compared to the original map. Studies reporting measures of *forest condition* more than doubled (n = 13 in original vs n = 28 studies in update search). *Carbon storage and sequestration* continue to be the least reported outcome, but it shows more than a threefold increase since 2016 (n = 2 in original vs n = 7 studies in update search). Direct measures of *GHG emissions* present the largest increase: while in the original map only one study included this outcome, the update search captured 14 new studies reporting on emissions measures. Comparatively, other human welfare outcomes other than income and expenditure are scarcely evaluated in this body of evidence. In fact, 6% of the impact evaluations (n = 36) reported at least one measure of an environmental and a human welfare outcome, and as in the original map, we found no studies that measured GHG emissions and food security outcomes in particular.

Figure 4: Number of studies per outcome category, by original vs update search

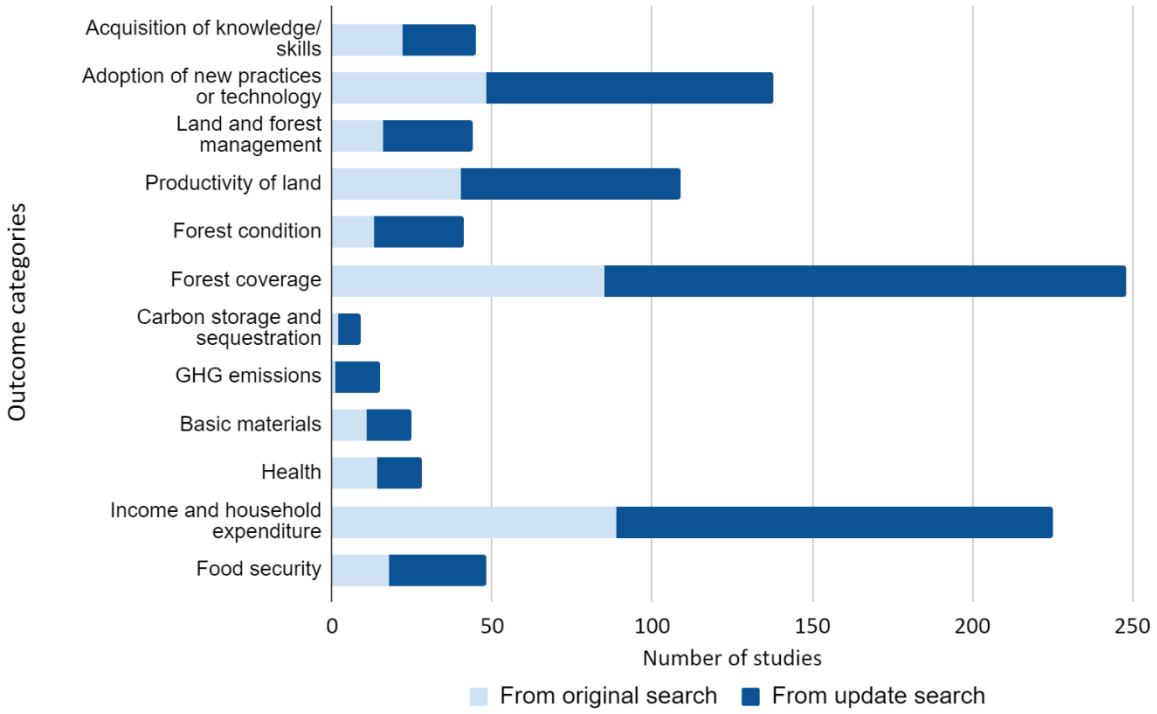


Table 4 illustrates that, when focusing on the intervention categories most commonly evaluated, more than half of the studies evaluating *protected areas, C/DFM*, and *PES* interventions reported *forest coverage* (59%, 32%, and 26%, respectively) and *income*

and household expenditure measures (17%, 25%, and 28%, respectively). Studies evaluating *agricultural extension and training* interventions tended to focus more on uptake measures of productive and management practices, mostly reporting on the *adoption of new practices and technology* (28%), *productivity of land* (21%), and *income and household expenditure* (23%). Appendix J includes additional visualisations of the online map showing the evidence identified by groups of interventions and outcomes.

