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REVIEW

From Tree Fellers to Planters: A Systematic Review of Forest Restoration Initiatives Involving Local Populations in Central Africa

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Abstract
In tropical regions, forest restoration is regarded as a valuable strategy for mitigating the impacts of global warming and improving the livelihoods of local populations. Although numerous international donors have provided substantial financial support for forest restoration in the tropics, the strategies and effectiveness of these initiatives in Central Africa have been poorly documented and never synthesised. To this end, we carried out a review of forest restoration initiatives involving local populations in Central Africa, following a systematic literature review approach. We retained 64 publications, pertaining to 26 initiatives that predominantly applied agroforestry techniques, used exotic species, and were implemented in the Democratic Republic of Congo ($n = 12$ initiatives), Cameroon ($n = 11$), Cameroon & Gabon ($n = 1$), Rwanda ($n = 1$), and Central African Republic ($n = 1$). This review shows that: (1) most forest restoration initiatives were based on pre-established technical approaches, mainly agroforestry or plantations of exotic species; (2) there was a lack of monitoring and data sharing; (3) local people were rarely consulted on the choice of technical approach and (4) prior consent, proposed land arrangements and benefit sharing were seldom mentioned. Based on our analysis, the two key issues for donors and project managers are: (1) building real partnerships with local people, which can mean compromising and downgrading objectives, and (2) monitoring their experiences and sharing the findings to improve future sustainable forest restoration initiatives.

Keywords Tree plantations · Agroforestry · Assisted natural regeneration · Smallholders · Congo basin · Tropical forest restoration

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Introduction

In recent decades, the Congo Basin (covering around 200 million ha of land) has been shown to hold the greatest capacity for storing carbon (-0.61 Gt CO_2 per year), ahead of the Amazon (-0.1 Gt CO_2) and Southeast Asia, which emitted more CO_2 than it absorbed (+0.49 Gt CO_2) (Dalimier et al. 2022; Harris et al. 2021). However, today Africa is the continent with the largest net forest loss in the world, and this phenomenon is accelerating. An average of 1.79 million ha of forest cover was lost each year over the period 2015-19 in Central Africa, against 1.36 million ha in average each year during the previous decade, 2005–2015 (Vancutsem et al. 2021). Over the last decade (2010–2020), the Democratic Republic of Congo (DRC) was the second country in the world (after Brazil) in terms of forest loss, with more than 1 million ha in average lost per year (FAO 2020). In this context, forest restoration is seen as a possible solution, alongside the fight against deforestation, to limit, compensate for or reverse the trend of biodiversity loss and the disappearance of forest ecosystems (Bastin et al. 2019; Chazdon 2008; Lewis et al. 2019).

In Central Africa, the main direct driver of deforestation is the expansion of shifting agriculture to produce food and wood fuel (Curtis et al. 2018; Shapiro et al. 2023; Tchatchou et al. 2015). According to Tyukavina et al. (2018), 84% of deforested land in the Congo Basin has been cleared by farmers cultivating small areas and practising slash-and-burn agriculture which relies on long fallow periods that have drastically decreased in these last decades as a result of demographic pressure. Deforestation is mostly increasing in small patches of fragmented and degraded forests that contain little biomass (Shapiro et al. 2023) and where natural fires (hardly identified by satellite imagery) probably play a role in addition to anthropic factors (Curtis et al. 2018; Shapiro et al. 2023). Until now, public policies in the region have failed to prevent deforestation and forest degradation (Guizol et al. 2022; Tegegne et al. 2016). If no remedial action is taken, Vieilledent et al. (2022) estimate that Central Africa will lose more than 50% of its current forest cover by 2100, with drastic consequences for carbon stocks and sequestration (Harris et al. 2021), flora and fauna found across the region (Fonteyn et al. 2023; Shapiro et al. 2021) and people's livelihoods (Gillet et al. 2016).

Deforestation and degradation predominate in the most accessible areas with a high population density, like the peripheries of cities or near main access ways such as road and river networks (Gillet et al. 2016), in the so-called "rural complex" of Shapiro et al. (2023). These areas are not allocated by states in contrasts to forest concessions for timber production or protected areas (which together cover 72 million ha of the Congo Basin) (Dalimier et al. 2022; Lhoest 2020). This "rural complex", includes community forests (around 2 million ha) (Lhoest 2020), i.e., forests managed by local people on behalf of the state and other areas (more than 100 million hectares) (Dalimier et al. 2022; Lhoest 2020), where there is an overlap between state laws and customary rules governing access to and use of natural resources (Karsenty and Assembe 2010; Vermeulen et al. 2011). This management by the local population itself does not always succeed in achieving sustainability, as shown by the example of the outskirts of Kinshasa (Gond et al. 2016).

