

Smallholder reforestation and livelihoods in the humid tropics: a systematic mapping study

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Abstract Systematic mapping studies provide a snapshot of the literature based on systematic literature searches. In this systematic mapping study, the original research that links reforestation and livelihoods in the tropics was mapped and analysed to identify the trends, biases and gaps in the literature. In total, 339 papers from 92 journals were identified. *Agroforestry Systems* was the journal in which articles were most frequently published, and Cameroon and Indonesia the most frequently studied countries. The greatest number of authors came from the USA, and authors were most commonly affiliated with ICRAF. A limited collaboration between research groups in the tropical regions was identified. Anthropology and Social Sciences were the most frequent areas of research, especially in Africa. Latin America had more

technical studies and more publications discussing payment for environmental services than the other regions. Based on the temporal analysis of the main terms in abstracts of the publications included, it was found that agriculture-related terms and terms related to the human component in the landscape were consistently prevalent in the literature relating reforestation and livelihoods throughout time. Agroforestry systems were especially important in small-scale reforestation and livelihoods. Trends, biases and gaps were discussed. Broader cooperation between tropical regions and between clusters of authors would be beneficial for research and practice.

Keywords Agroforestry · Forest restoration · Community forestry · Systematic search · Systematic map

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Introduction

Systematic mapping studies are snapshots of the literature based on systematic searches. When the available scientific evidence is too limited or too extensive, systematic maps are an alternative to systematic reviews (Engström and Runeson 2011; James et al. 2016). Whereas systematic literature reviews are driven by specific research questions, systematic mapping studies are generally based on broader questions (Keele 2007) and are aimed at

mapping out topics instead of synthesising study results (Dicheva et al. 2015). Mapping studies provide information on the nature and extent of available evidence relating to a topic of concern (Engström and Runeson 2011; Fernandez et al. 2011; James et al. 2016).

Smallholder reforestation and livelihoods is a broad-framed topic of current high importance. *Reforestation* is used in this study to refer to all intentional forms of reestablishment of forest cover, such as restoration and rehabilitation (Chazdon et al. 2016), and establishment or expansion of forests on land previously not classified as forests, such as afforestation and forest expansion (Chazdon et al. 2016). Livelihood is the means of life resulting from the combination of capabilities, assets and activities of a person or a household (Chambers and Conway 1991). In developing countries reforestation will only be successful if it also improves livelihoods (Baynes et al. 2015). However, there is a frequent mismatch between social and ecological goals of reforestation (Le et al. 2014; Nguyen et al. 2015). Therefore, a deeper socioecological understanding must be pursued in reforestation (Chazdon 2013), especially in the tropics, where there is a strong and negative correlation between poverty levels and forest cover (Palo 2004). Because the link between forest resource management and livelihoods is crucial for designing effective poverty alleviation programs based on forestry (Sunderlin et al. 2003), an understanding of the available evidence of the relationships between smallholder reforestation and livelihoods is critical.

This study aimed at identifying trends, biases and gaps in the literature on reforestation and livelihoods in the humid tropics. This was achieved by developing a snapshot of the literature, together with insights on how smallholder reforestation research could be improved, with the use of a systematic mapping study. The specific research aims were to investigate: (a) the spatiotemporal distribution of research linking reforestation and livelihoods in the tropics; (b) the main journals, authors and organisations involved; (c) the main research focuses; and (d) the reforestation systems under research.

The paper commences with the description of the methods used for the systematic search, data extraction and analysis. The main results of the study are then presented, including the main journals and authors involved, the spatiotemporal distribution of

the research on reforestation and livelihoods and the topics addressed in the literature. The conclusions and implications of the study are then discussed.

Materials and methods

The Thomson Reuters ISI Web of Science database was selected for the literature search because it covers journals with higher impact and literature from a larger time span than Scopus (Chadegani et al. 2013). The Population, Intervention, Comparators and Outcomes methodology, an approach recommended by Keele (2007), was adopted and used to define keywords derived from relevant papers, and search strings based on the research questions (Petersen et al. 2015). The *Population* was defined as ‘smallholder in the tropics’. The *Intervention* under study was ‘reforestation with livelihood components’. The focused *Comparators* were: temporal and spatial distribution, forms of reforestation, and the ways in which livelihood strategies are being addressed in reforestation. The *Outcomes* expected were the trends, biases and gaps on the ways in which livelihood strategies are being addressed in smallholder tropical reforestation. The search string was then used for a search in the Web of Science database. Further details on the search protocol are provided in Appendix A (see online supplementary materials).

Criteria for including publications

Two members of the research team applied the inclusion criteria in a subset of 962 of the retrieved documents. The degree of agreement between the classification of the documents by these two observers in relation to whether to include or exclude the papers assessed was calculated using the Kappa statistic. The Kappa statistic measures the level of agreement of two or more observers in regard to a categorical variable, in this case the inclusion or exclusion of an article, in a range from 0 to 1. The Kappa statistic for assessing the subset of 962 documents was 0.71, indicating substantial agreement between the classification of the articles of the two team members. Then, the remaining documents were evaluated by only one member of the research team.

Publications were searched in English, Spanish, French and Portuguese, from all years. The search initially yielded 1244 journal articles published from

1989 to June 2016. Articles out of the geographic search area or not related to reforestation and livelihoods were excluded. For example, studies on mangroves, dry forests, savannas, native forest management as well as articles that did not clearly state the livelihood component of the study were excluded. Also, publications dealing only with seedling nurseries for reforestation were excluded. Although nursery seedling production is an important livelihood enterprise in smallholder forestry programs (Gregorio et al. 2017), only publications addressing the tree planting component of forestry were included.