Table 4: Distribution of outcomes reported by most frequent interventions

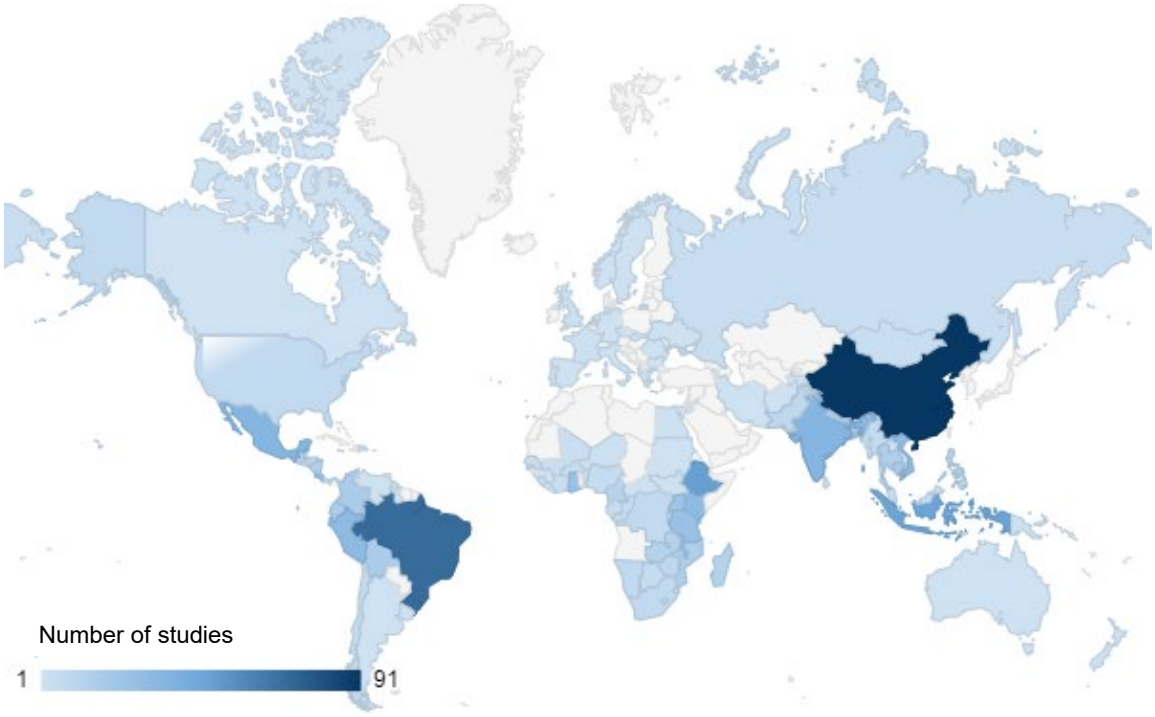
The most frequently reported outcome categories per intervention are highlighted in grey.

	Interventions			
Outcomes	Protected areas	Community/ decentralised forest mgmt.	Payment for environmental services	Agricultural extension and training
Acquisition of knowledge/ skills	1%	1%	3%	14%
Adoption of new practices or technology	1%	4%	8%	28%
Land and forest management	2%	6%	8%	2%
Productivity of land	4%	1%	7%	21%
Forest condition	4%	13%	6%	0%
Forest coverage	59%	32%	26%	1%
Carbon storage and sequestration	1%	1%	1%	1%
GHG emissions	2%	2%	1%	0%
Basic materials	4%	4%	2%	0%
Health	2%	5%	2%	2%
Income and household expenditure	17%	25%	28%	23%
Food security	1%	5%	7%	6%

4.1.3 Geographic distribution

The body of evidence has diversified in terms of its geographical coverage. While in the original map, the studies covered interventions implemented in 48 countries, the EGM update now includes studies across 105 countries. These studies continue to be highly focused on Sub-Saharan Africa (n= 340), Latin America and the Caribbean (n = 290) and East Asia and the Pacific (n = 243). Likewise, there is still a small number of studies evaluating interventions in the Middle East and North Africa region (n = 8). Figure 5 illustrates the distribution of IEs and SRs by country, with more than half of the evidence covering 13 countries (in frequency order: China, Brazil, Ethiopia, Indonesia, India, Mexico, Malawi, Kenya, Peru, Vietnam, Costa Rica, Ghana, and Tanzania).