Forest restoration is a method that employs various approaches (assisted natural regeneration, plantations, agroforestry, etc.) with the aim, in a delimited territory, of limiting the degradation of an already slightly degraded forest ecosystem or, conversely, restoring the ecological functionalities of a degraded ecosystem, while also improving the livelihoods of local populations (Besseau et al. 2018; Chazdon 2008; Chazdon and Brancalion 2019; Gann et al. 2019; Guizol et al. 2022). Over the last decade, a strong interest in forest restoration has emerged thanks to the UN Decade on Ecosystem Restoration, the Bonn Challenge, the REDD+process, AFR100 initiative, Kunming-Montreal Global Biodiversity Framework and various other campaigns to plant trillions of trees (Holl and Brancalion 2022; Martin et al. 2021; UNEP 2022). Relating to the second target of the Kunming-Montreal Global Biodiversity Framework, the Bonn Challenge and the AFR100 initiative, the Central African Forests Commission (COMIFAC), responsible for coordinating efforts related to forest and environmental matters in the region, has issued a political commitment to restore 25% of degraded lands by 2025 (Guizol et al. 2022).

At the scale of the African continent, about 60% of the land with low-cost restoration potential consist of a mosaic of land uses (e.g., small settlements or small areas of cropland, pasture, recovering forests or shifting cultivation) (Shyamsundar et al. 2022). Expanding the body of evidence regarding the integration of local populations in forest restoration processes is a priority (Gnacadja and Vidal 2022; Guizol et al. 2022; Marshall et al. 2022). Indeed, although a vast literature exists on participatory approaches to involve local stakeholders in natural forest management (Borrini-Feyarabend et al. 2000; Buttoud et al. 2016), these approaches remain infrequently or unconvincingly implemented in forest restoration initiatives across the global tropics (Chazdon 2008; Chazdon and Brancalion 2019; Gann et al. 2019; Herbohn et al. 2023; Holl and Brancalion 2020). More broadly, research on the recovery of forest ecosystem services, i.e., ecological succession in secondary forests, has grown significantly over the past 10 years in the Neotropics (Chazdon et al. 2017; Poorter et al. 2016, 2021). Though a vast amount of research is being conducted on monitoring and mapping tree cover loss and its causes (Achard et al. 2007; Curtis et al. 2018; Hansen et al. 2013; Mayaux et al. 2003; Tyukavina et al. 2018; Vancutsem et al. 2021; Vieilledent et al. 2022), only a few initiatives focus on reversing the ongoing deforestation/degradation in the Global South (Martin et al. 2021), and even less involve local populations. This knowledge gap is particularly notable in Central Africa, compared to Amazonia or Southeast Asia (Fagan et al. 2022; Ota et al. 2017).

In this study, we reviewed the existing literature (including peer-reviewed publications and grey literature) on forest restoration initiatives involving local populations in Central Africa. First, the relevant initiatives were contextualised according to location, date, number of related publications, donors, implementers, expected benefits and, finally, the planted area or the number of planted trees. Second, we tested for differences in the technical approach (notably the type of species and the type of restoration) adopted by the initiatives based on their geographical area, and third, we analysed the level of local population participation in these initiatives. The success of forest restoration hinges primarily on the chosen technical approach and the degree of local population participation (Chazdon 2008).

Methods

Research Strategy

A systematic literature review was conducted to gain a comprehensive understanding of the forest restoration initiatives in Central Africa that explicitly involved local populations. A systematic literature review is a structured method of searching, screening, selecting, appraising and summarising the results of previous research in order to answer a specific research question (Greenhalgh et al. 2018). Our research strategy involved querying reference databases using the following inclusion criteria, in both English and French: (i) forest restoration, (ii) engaging the local populations and (iii) located in the countries belonging to the COMIFAC, namely Angola, Burundi, Cameroon, Central African Republic (CAR), Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Rwanda, and Saõ Tomé e Principe (Fig. 1). The details of our review process were included in a published protocol (Peroches et al. 2023).