The inclusion of the term *community* in the search string led to a large number of articles focusing on microorganism or wildlife communities, topics not relevant for the study. Synthesis, meta-analysis and review articles were also excluded. Non-peer reviewed articles were excluded based on the classification of journals from UlrichsWeb. From the Web of Science search, 182 relevant articles accessible in full text were included in the study (Fig. 1).

A complementary search was performed to include documents that were not reached in the main search. The complementary search consisted of searching peer-reviewed publications of interest in the list of references of the publications included in the main search. First, the reference lists of the articles published in 2016 were browsed, and ten papers were extracted to be included in the study. The search continued by browsing the reference lists of the papers published in 2015, 2014 and so on back to 2002, from which no further inclusions were made. Further details of the complementary search can be found in the Appendix A (see online supplementary materials). Additionally, 16 publications that were considered relevant to the authors and not reached by the systematic search were included.

Data extraction and analyses

Retrieved documents were assessed and classified according to their main research focus as interpreted from their main aim, title and abstract. Data extraction involved collecting information about authors and institutions involved, topics and type of reforestation systems studied, approaches used, systems studied and overall context of the publication.

Data were entered in Microsoft Excel and statistical analyses were undertaken using SPSS 22. Retrieved

publications were also analysed with VOSviewer, a freeware package to construct and view bibliometric maps (van Eck and Waltman 2010). The world maps (Figs. 4 and 5) were prepared using rworldmap (South 2011) in the software R 3.2.4 and MS Excel.

The publications were classified into one or more of the research focus groups listed in Table 1. Three relevant topics were selected for an evaluation of their spatiotemporal occurrence: gender, payments for environmental services, and tenure. The number of studies per country and the focus of study per continent were compared. Chi square tests for goodness of fit were undertaken to analyse differences between continents regarding the main research focus and selected topics discussed. Because there were few papers from Australia in the study, the continent was not included in the Chi square tests.

Results

Journals publishing research on reforestation and livelihoods in the tropics

The study identified articles published in 92 peer-reviewed journals [a list of these journals is provided in Appendix B (see online supplementary materials)]. More than half of publications identified (53%) were published in one of seven journals. Most of the remaining papers were spread across a large number of journals, i.e. three or less papers were found in each of 76 journals. Figure 2 shows the citation connections between the 13 journals with at least five included documents. By far the largest number of papers was published in *Agroforestry Systems* ($n = 90$). The central position of this journal in the bibliometric map and the journal's connections to all the other sources suggests it has substantial influence in the topic of study. The next most frequent journals in the study were *Agriculture, Ecosystems and Environment* ($n = 25$), *Small-scale-Forestry* ($n = 20$), *Forest Ecology and Management* ($n = 15$), and *Biodiversity and Conservation* ($n = 13$).

The total number of articles per journal is biased by when publication of the journal commenced, e.g. *Small-scale Forestry* started in 2002, whereas *Agroforestry Systems* was first published in 1983. About 9% of the articles published in *Small-scale Forestry* and 4% of those published in *Agroforestry Systems* were assessed.