Figure 5: Distribution of studies by country



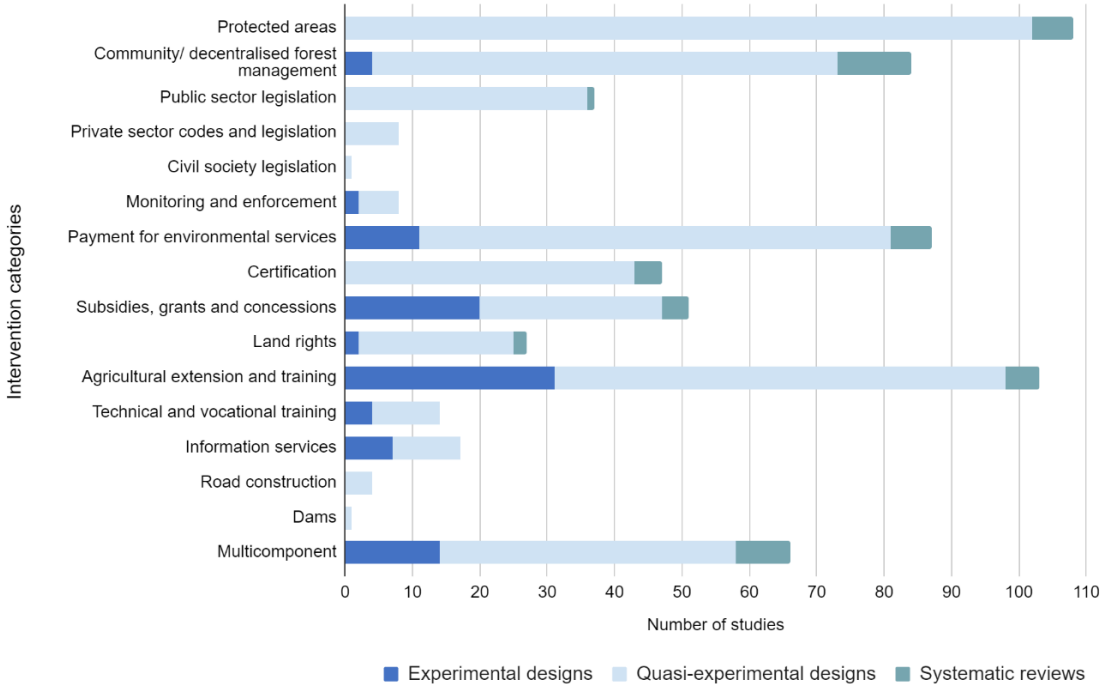
Note: The map shows the number of countries covered by the EGM, which is higher than the total number of studies included in the map. The original EGM included a small number of studies from high-income countries (n = 10).

Across the most frequent intervention categories, Brazil, China and Indonesia have the highest number of studies evaluating *protected areas* (n = 22; 16; 16, respectively). India, Indonesia and Kenya are the countries with the most studies on *C/DFM* interventions (n = 11; 10; 10, respectively). Evaluations of *PES* programmes are mostly found in China, Mexico and Costa Rica (n = 27; 13; 10, respectively). Finally, China, Ethiopia, Ghana and Bangladesh are the countries with the most studies related to *agricultural extension and training* (n = 16; 15; 12; 11, respectively).

4.2 Impact evaluation methods used

Following the same trend seen in the original map, this body of evidence is heavily based on primary studies using quasi-experimental designs (81%), compared to experimental designs (12%) and systematic reviews (7%; Figure 6; see Appendix D for more details on the study designs included). The use of randomised evaluations depends on the intervention type. For instance, it could be challenging to randomise national or regional policies (such as protected areas or legislation) and, in fact, we did not find experimental designs in these categories. Two interventions categories concentrate more than half of the studies based on experimental designs: *subsidies, grants and concessions* (n = 20), covering, for example, price incentives (e.g., Hagerty & Zucker, 2020) or unconditional conservation payments (e.g., Wilbore et al., 2019), and *agricultural extension and training* programmes (n = 31), which usually focused on promoting sustainable practices (e.g., fertiliser or pest management) and adoption of new technologies (e.g. for irrigation).

Figure 6: Intervention categories by study design



Among the quasi-experimental designs used by primary studies, matching techniques are the most common (45% of studies used this approach, n = 325), particularly when evaluating *C/DFM*, *agricultural extension and training*, and *protected areas*. The evaluation of *PES* interventions relies on the use of both matching techniques and fixed effects estimations (which include difference-in-difference designs). Fewer studies used other quasi-experimental designs, such as instrumental variables (n = 78), regression discontinuity design (n = 14) and synthetic control (n = 9).