Selection Process

In January 2023, we ran a search query in Scopus and Web of Science Core Collection and applied to titles, abstracts, and keywords from 1960 to the present, resulting in a batch of 389 articles (Fig. 1). A total of 78 documents, mostly grey literature (technical or evaluative reports from NGOs or consulting firms) deemed relevant (including a forest restoration initiative in Central Africa with local populations) by the co-authors were added to this batch. All articles published in English or French were sorted ($n=467$): first, by deleting duplicates ($n=38$ duplicates removed, $n=429$ articles and reports kept), second, by screening titles and abstracts ($n=295$ articles and reports excluded, $n=134$ kept) and third, by reading the whole paper ($n=77$ articles and reports excluded, $n=57$ kept). Peer-review articles or documents coming from the grey literature were considered relevant if they included, at least, a forest restoration action performed with a local population in Central Africa. The last step of the selection process entailed checking the references cited in the selected articles and reports, which led to the identification of 41 more records. After the application of the three eligibility criteria to the additional texts only seven were considered relevant ($n=36$ articles and reports excluded). Finally, 64 studies were selected, including 46 scientific articles, 2 working papers and 16 technical reports or guides (Fig. 1).

Article Analysis

For all articles and reports, we collected the year of publication, the topic of the publishing journal, the geographic location of the study, the type of restoration (agroforestry, forest plantation or assisted natural regeneration), the type of species (native, exotic or mixed), the planted area and/or the number of trees planted, the monitoring factors and the strategies to involve local populations (including prior consent, proposed land arrangements and benefit sharing).

Criteria		Search query
What ?		"restauration forestière*" OR"réhabilitation forestière*" OR "reconstitution forestière*" OR reboisement* OR reforestation* OR "régénération naturelle assistée" OR "plantations forestières*" OR agroforesterie* OR"gestion forestière*" OR "forest restoration*" OR "forest reclamation*" OR"forest rehabilitation*" OR "reconstitution offorest*" OR reforestation* OR"natural assisted regeneration*" OR"forest plantations*" OR agroforestry*OR "forest management*"
Who ?	AND	"populations locales*" OR "communautés locales*" OR"communauté villageoise*" OR communauté* OR métayer* OR fermier* OR agriculteur* OR villageois* OR "local populations*" OR community* OR "local communities*" OR "village communities*" OR farmer* OR smallholder* OR agricultor* OR sharecropper* OR villager*
Where ?	AND	"Afrique centrale" OR COMIFAC OR Burundi OR Cameroun OR Congo OR Gabon OR Guinée-équatoriale OR République centrafricaine OR RCA OR RDC OR République Démocratique du Congo OR Rwanda OR Sao Tomé-et-Principe OR Tchad OR "Central Africa" OR Cameroon OR "Equatorial Guinea" OR "Central African Republic" OR CAR OR DRC OR "Democratic Republic of Congo" OR "Sao Tome and Principe" OR Chad
Date		1960s to 2023