Fig. 1 Summary of the steps in the systematic search

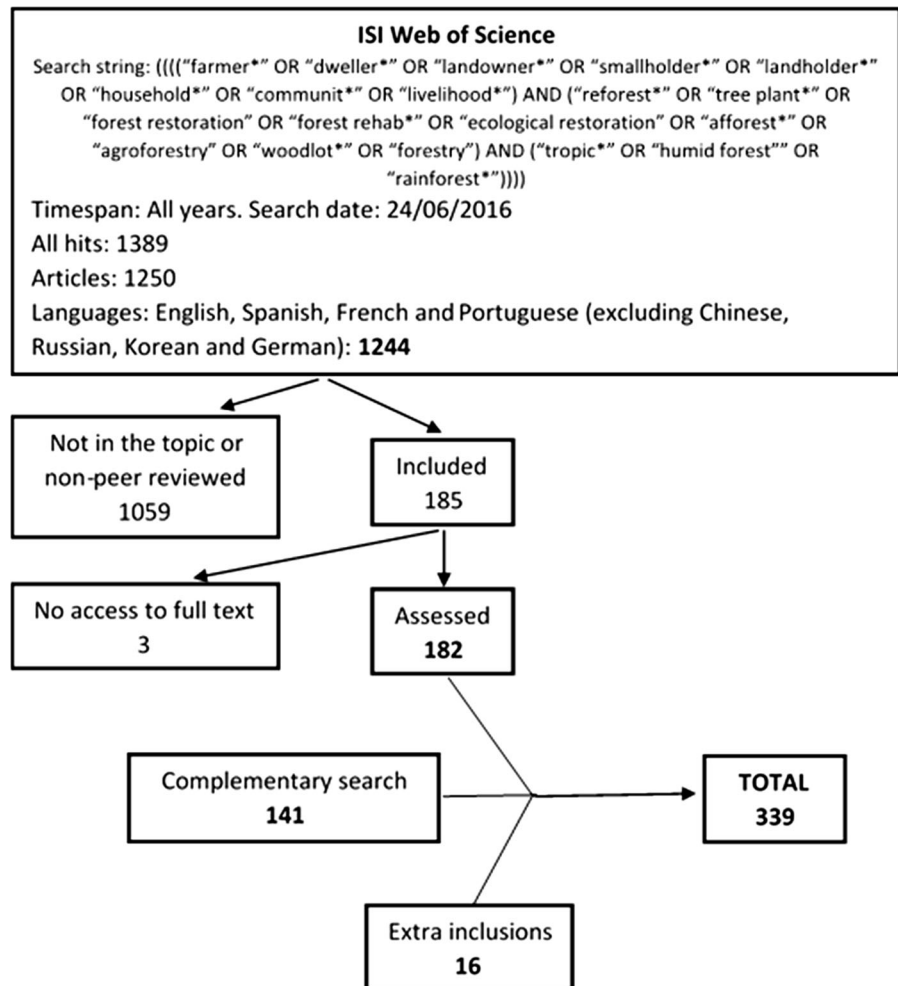


Table 1 Example of themes under the research focuses

Research focus	Example
Anthropology and social sciences	Farmers' perception, forest uses, agroforestry adoption
Technical forestry	Growth performance, soil fertility enhancement
Economic and financial analyses	Financial outcomes, payment for environmental services
Conservation biology	Species diversity, conservation values of agroforestry
Project and program overview	Project evaluation, lessons learnt
Markets for forest products	Market opportunities, challenges to access markets
Forest policies	Land use policy, tenure

Not surprisingly, a very low proportion (less than 1%) of all papers published in the following journals within the search period were included in the study: *Agriculture, Ecosystem and Environment, Forest Ecology and Management, Biodiversity and Conservation* and *Human Ecology*. In contrast to *Small Scale Forestry* and

Agroforestry Systems, these journals are not specifically focused on the topic of this study. The proportion of papers related to reforestation and livelihoods over the total number of papers published in each of the most frequent journal can be found in the Appendix C (see online supplementary materials).

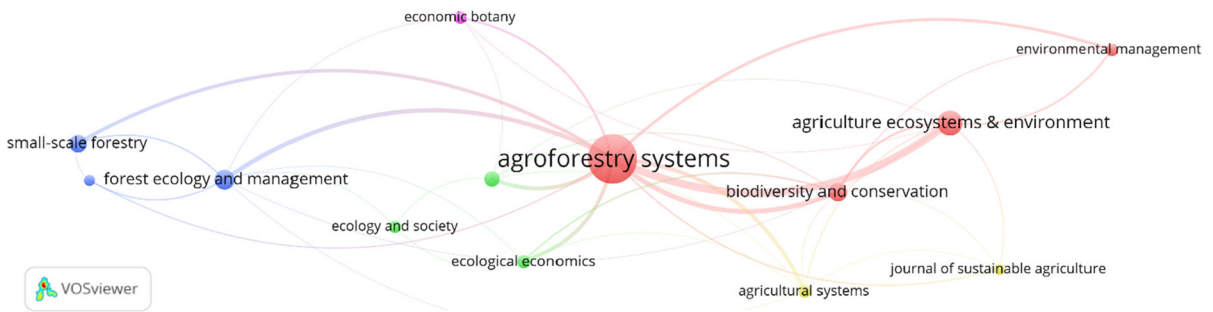


Fig. 2 Bibliometric map of the citations connections of the most frequent journals in the systematic study of the literature linking reforestation and livelihoods in the tropics. *Note lines indicate citation connections between journals. Strongly related journals are located close to each other. Colours are based on the*

cluster to which the items belong. The default clustering technique used by VOSviewer is explained by Waltman et al. (2010) and Waltman and van Eck (2013). The size of the nodes indicates the number of documents from each source. (Colour figure online)

Spatiotemporal distribution of research linking reforestation and livelihoods in the tropics

There has been a relative increase in the research of reforestation and livelihoods over time (Fig. 3). There was a significant difference in the number of studies per continent ($\chi^2 = 13.681$, $df = 3$, $p = 0.003$). For most years Asia, Africa and North America (in this case represented by Mexico and Central American countries) were the most frequently studied continents. In total, North America was the most frequently studied continent, and Africa the continent with the largest number of countries studied. The geographic distribution by country is displayed in Fig. 4. The most frequently studied countries were Cameroon and Indonesia ($n = 33$), Philippines ($n = 30$), Brazil and Mexico ($n = 28$), and Costa Rica ($n = 27$). Cross-country research represented only 7% of the publications. The majority of the cross-country studies were in Latin America.

Some areas were not represented, with no studies from the Pacific island countries. Even though great effort was made to include a large amount of evidence in reforestation and livelihoods, it is recognized that some potentially relevant papers were not identified. Nevertheless, the study includes publications from 44 countries over a range of 31 years, and it reasonably representative of the overall literature dealing with reforestation and livelihoods.

The main authoring countries, institutions and authors in the research linking reforestation and livelihoods in the tropics

Authors were most commonly from North America (USA, Canada and Central America), with the largest contribution by USA ($n = 110$). Other frequent countries were France ($n = 32$), Kenya ($n = 31$), Australia ($n = 30$) and Cameroon ($n = 30$) (Fig. 5). In total, ICRAF was the institution with the highest