There is an increase in the use of geospatial data to evaluate these interventions, from 29% of studies in the original search (n = 75) to 39% in the update search (n = 182). In total, a third of the studies in the EGM (36%) used geospatial data, which publications are concentrated in the last five years. This type of data is most commonly sourced when evaluating protected areas (32%), PES (15%) and C/DFM (13%) and is usually paired with matching techniques. Examples of these sources include data from Landsat (Walker, 2021; Salazar et al., 2021), Global Forest Change (e.g., Wiik et al., 2019) and Brazil's MapBiomas collection (e.g., Oliveira et al., 2020).

5. Systematic review appraisal and findings

This section presents the results of the critical appraisal of SRs identified in the EGM, along with the characteristics and a summary of the findings from high and medium confidence SRs. We then discuss the main implications and synthesis gaps of this body of evidence.

5.1 Critical appraisal of SRs

We critically appraised SRs in terms of how the reviews conducted the search, selection and analysis of primary studies. As presented in Table 5, of the 39 SRs identified, 72% (n = 28) were assessed as having low confidence, meaning there is a high risk of bias in their findings.

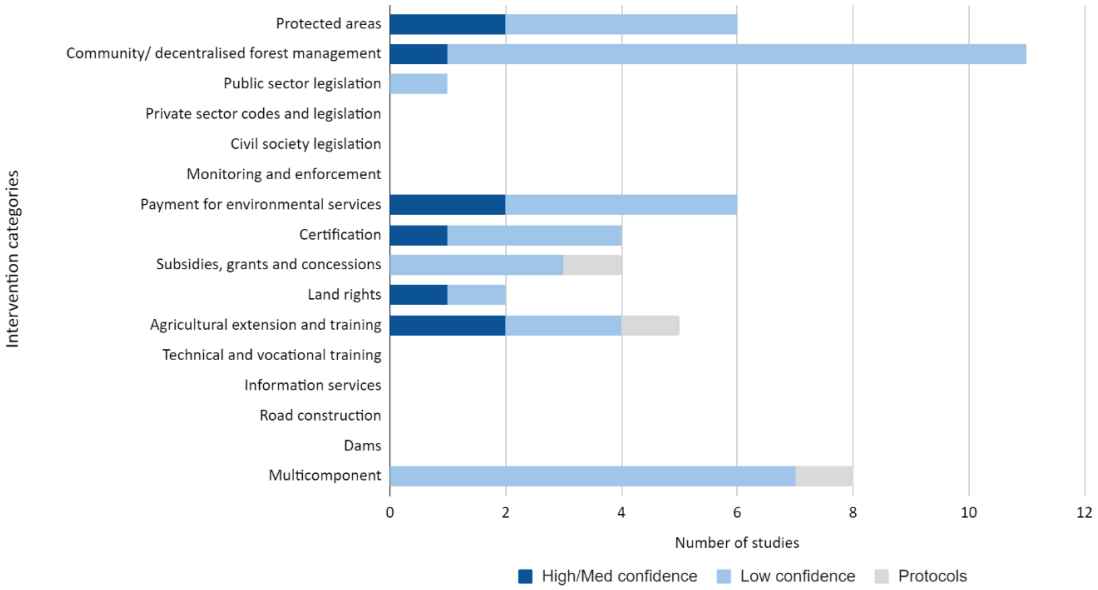
Table 5: Results of critical appraisal of SRs

	Original search	Update search	Total in EGM
High or medium confidence	6	3	9 (23%)
Low confidence	5	23	28 (72%)
SR protocols (ongoing)	1	1	2 (5%)
Total	12	27	39

With a few exceptions where the search (i) relied on just a couple of sources, (ii) did not include grey literature sources, or (iii) looked for studies in English only, the approaches to searching for relevant literature across these SRs were generally clear. We identified three main issues that led to these reviews being assessed as having low confidence, all of which relate to the selection and analysis of studies. First, reviews did not always report if the screening process followed best practices (e.g., independent double coding of studies). Second, many reviews did not conduct a quality assessment of the studies identified. Assessing the risk of bias of each primary study allows us to discern if their results are reliable, and incorporating this information into the synthesis of evidence helps identify if the effects are sensitive to the quality of primary studies. Third, most of the reviews analysed the evidence using vote counting approaches, mainly based on the direction of effects (i.e., how many studies reported positive or negative effects). By combining the magnitude and direction of the effects, meta-analysis can combine associations of different strengths into the synthesis of evidence to provide a clearer picture of the effects of interventions (Borenstein et al., 2009; Lipsey & Wilson, 2001).