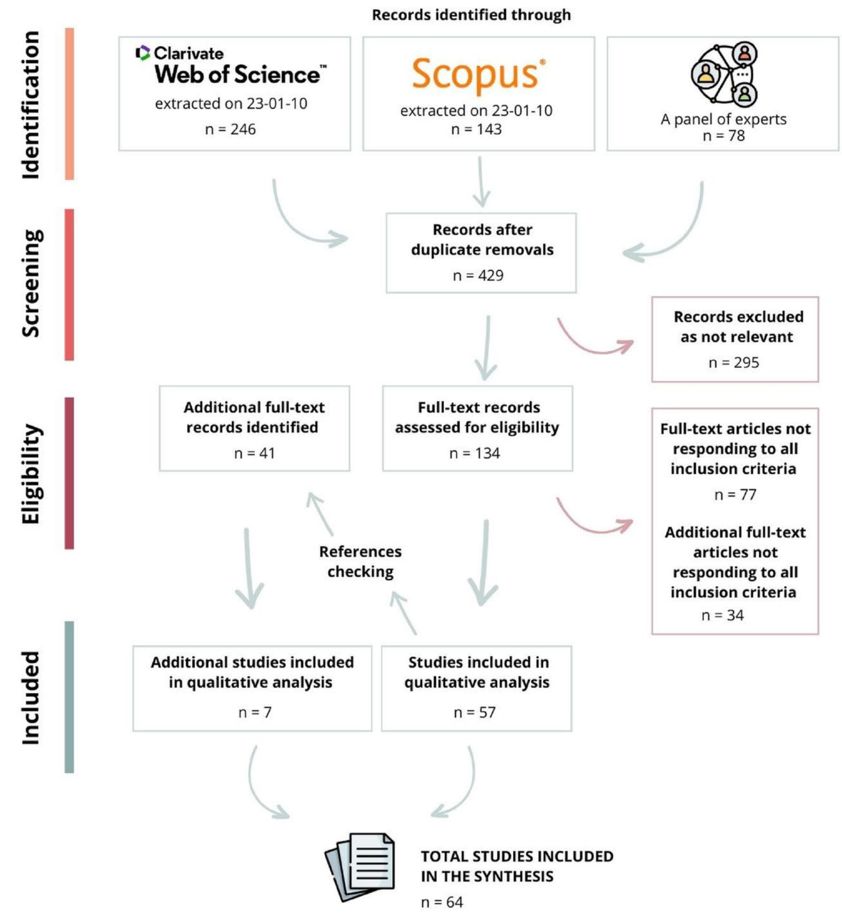

Fig. 1 Study diagram (preferred reporting items for systematic reviews and meta-analyses—PRISMA) showing the flow of information through the different phases of the systematic review (adapted from Moher et al. 2010)

To identify possible differences in the forest restoration strategies depending on their location or the techniques used, four chi-square tests were carried out using the R open environment. The forest restoration initiatives were grouped into five geographic areas to test for spatial differences in their stated objectives, methods and the tree species used. In addition, the association between the type of species and the restoration methods used was also tested. Given the small sample available ($n=26$ initiatives), the confidence interval used was 90%.

The involvement of local populations in the forest restoration initiatives was examined from two perspectives, during the project design and during the project implementation (Arnstein 1969; Buttoud et al. 2016; d'Aquino and Seck 2001). Firstly, for the design phase, the involvement of local populations was determined by their level of choice for technical options, in terms of location to be reforested (ranging from one mandatory site to several optional sites) and species (ranging from one mandatory species to several optional species). Secondly, for the implementation phase, the involvement of the population was assessed according to their level of autonomy within the reforestation initiative's project activities, ranging from simply raising awareness to full participation in restoration actions. Thus, the selected forest restoration projects were placed on a graph along these two axes of analysis.

Results

Temporal and Geographical Scope

During the systematic review process, we identified 26 different forest restoration initiatives involving local populations in Central Africa, these were described in 58 publications, and six reports, i.e., technical guides on forest restoration in the Great Lakes region (Molenaar and Kessler 2008; Smith-Dumont et al. 2012, 2015; Yangambi-Bosunga 2016) and studies regarding the institutional context of the DRC and Cameroon (Dkamela 2012; Foundjem-Tita et al. 2013). Forest restoration involving local populations in Central Africa has been little studied and is a recent topic. The first recorded publication dates from 2000 (Fondoun and Tiki Manga 2000), it was published in the review *Agroforestry Systems* and describes indigenous farmers using assisted natural regeneration (ANR) in Cameroon. We note an increasing interest in recent years (87% of records since 2010). Most of the records were published in journals devoted to forestry (52%), agriculture/agronomy (19%) or agroforestry (14%) while recent interest from other disciplines (since 2012) is also perceptible (Fig. 2).

The 26 forest restoration initiatives identified mostly encompass four areas/regions of Central Africa: (i) the Grassfields area in Cameroon (Northwest, Southwest and West regions), (ii) the dense forest area of Cameroon (Center, Eastern and Southern regions), (iii) the periphery of Kinshasa in the DRC (Kinshasa, Kongo Central, Kwango and Kwilu provinces) and (iv) the Great Lakes region straddling the South and North Kivu in the DRC and Rwanda (Fig. 3). According to these results, vast areas in Central Africa remain overlooked in terms of tropical forest restoration efforts.