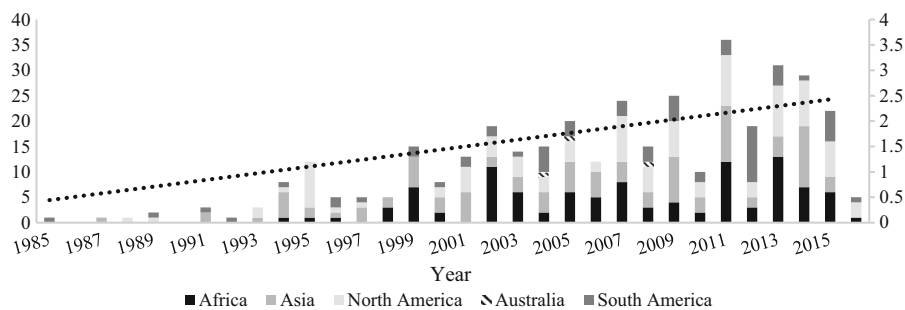


Fig. 3 Spatiotemporal distribution of research on reforestation and livelihoods with smallholders. *Note primary vertical axis is the number of studies included in the study. Secondary vertical axis and dotted line are the number of articles included in the*

study over total number of papers published in the five main journals per year [details can be found in the Appendix D (see online supplementary materials)]

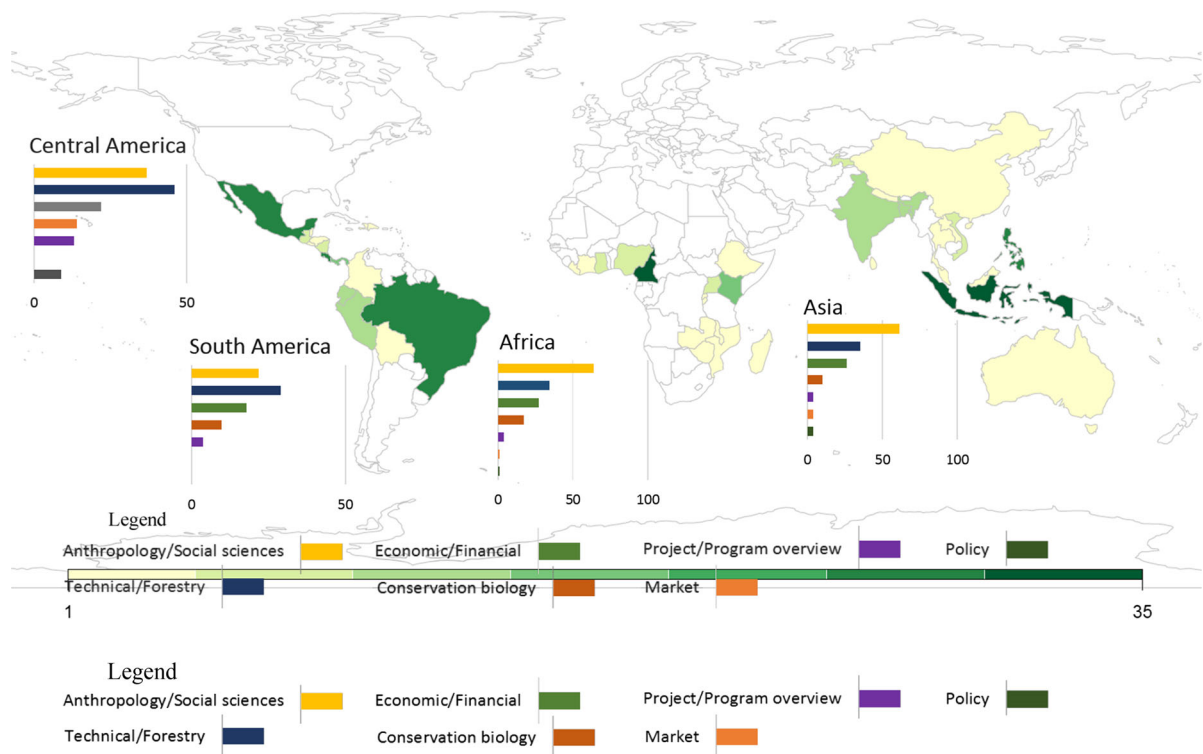


Fig. 4 Spatial distribution of the literature linking reforestation and livelihoods in the tropics. *Note* the map displays the frequency a country was studied in the 339 total publications

number of authorship, with 49 publications in 18 countries in all the regions except Oceania. ICRAF was followed by CATIE ($n = 24$), CIFOR ($n = 19$) and CIRAD ($n = 19$).

Co-authors of publications came from 68 countries, with 18 countries having instances of seven or more co-authorships (see Fig. 6 for a map of these country co-authorship relationships). Authors from tropical developing countries have usually undertaken research with institutions from developed countries. Clear connexions were noticed between Brazil and USA (with 11 co-authored papers), Mexico and USA ($n = 9$), Cameroon and France ($n = 8$), Panama and Canada ($n = 6$), Costa Rica and France ($n = 6$), and Indonesia and Germany ($n = 6$). This was probably due to cooperation initiatives between major research organizations. Nevertheless, cooperation was also found to exist between developing countries, including Cameroon and Kenya ($n = 4$), and Brazil and Costa Rica ($n = 3$).

In a map of co-authorship of papers, the nine most frequent authors, with five to eight publications, were

assessed on the literature linking reforestation and livelihoods in the tropics and frequency of main research focus in the assessed articles

found to have no co-authorship links with each other. The most frequent authors came mostly from North America and Africa. A second authors' co-authorship map was produced including authors with two or more co-authorships. From the 888 authors listed, 140 met this threshold. Even though there are citation links between authors' clusters (results not displayed), the limited co-authorship links between the clusters suggest that research cooperation is almost exclusively within authors clusters. Maps of collaboration between authors can be found in Appendix E (see online supplementary materials).