Among all included SRs, 35 evaluated a single intervention, while four SRs studied between 2-5 intervention categories. Figure 7 shows the number of individual interventions (n = 47) evaluated by the 39 SRs included in the map. SRs that evaluated more than one intervention include those that focused on characteristically multicomponent interventions (e.g., REDD+ interventions as in Špirić et al., 2023 or Duchelle et al., 2017) or SRs driven by questions related to outcomes (e.g., "what drives deforestation?", Busch & Ferretti-Gallon, 2017).

Figure 7: Intervention categories by confidence level



The low confidence SRs mainly evaluated *C/DFM* and *multicomponent* interventions. Two SRs (5%) are still ongoing, so were not appraised. These aim to evaluate silvicultural interventions on production and conservation outcomes (Petrokofsky et al., 2015), and how climate-smart agriculture affects productivity, resilience and climate change mitigation outcomes (Rosenstock et al., 2016). Appendix I describes additional studies (but nor SRs) related to these protocols.

From the 39 SRs included in the EGM, 23% were assessed as having high (n = 7) or medium (n = 2) confidence. This group of nine SRs is the focus of the rest of this section.

5.2 Characteristics of high or medium confidence SRs

Eight of the nine SRs appraised as having high or medium confidence had a multi-continent coverage; that is, they either focused on L&MICs or had a global coverage. The exception is the review from Dressler and colleagues (2017), which focused on multiple countries in Southeast Asia. The nine reviews drew their results by synthesising between 8-92 impact evaluations. Seven of these SRs also relied on evidence from between 4-136 qualitative primary studies. Six of these SRs were funded or co-authored by 3ie.

Each of the high or medium SRs evaluated a single intervention category. As presented in Table 6, two reviews studied *protected areas*, *PES* and *agricultural extension and training* interventions, while a single review covered *C/DFM*, *certification*, and *land rights.* In terms of outcomes, the high or medium confidence SRs reported between one and eight outcomes across the three groups of interest. While most of these SRs evaluated at least one human welfare outcome, half reported at least one environmental outcome. Two reviews (Geldmann et al., 2013; Dressler et al., 2017) only reported effects on environmental outcomes, while three SRs considered both environmental and human welfare outcomes (Snilstveit et al., 2019; Samii et al., 2015a; 2015b).

Table 6: Outcomes reported in high and medium confidence SRs

	Outcomes		
Interventions evaluated by SRs	**Intermediate**	**Environmental**	**Human welfare**
Protected areas (Pullin et al., 2013)	1	0	4
Protected areas (Geldmann et al., 2013)	0	1	0
Community/ decentralised forest management (Samii et al., 2015a)	0	2	1
Payment for environmental services (Snilstveit et al., 2019)	2	4	2
Payment for environmental services (Samii et al., 2015b)	0	1	1
Certification (Oya et al., 2017)	1	0	1
Land rights (Lawry et al., 2014)	1	0	1
Agricultural extension and training (Waddington et al., 2014)	2	0	1
Agricultural extension and training (Dressler et al., 2017)	0	4	0

5.3 Main findings of high or medium confidence SRs

This section draws from the summaries included in the original EGM report (n = 6), adding the findings from newly identified high or medium confidence SRs (n = 3).

Two reviews examined *protected areas*. Pullin and colleagues' review (2013) was assessed as having high confidence and examined the effects of terrestrial protected areas on human wellbeing. The authors identified 79 quantitative and 34 qualitative studies; however, they assessed a high risk of bias in most quantitative studies and found that the evidence was disparate and fragmented. The authors concluded that the effects of protected areas are highly context-dependent, and the quality and quantity of rigorous evidence restrict their ability to generalise any policy recommendations. The second review was assessed as medium confidence (Geldman et al., 2013). Based on 118 studies, the authors evaluated the effect of protected areas on the maintenance of populations of natural species and the prevention of habitat loss. They found generally positive outcomes, particularly for the protection of habitat in tropical forested areas. The authors conclude that protected areas can be effective conservation strategies to preserve tropical forests, but that there is insufficient evidence to make policy recommendations about other types of areas.

Samii and colleagues (2015a) examined the effect of *decentralised forest management* (DFM) on environmental and human welfare outcomes, and their review was assessed as having high confidence. Drawing from eight impact evaluations that reported measures on different forest types, meta-analysis was not possible, but authors state that DFM could have a positive effect on reducing deforestation. Due to the small evidence base, the authors could not rule out a negative effect of DFM on poverty. From their review of four additional qualitative studies, the authors highlighted institutional capacity issues, as some programmes could not carry out their mandates of achieving reduced deforestation rates.