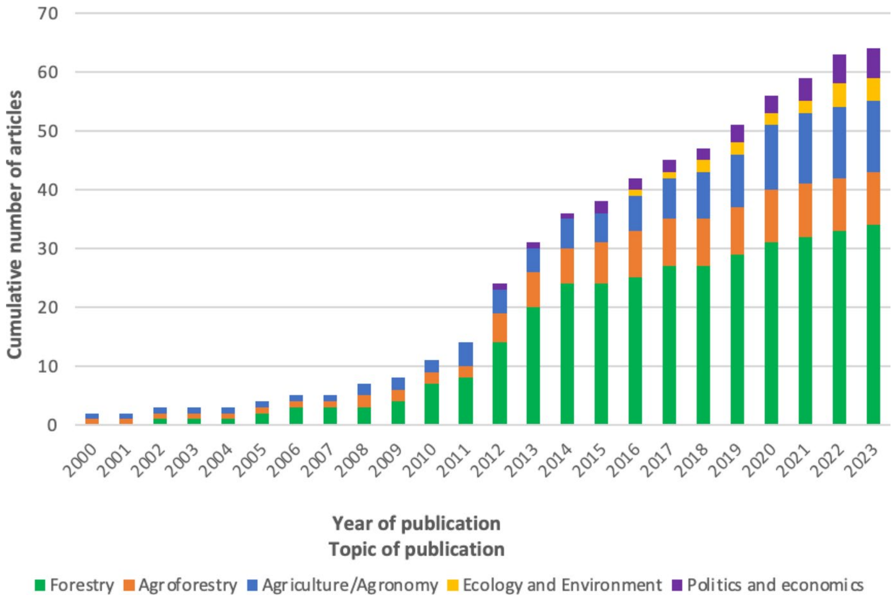

Fig. 2 The cumulated number of published articles and reports about forest restoration with local populations in Central Africa from 1960 to January 2023. Colours indicate the topic of publication, with forestry in green, agroforestry in orange, agriculture/agronomy in blue, ecology and environment in yellow and politics and economics in purple. (Color figure online)

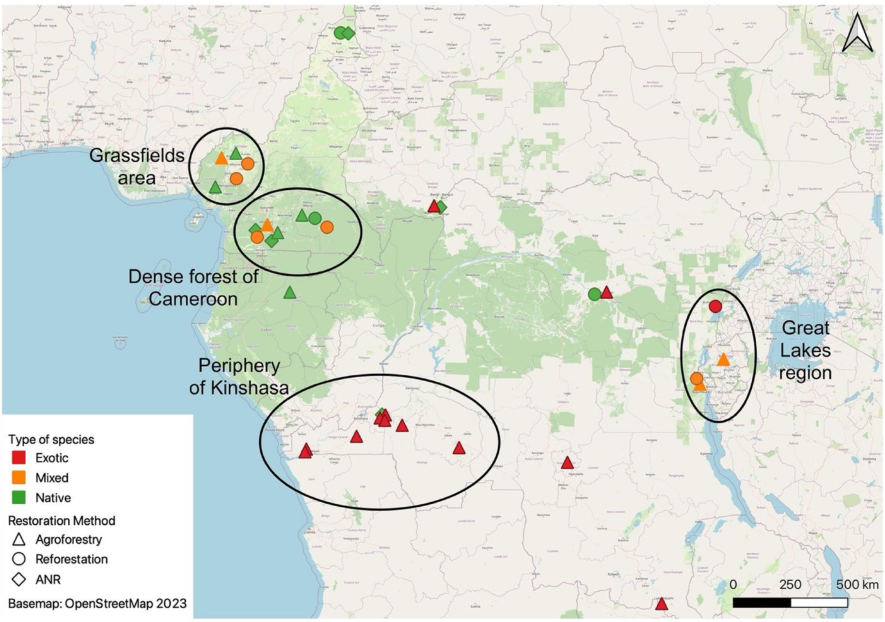

Fig. 3 Location of the 26 forest restoration initiatives involving local populations in Central Africa and the type of species and restoration methods used

Objectives

The primary objectives of the forest restoration initiatives involving local populations were economic. Based on the 26 initiatives analyzed, the most cited objectives were: the diversification and increase of rural incomes (16 initiatives), followed by sustainable wood fuel production (13 initiatives). Environmental issues (slowing forest or biodiversity degradation and the restoration or protection of soils) were less frequently cited (8 initiatives), as were other productivity objectives such as sustainable non-wood forest products (NWFP) and sustainable timber production.

The initiatives' objectives differed according to geographic area (P-value = 0.072). In the periphery of Kinshasa (Bisiaux et al. 2009; Peltier et al. 2014; Péroches et al. 2019; Proces et al. 2017) and the Great Lakes region: including North Kivu, South Kivu (Bouyer et al. 2013; GIZ 2020a) and Rwanda (Bucagu et al. 2013; Iiyama et al. 2018a, b; Kiyani et al. 2017; Mukuralinda et al. 2016; Ndayambaje et al. 2012, 2013; Noeldeke et al. 2022; Stainback et al. 2012), the main expected benefits were sustainable wood fuel production, positive impacts on soils and the diversification or increase of rural incomes. In contrast, in both the Grassfields and dense forest areas of Cameroon, the restoration initiatives mostly focused on the sustainable production of timber and NWFP (Awazi et al. 2020, 2021; Njoukam et al. 2013; Robiglio et al. 2012; Semereab 2006; Temgoua et al. 2011).