The main research focus of the literature on reforestation and livelihoods

In Africa and Asia, Anthropology and Social Sciences was the most frequent research focus in the articles assessed, whereas in Latin America technical aspects were the most frequently discussed (Fig. 4). Nevertheless, no significant differences ($p < 0.05$) were observed in the geographical distribution of the

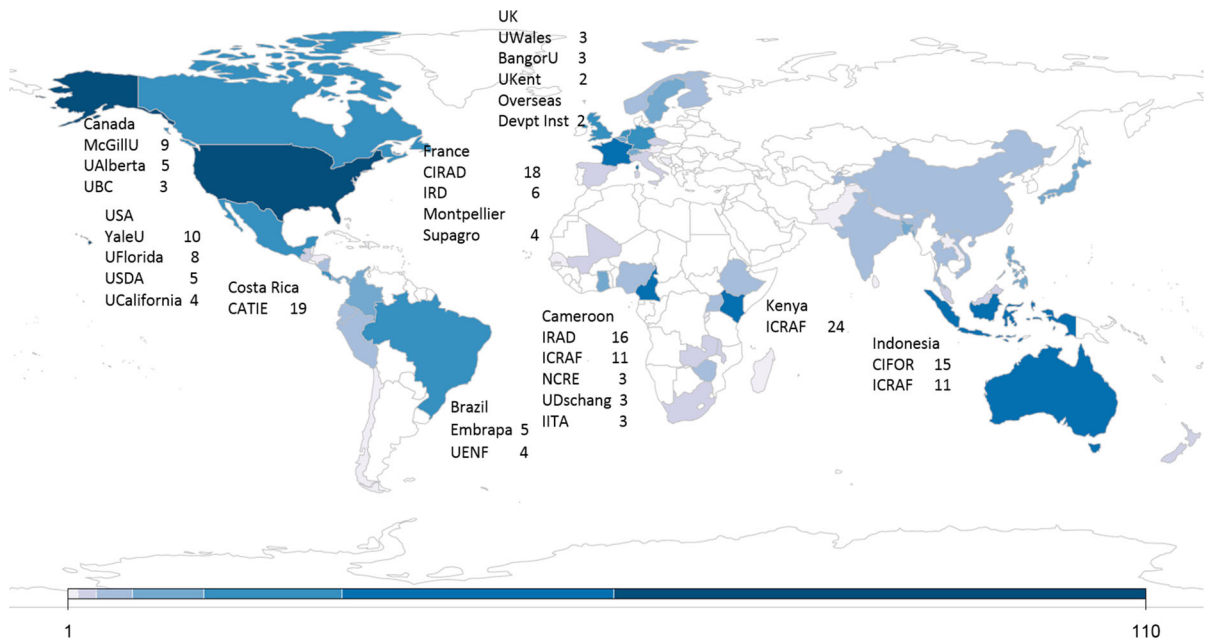
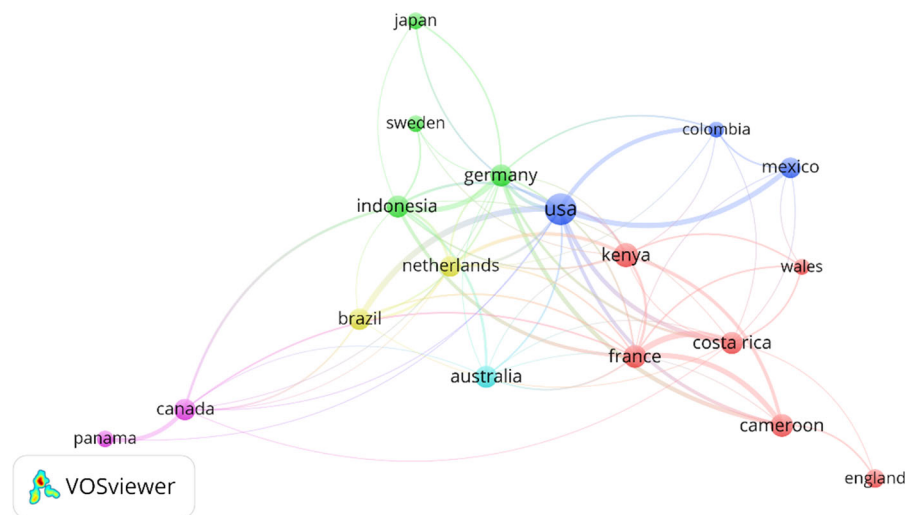


Fig. 5 Main countries and institutions authoring articles on reforestation and livelihoods. *Note* the map displays the frequency a country was present in the list of authors in the 245 total publications assessed on the literature linking tropical

reforestation and livelihoods and frequency of the most recurrent institutions from each of the selected countries. The recurrent institutions were the three first in the ranking of each country present in two or more studies

Fig. 6 Bibliometric map of the most frequent co-authoring countries in the literature that links reforestation and livelihoods. *Note* lines indicate links between countries, proximity between pairs of nodes indicates the relatedness of co-authoring countries and colours are based on the cluster to which the items belong. (Colour figure online)



literature focusing Technical Forestry, Conservation Biology, Economic and Financial Analyses, Markets for Forest Products, or Project and Program Overview.

Technical studies in Latin America focussed on research on tree growth performance, crop or timber yield, site management, species selection, carbon storage, systems’ structure and composition, and soil fertility. Among the topics studied in Anthropology

and Social sciences in Asia and Africa were: the likelihood of adoption of a given reforestation practice, farmer’s or household’s characteristics influencing land use, the socioeconomic benefits of reforestation, local people’s perceptions on reforestation, and the uses and values of forestry goods and services.