Two reviews analysed *PES* interventions; both were assessed as high confidence SRs. Samii and colleagues (2015b) identified 11 studies that evaluated the effects of six different PES programmes in four countries. The authors found that PES reduce deforestation, but impacts are modest and inefficient, reducing the annual deforestation rate by 0.21 percentage points on average. They also identified modest improvements in household income. The authors concluded that the evidence base on the effects of PES programmes is limited in both quantity and quality. In the second review of PES programmes (Snilstveit et al., 2019), the authors identified 44 impact evaluations and 60 qualitative studies, which covered 18 PES programmes in 12 countries. They found that PES could reduce deforestation and improve forest cover as well as household income. The qualitative synthesis suggested that these effects may depend on the programmes' targeting strategies, on how they are implemented and governed, and on other contextual and attitudinal factors. However, the authors suggested treating these findings with caution due to the state of the evidence: it covers a small number of contexts, it has a high risk of bias, and it is based on a wide range of outcome measures. The authors concluded that PES remain a high risk strategy.

Oya and colleagues (2017) evaluated the evidence around *certification* schemes, and their review was assessed as having high confidence. They identified 43 impact

evaluations and 136 qualitative studies, which covered 12 types of certification schemes across Latin America and the Caribbean, Africa, South Asia and East Asia and the Pacific. The authors assessed the evidence as having mixed quality and found that, despite identifying a 14% increase in prices and an 11% increase in income from certified production, these schemes had no positive effect on other longer-term and socio-economic outcomes, such as wages, household income and assets. Due to the mixed results, the variation of effects based on a range of outcomes, and the focus of the evidence on specific certification types, the authors could not generalise conclusions.

One SR evaluated *land rights* (Lawry et al., 2014), which was appraised as having high confidence. Drawing from 20 quantitative studies, the authors found that agricultural productivity improved in some contexts, as gains were more limited in Africa than in Latin America and Asia. The evidence also suggested an average improvement of around 15% for income and consumption measures. Based on nine qualitative studies, the authors highlighted that these land rights interventions may have unintended negative consequences, such as displacement or diminished property rights for women.

Finally, two reviews focused on agricultural extension and training. The review from Waddington and colleagues (2014) was assessed as a high confidence review. The authors synthesised the effect of farmer field schools promoting integrated pest, crop and soil management based on 92 impact evaluations and 20 qualitative studies. They found that farmer field schools improved farmers' knowledge and adoption of environmentally friendly practices and identified a 13% increase in agricultural yields and a 20% increase in farmers' income. These positive effects were observed in small-scale and short-term programmes; when implemented at scale, these effects tend to fade in time. The authors did not find evidence that neighbouring farmers benefit from the diffusion of knowledge from farmer field school participants. In turn, the review from Dressler and colleagues (2017) was assessed as a medium confidence review. The authors identified 40 quantitative and 50 qualitative studies on transitions from long-fallow swidden to other land uses. Through meta-analyses the authors found that transitions from long-fallow swidden show negative effects on soil fertility and carbon stocks indicators. Moreover, after conducting a qualitative comparative analysis, the authors suggested a trade-off between an increase in income and a reduction in other productive and socio-economic indicators, such as staple yields or customary practices.

5.4 Implications for research

Although the nine high or medium confidence SRs covered six different intervention types, the implications for future research drawn from these syntheses have some shared suggestions that can be applied across interventions. Overall, there is a need for more and better evidence. In many cases, the evidence identified is insufficient to address effectiveness questions due to the quality of primary studies and the variety of outcomes used in the sector. This hinders understanding if interventions are effective and making generalisations of findings for policy decision-making.

There is also a common call to incorporate the rigorous evaluation of programmes at their design stage and encourage partnerships to leverage research agendas. This coordination of efforts could include:

- Design and implement theory-based mixed-methods evaluations to identify not

only if interventions are effective but also to understand why, in which contexts, and for whom.
- Plan evaluations of different versions of the interventions, at different scales and in different contexts.
- Use a common set of comparable measures for environmental and human welfare outcomes.
- Use rigorous evaluation designs to disentangle the effects of interventions, particularly when these are implemented in tandem with other activities.
- Prioritise randomised evaluations. In cases where randomisation is not possible, or is unethical, the use of other quasi-experimental designs can still support the identification of causal estimates. Leveraging existing data (e.g., satellite imagery) can help assess the changes due to these interventions.
- Align with reporting standards to increase transparency. This includes richer information about the programmes evaluated (e.g., location, context, participants) and greater methodological details of the study designs employed (e.g., data collection tools, sample, pre-analysis plans).