Donors

Forest restoration initiatives by local populations in Central Africa have been largely subsidised by public development aid agencies (62% of all initiatives). Among the 26 relevant initiatives, nine were funded by the European Union, three by the French development agency, two by the German development agency, one by the United Kingdom development agency, one by the Danish development agency and one by the World Bank. In Rwanda, the development of agroforestry is partially supported by public funding and nine articles examine the application of this public support to agroforestry (Table 1; Fig. 3). However, most public initiatives are particularly difficult to detect since they are poorly documented, particularly in international journals.

Finally, in Cameroon, we identified three spontaneous local practices (defined as initiatives originating from the local populations themselves) which had not benefited from direct support from an external structure. These three initiatives were: agroforestry for cocoa production (Alemagi et al. 2015; Essouma et al. 2020; Folefack and Darr 2021; Jagoret et al. 2009, 2014), ANR in the dense forest area (Carriere 2002; Fondoun and Tiki Manga 2000; Robiglio et al. 2012) and agroforestry based on native and exotic species (sometimes in association with animals) in the Grassfields area (Awazi et al. 2020, 2021; Kimengsi and Ngu 2022; Nkamleu and Manyong 2005; Temgoua et al. 2011).

Implementers

Few forest restoration initiatives by local populations in Central Africa have been led by national structures (only 31% of all initiatives). Then, among the 31 implementers of the 26 relevant initiatives, we found eight international NGOs (against four national NGOs), five international research centres or universities (against one national university), four international companies (against two national private companies), one international cooperation agency (against two national public programs or agencies) and finally three initiatives are implemented with no external support (Table 1). These implementers are likely to work in different ways with centralised, decentralised, or deconcentrated government administrations, producer groups or local NGOs, but little information is available in the literature.

Forest Restoration Approaches

Eight different approaches to forest restoration were identified, based on planting techniques (ANR, forest plantation or agroforestry) and type of planted species (native, exotic, or a mix of both). The most common planting method used was agroforestry (implemented in 16 initiatives). We did not find any significant difference in methods used between regions (P-value = 0.181). Agroforestry was significantly more associated with exotic species than reforestation or ANR (P-value = 0.038). Native species were used in five initiatives, a mix of both native and exotic species in four initiatives, and exotic species in nine initiatives. Initiatives using exotic species were mostly located in the periphery of Kinshasa and relied on the "Mampu System" based on *Acacia spp.* (Table 1; Fig. 3). In this sequential agroforestry system, farmers plant *Acacia auriculiformis* or *A. mangium* between cassava rows, and sometimes mixed with maize, thus combining crop production in the first years with fuelwood production after eight years, when the trees are harvested, and after which burning is used to promote seed germination (Bisiaux et al. 2009; Dubiez et al. 2018; Proces et al. 2017).

Nine initiatives mentioned reforestation actions by means of tree plantations: three using native species in Cameroon and the DRC, five mixing native and exotic species in Cameroon and one using exotic species, in North Kivu. Finally, ANR was promoted in five initiatives: in the dense forest area of Cameroon, CAR and the periphery of Kinshasa (Table 1; Fig. 3).

The types of species employed differed significantly among regions (P-value = 0.003). Exotic species were mostly promoted in the periphery of Kinshasa, although a mix of exotic and native species was used in the Great Lakes and Grassfields areas. Finally, in the dense forest area of Cameroon, native species were preferred (Table 1; Fig. 3).