Of the seven publications dealing with policy, four were in Asia, two in North America and one in Africa.

The policy papers in Asia addressed the ways in which public policy stimulates reforestation and how political-economic factors may even overpower biological ones in development and conservation in the tropics. They also stressed the way in which unsuitable policies can result in negative livelihood impacts. All the four papers on forest policy in Asia discussed tenure policies and arrangements, especially on how tree planting and maintenance is a means of achieving secure tenure (Dove 1995; Guillerme et al. 2011), and the way in which tenure policies can have a negative effect for indigenous people or traditional communities (Clement and Amezaga 2009; Guillerme et al. 2011).

Gender, tenure and payment for environmental services issues are topics that have been increasingly present in the literature (Fig. 7). The frequency of gender discussions is significantly different between the continents ($\chi^2 = 38.339$, $df = 3$, $p \leq 0.000$). It was higher in Africa than in North America and Asia, and lower in South America. Difference in the frequency of tenure discussions between continents was not significant. Frequency of discussions related to payment for environmental services differs significantly between continents ($\chi^2 = 23.520$, $df = 3$, $p \leq 0.000$). Asia and Africa have significantly fewer publications discussing this topic than North and South America.

Figure 8 displays the most frequent of the 8328 terms found in abstracts. Non-pertinent words (e.g. *paper*, *site*, *number*) were excluded from the analysis. Each of the 21 relevant terms with at least 25 occurrences is mapped by a node. Terms related to agriculture and production from reforestation sites have always been frequent in the literature, as have terms related to the human component, e.g. *farmer*, *household*, *livelihood*. Apparently, cocoa systems are a more recent regular topic than shaded coffee systems. The term *biodiversity* has gained higher

attention in the last decade. Confirming the premises of this paper, *reforestation*, *smallholders* and *livelihoods* have been frequently used terms in the recent years.

Reforestation systems under study

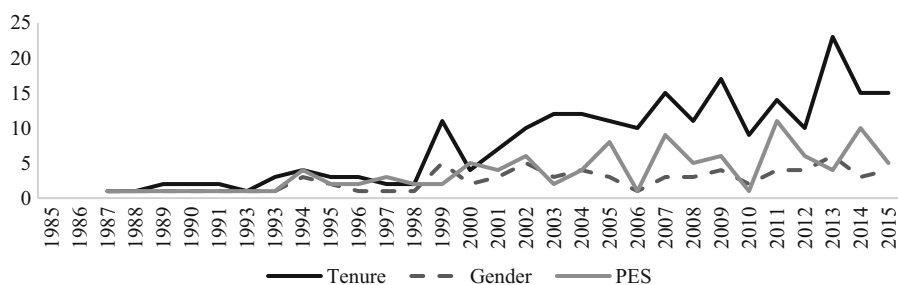
About 80% of the publications focused on systems that combined agricultural and/or livestock components with forestry. Interestingly, the most frequently studied system was homegarden, followed by cocoa agroforestry systems (Fig. 9). In total, the agroforestry systems (including homegarden, improved fallow, coffee, cocoa, rubber, and oil palm agroforestry system, contour hedgerow, alley cropping and silvopastoral system) have consistently had more importance than the non-agroforestry reforestation systems (including mixed-species, tree monocultures, enrichment planting, ecological restoration and non-specified reforestation systems) throughout time in the literature identified.

Discussion

Increasing evidence on the links between reforestation and livelihoods in a variety of tropical countries

There is increasing evidence on the links between reforestation and livelihoods in the tropics (dotted line, Fig. 3). However, gaps in the literature were identified. There is still the need for more research on the contribution of agroforestry, and other reforestation systems, to human well-being (Fagerholm et al. 2016). Even though policy and market issues heavily influence smallholder reforestation success, these topics were the core subject of few publications, even though were discussed in many

Fig. 7 Temporal evolution of selected relevant topics in the literature that links reforestation and livelihoods in the tropics