5.5 Synthesis gaps

This EGM update identified almost twice the SRs compared to the original map. However, after appraising how these new reviews were implemented, 85% of the new SRs did not follow best practices for conducting SRs and were assessed as having low confidence. Hence, we can only suggest relying on the findings of nine of 39 reviews (23%).

The high or medium confidence SRs drew, on average, from 47 quantitative studies, which is not a small size of literature. However, many of these SRs concluded that more high-quality evidence is needed to understand the effectiveness of these interventions, largely due to the risk of bias of individual studies and/or the different outcome measures reported across primary studies. Moreover, these SRs were published between 2013 and 2019, so is likely that they are outdated. As an example, the two high or medium confidence SRs on *protected areas* (Pullin et al., 2013 and Geldman et al., 2013) were published in 2013 and they included 79 and 86 quantitative studies, respectively. We identified 62 new studies on *protected areas* since the original search. There is an urgent need to produce high-quality synthesis incorporating the latest evidence around land-use and forestry interventions.

Finally, although there is at least one high or medium SR for each of the most frequent interventions categories in the map, the following areas have an adequate number of primary studies to explore synthesis options but have no (high-quality) SRs:

- Public sector codes and legislations: the map includes one low confidence SR and 37 impact evaluations.
- Multicomponent interventions: the map includes 58 impact evaluations, seven low confidence SRs and one ongoing SR.

6. Funding and implementing agencies

Table 7 shows that among included studies, 54% reported the agency that implemented the intervention and 39% reported the organisation that funded the intervention, most of which were government agencies. Studies in the EGM are concentrated in China and

Brazil, and government agencies from these two countries are most frequently reported as implementers and funders of these interventions.

Table 7: Distribution of implementing and funding agencies

The most frequently reported agencies per category are highlighted in grey.

	Programme implementation	Programme funding	Research funding
Studies that reported this data	**54%**	**39%**	**64%**
Academic institution	4%	1%	21%
Charitable or private foundation	1%	2%	6%
For-profit firm	3%	2%	0%
Government agency	72%	65%	41%
International aid agency	4%	13%	14%
International financial institution	1%	7%	5%
Non-profit organisation	17%	10%	13%

In turn, 64% of included studies stated the agency that funded the research. Government agencies from China and the United States are most commonly reported as funding these studies (e.g., the U.S. National Science Foundation or the National Natural Science Foundation Of China); while the academic institutions most commonly reported as supporting these studies are based in China (e.g., Nanjing University, China University of Geosciences), US (e.g., University Of Michigan, Harvard University), UK (Economic And Social Research Council, London School of Economics and Political Science).

7. Conclusion

This EGM has updated the evidence on the effects of a range of commonly implemented programmes in land-use and forestry. We identified 557 impact evaluations and 39 systematic reviews, of which 63% come from the update search. The body of evidence has kept its major trends in terms of where the studies have been conducted and the intervention and outcome categories most and least frequently evaluated. However, the increase in impact evaluations is not followed by a larger number of high confidence systematic reviews to assess the effectiveness of these interventions: only 23% of the systematic reviews were assessed as having high or medium confidence. The limitations in the evidence base mean that it is difficult to determine with confidence that land use and forestry policy interventions are achieving their intended impact.

While the latest evidence may not always have clear paths to guide decisions on policy and practice, it provides a wealth of primary evidence that decisionmakers can consult when designing policies, interventions, and the evaluations of these programmes. EGMs can also signpost areas where research is needed more urgently, in terms of interventions, outcomes, and the type of research required most.

7.1 Implications for policymakers

Decision-makers should prioritise consulting reviews that have been assessed as having high or medium confidence. The key findings of high or medium confidence systematic reviews were summarised in section 5. Here we present the main policy implications

highlighted by these reviews. While we suggest consulting the original reports for more details, these are areas where there is sufficient evidence to potentially inform decision-making on new policies and programmes:

1. Small and short-term *farm field schools* can be effective in promoting sustainable management practices but may not be suitable for large-scale contexts.
2. Land-sharing approaches that incorporate long-fallow management could be used as a legitimate source of sustainable livelihood and agroecological renewal to avoid negative effects on swidden farmers and proxies for ecosystem services.
3. Providing *land titling* to smallholders can increase investment, agricultural productivity and farmers' income, particularly in Latin America and Asia. However, gains in agricultural productivity may take time to realise and can be context-dependant. Decisionmakers should consider appropriate tenure models to accommodate regional and national contexts.
4. *Protected areas* can be effective in preserving tropical forests, but the evidence is insufficient to generalise policy recommendations for other areas.