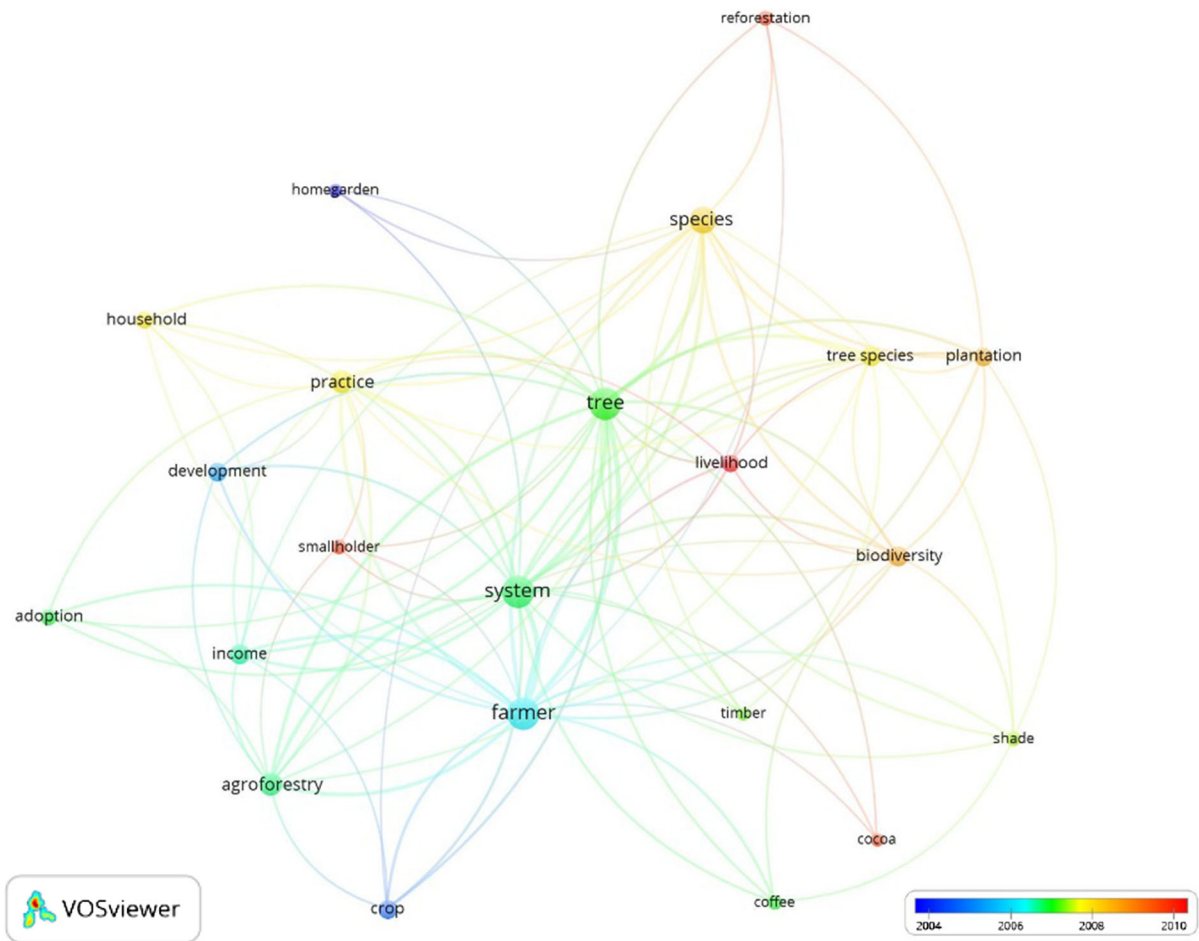
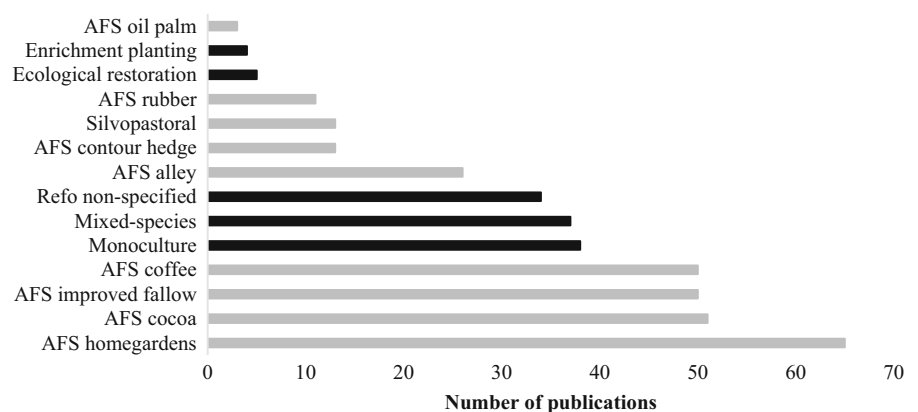


Fig. 8 Frequent terms in abstracts with at least 25 occurrences. *Note* Colours are based on the years for which the terms were relevant, and distance between two nodes indicates the degree of relatedness between the terms. (Colour figure online)

Fig. 9 Frequency with which each reforestation system was studied in the literature assessed. AFS stands for agroforestry system. *Note* Grey bars represent agroforestry reforestation systems, *black bars* represent non-agroforestry reforestation systems



others. Another gap identified was that some tropical regions were underrepresented in this study. This can be due publication biases, such as

language and geographic location of the study (Wager and Williams 2013), added to the time limitations of the systematic search.

Reforestation and livelihoods: a comprehensive research topic

The large number of journals in which reforestation and livelihoods research is published suggests that this is a mature field of research which is not restricted to a small number of scientific journals. The range of journals also suggests a broad discipline base, which addresses topics from culture and well-being to forestry productivity and marketing, and with more recent increasing importance, payments for environmental services and climate change, tenure and gender issues.

The importance of agroforestry in smallholder reforestation systems

The agricultural components were confirmed to be fundamental in small-scale reforestation: agricultural components were main terms in abstracts of papers dealing with reforestation and livelihoods, and agroforestry were more frequently studied than non-agroforestry reforestation systems. It is not surprising that agroforestry farming systems were dominant, since 1.2 billion people rely on these systems for agricultural productivity and income (World Bank et al. 2009). Species present in agroforestry systems often have a crucial role in smallholder livelihoods, either for subsistence, or sale (e.g. Jagoret et al. 2014; Somarriba et al. 2014). This dominance can also explain or be explained by the high frequency of studies under the affiliation of ICRAF and the prevalence of the *Agroforestry Systems* journal in the literature on reforestation and livelihoods. The journal is central to the research topic, not only for the number of publication but also for its connections to all other sources through citation links.

Interestingly, homegardens were the most frequent systems in the study, whereas it was only the sixth most important system in a review of agroforestry system studies between 1982 and 1996 (Mercer and Miller 1997). The higher importance of homegardens identified in the current study indicates that they are increasingly being recognised as being especially important to smallholder livelihoods compared to other agroforestry systems. In Sri Lanka, for instance, homegardens have been included in several governmental programs as key components to address food security issues (Mattsson et al. 2017). Homegardens

have been recognised as being highly valuable for food security globally, due to the increased costs of food production, climate change mitigation potential and their potential to be an alternative farming system to intensive agriculture and forestry monoculture (Mattsson et al. 2017). Besides food and nutritional security, homegardens also provide income security and family labour employment to smallholders, and they are often crucial for the subsistence of the poor and marginal farmers in developing countries (Singh et al. 2016). Advantages of homegardens include having small area and low technological level requirements, use of family labour, and provision of several products from a crop-tree-animal system.

A call for more inter-regional research on reforestation and livelihoods

Higher interconnectivity between authors' clusters and tropical regions would be beneficial for research and smallholders. Supporting Cole (2010) and Pagiola et al. (2005), this paper argues that there has been a special interest in payment for environmental services in Latin America, where more technical studies were found. Studies in African and Asian countries had lower incidence of this topic. In Latin America, farmers are receiving payments for tree planting, income from reforestation credits, and carbon offset payments, even if in relatively low amounts. In Asia and Africa such incentives are also taking place. Nevertheless, in many cases the potential contribution of payments for environmental services and similar mechanisms to small-scale reforestation and poverty mitigation are still not realised or realised in sub-optimal levels. The accumulated experience in Latin America is possibly useful for the Asian and African cases.

Similar to the dominance of Latin America in the research of payments for environmental services, more gender discussion was found in studies in Africa than in the other continents. Despite the importance of the topic, only 21% of all publications assessed included discussions concerning gender issues. In smallholder land use in the tropics, women were frequently in the group of disfavoured members of the social structure along with youth, children and the poor (Hegde and Bull 2011; Lennette et al. 2011; McElwee 2009; Tchoundjeu et al. 2010). They were found to be less likely to adopt more sustainable reforestation practices. In concordance, Mwangi et al.

(2011), revealed that forestry technologies were less likely to be adopted by female-dominated user groups in Africa and Latin America. Due to women's lack of land, labour and other resources they have lower involvement in reforestation (Adesina et al. 2000; Fouladbash and Currie 2015; Gladwin et al. 2002; Kiptot and Franzel 2011; Ogunlana 2004; Tchoundjeu et al. 2010). The lack of access to extension and support programs also limits women's involvement in reforestation. Policy makers and extension officers frequently ignore women in reforestation (Fouladbash and Currie 2015). Extension assistance has traditionally focused on male farmers (Jiggins et al. 1997). To mitigate social inequalities, extension projects and reforestation support programs in Africa have been recently targeting women, and other vulnerable groups (Asaah et al. 2011; Johansson et al. 2013).

The two cases presented above, related to payment for environmental services and gender issues, are just examples of topics with analogue circumstances in multiple regions of the tropical world that could benefit from a more inter-regional research. The list of possible topics is extensive, including: community-based forestry management; evidence-based policy; tenure arrangements; rubber, coffee and cacao agroforestry management; and biodiversity-friendly certification. Therefore a call for larger inter-regional collaboration in tropical small-scale reforestation and livelihoods research is made here.

Systematic maps as a first step to exploring a research area

Systematic maps have a more limited impact than a systematic literature review. A systematic map is not aimed at providing implications for practice, but at influencing the future direction of primary research. Therefore, systematic mapping studies are highly useful in a first step of the investigation of a given research area, as a means of identifying the leading journals, researchers, institutions and countries involved, the evolution of the literature, the main topics addressed and the opportunities for future research.

Conclusions

Trends, biases and gaps were identified in the analysis of 339 peer-reviewed scientific papers linking

reforestation and livelihoods. There is an increase in the number of articles on reforestation and livelihoods published in a variety of journals, relative to the total number of papers published. Agriculture is a central component of smallholder reforestation, and agroforestry have a central role in smallholder reforestation for livelihoods. Despite claims that biophysical studies have dominated the agroforestry literature over the socioeconomic issues (Mercer and Miller 1997) and that few studies have evaluated the socioeconomic impacts of forestry (Landry and Chirwa 2011), the main research focus in the literature on reforestation and livelihoods is Anthropology and Social sciences, while a gap was identified regarding forestry policy and market structures for small-scale forestry products.

Some tropical regions and countries are under-represented in the study, potentially due to publication or researchers' biases. The world tropical regions differ between each other in regard to the focus of the research and issues addressed. This can be due to the diversity of socioeconomic circumstances of the tropical regions or bias of the researchers in each region. Higher interconnectivity in research could be beneficial for the exchange of experiences and knowledge, potentially reducing biases. Therefore we call for more cross-country studies and cooperation between tropical regions and between groups of authors.

Bibliometric mappings reveal the structural and dynamic aspects of a scientific field (Nardi et al. 2016). This systematic mapping study displayed relevant topics and approaches found in the literature. The main terms in abstracts assert the timely feature of this mapping study, since the terms *livelihoods*, *smallholder* and *reforestation* are central terms in the literature in the last decade.

Important caveats on the research methods must be stressed: (i) only studies in English, French, Portuguese and Spanish were searched, possibly excluding more sources from Asia than from other tropical regions; (ii) the quality of studies included varied from strictly rigorous to loosely designed; (iii) grey literature was not comprised in the search, and (iv) similar to Nardi et al. (2016) and Mukul and Herbohn (2016), the systematic search was carried out in a single database, whereas the use of other databases, which was constrained by time, could have enhanced the results. Nevertheless, the study brings together a robust portion of the available literature.

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