However, the map also shows that the evidence available on *decentralised forest management* and *certification schemes* does not allow to provide actionable conclusions for decision-making. Likewise, the evidence on *payment for environmental services* is limited and methodologically weak. While the question on whether these policies are effective remains open, decision-makers are suggested to pilot and closely evaluate *PES* projects, paying special attention to the programmes' targeting and governance.

Policymakers can also consult the map to identify other evidence available, but be cautious about low-confidence SRs or drawing conclusions from single primary studies. Low-confidence reviews are more likely to be susceptible to bias, while individual studies are just one piece of the big picture.

7.2 Implications for research

7.2.1 Designing and commissioning impact evaluations

Systematic reviews have stressed the need to incorporate rigorous evaluation at the programme design stage and coordinate efforts to build the body of evidence more efficiently, including testing different versions of the programmes, using common outcome measures, and abiding by reporting standards. Based on the EGM findings, we put forward the following considerations for commissioning and designing impact evaluations:

1. In addition to forest coverage and income and expenditure, prioritise the evaluation of interventions on other environmental and human welfare outcomes. For example, incorporating direct GHG emissions or food security measures may be particularly useful to understand different aspects of this evidence.
2. Consider filling one or more of the seven areas with scarce or no impact evaluations (legislation in the private sector and within civil society, monitoring and enforcement strategies, the provision of formal training and information services, and the construction of roads and dams under sustainable approaches) or in contexts of interest with less evidence available, such as the Middle East and North Africa region.
3. When planning new programmes, embed theory-based mixed-methods evaluations to assess if interventions work and understand why, in which

contexts, and for whom. Implement evaluations of different versions of the interventions, at different scales and in different contexts, while using comparable measures for environmental and human welfare outcomes. And, if feasible, prioritise the use of randomise evaluations and leverage remote sensing data to identify credible counterfactual designs.

7.2.2 Planning and commissioning synthesis research

The lack of high-quality synthesis is one of the major findings of this EGM update. The increasing production of primary evidence needs to be paired with synthesis efforts that follow standards for conducting and reporting reviews (see Page et al. 2021; The Methods Group of the Campbell Collaboration 2019b; 2019a; and Higgins et al. 2022 for internationally recognised standards). When commissioning or planning synthesis projects, we suggest considering the following priorities:

1. In seven years, the evidence has more than doubled. Prioritise (i) updating high or medium confidence reviews in areas with an increased number of new studies, such as protected areas, payment for environmental services, or agricultural extension and training; or (ii) commissioning new reviews in areas where no high or medium confidence review exists, such as public legislation or multicomponent interventions. In both cases, make sure that these reviews are conducted are reported under best practices.
2. This sector is an active research focus. We have identified new studies that would have been included if available when we conducted the search in February 2023 (e.g., government deforestation enforcement in Brazil, by Kuschnig et al., 2023). Updating the search for evidence within shorter intervals would help maintain a "live" map to ensure more constant access to the latest evidence available.

Online appendices

Online appendix A: Interpreting and using EGMs

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and%20forestry-update-2023-Online-appendix-A.pdf

Online appendix B: Included interventions

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-B.pdf

Online appendix C: Included outcomes

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-C.pdf

Online appendix D: Eligible study designs

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-D.pdf

Online appendix E: Search methods

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-E.pdf

Online appendix F: Studies included in the map

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-F.pdf

Online appendix G: Data extraction template

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-G.pdf

Online appendix H: Critical appraisal of SRs

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-H.pdf

Online appendix I: Studies citing SR protocols

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-I.pdf

Online appendix J: Additional visualisations of the evidence

https://3ieimpact.org/sites/default/files/2023-08/Land-use-change-and-forestry-update-2023-Online-appendix-J.pdf

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With global greenhouse gas (GHG) emissions on the rise, the agriculture, forestry, and other land-use sector continues to contribute a large proportion of these emissions, driven mainly by deforestation. International coordination and financing efforts persist in setting mitigation and adaptation strategies for climate change. To inform these and other investments, UK's Department for Environment, Food and Rural Affairs (Defra) commissioned 3ie to update an evidence gap map from 2016, to include the latest studies on the effects of programmes and policies that address land-use change and forestry.

Evidence Gap Map Report Series

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