Planted Areas and Trees

Of the 26 initiatives identified, only 18 mentioned a restored area or the number of trees planted (Fig. 4). A total of 26,475 ha of plantation was reported, almost exclusively in the DRC (96.9%). Most of these plantations target wood fuel production and correspond to the agroforestry "Mampu system" described earlier (85.7%), and that has been mostly implemented in the periphery of Kinshasa, and specifically on the Batékés plateau (Bisiaux et al. 2009; Proces et al. 2017; Reyniers 2014, 2019; Sylvatrop & SalvaTerra 2021). The second significant planted area reported was in

Table 1 General description of the 26 forest restoration initiatives involving local populations and based in central Africa

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
DRC	Mampu	EU	Hanns-Seidel Foundation (German NGO) and CADIM (DR Congo NGO)	Sustainable wood fuel production; Restoration of soil fertility; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*	8,000	NA	*Density*: 66 to 3,889 stems/ha with a mean of 1,500 stems/ha *Growth*: 1.23 cm DBH/year *Productivity*: 14.5 wood tons/ha/year	NA	(Bisiaux et al. 2009; Kachaka et al. 2020; Paul and Fraser 2014; Proces et al. 2017; Tassin et al. 2012)
	Ntsio	EU	Hanns-Seidel Foundation (German NGO)	Sustainable wood fuel production; Restoration of soil fertility; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*	4,200	NA	NA	NA	(Proces et al. 2017)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	Makala	EU	CIRAD (French Research Centre), CIFOR (International Research Centre) Gembloux AgroBio Tech and ERAIFT (Belgian and DR Congo Universities) and Hanns-Seidel Foundation (German NGO)	Sustainable wood fuel production; Deceleration of forest degradation processes; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*; Reforestation with native species; Assisted natural regeneration; Forest fallow protection	1,365 agroforestry and 19 reforestation	2,046 (ANR)	*Maintenance rate*: 23% of the agroforestry area planted with *Acacia spp.*; 0% of native species plantations *Mortality rate*: 29–91% depending on the conservation technique for ANR; 34% for agroforestry with *Acacia spp.* 64% for native species plantations *Productivity*: 43 months after clearing, ANR plots contain 44% more biomass than plots without ANR	*Adoption level*: 0–92% depending on the type of farm	(Nsimundele Nkondo et al. 2010; Peltier et al. 2014; Péroches et al. 2019; Proces et al. 2017; Vermeulen et al. 2011)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	Ibi-Terroir and Sud-Kwamouth Novacel	World Bank and private funds	Novacel (DR Congo Private Company) and GI-Agro (Belgian NGO)	Sustainable wood fuel production; Deceleration of forest degradation processes; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*	288.5	NA	NA	*Economics*: 500 USD/year/household	(ONFI & Novacel 2012; Paul and Fraser 2014; Reyniers 2014, 2019; Reyniers et al. 2015)
	Gungu	EU	Hanns-Seidel Foundation (German NGO)	Sustainable wood fuel production; Restoration of soil fertility; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*	1,800	NA	NA	NA	(Proces et al. 2017)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	DEFIV-DAFOMA	EU	GRET (French NGO)	Sustainable wood fuel production; Restoration of soil fertility; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*	14.5	NA	NA	NA	(Proces et al. 2017)
	AFODEK	EU	GRET (French NGO) and Nature+ (Belgian NGO)	Sustainable wood fuel production; Restoration of soil fertility; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*	1,500	NA	NA	NA	(Proces et al. 2017)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	Pilote integrated REDD + Luki	EU	WWF DRC (International and Congolese NGOs)	Sustainable wood fuel production; Deceleration of forest degradation processes; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*; Agroforestry with native species	NA		NA	NA	(Bandi et al. 2020, 2022)
	EcoMakala	EU	WWF DRC and BE (International, Congolese and Belgian NGOs)	Sustainable wood fuel production; Deceleration of forest degradation processes; Diversification and/or increase of rural incomes	Reforestation with exotic species (mostly *Eucalyptus spp.*, *Acacia spp.* and *Grevillea spp.*)	3,580	NA	*Density*: high density (up to 10,000 stems/ha) *Productivity*: 6 to 50 m3/ha/year, with a mean at 20 m3/ha/year	NA	(Bouyer et al. 2013; lejeune et al. 2013; Smith-Dumont et al. 2017)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	Forests and Biodiversity Program	GIZ	GIZ (German Cooperation Agency)	Sustainable wood fuel production; Deceleration of forest degradation processes; Diversification and/or increase of rural incomes	Reforestation with native and exotic species; Assisted natural regeneration	2,785	NA	*Productivity*: 5 to 10 m3/ha/year of mixed plantations (native and exotic species)	*Economics*: 800,000 USD in economic volume created in 15 years due to wood and wood fuel production	(GIZ 2013, 2020a, b)
	Ebenezer Ministries International	Kingdom Giving Fund	Ebenezer Ministries International (International NGO)	Deceleration of forest degradation processes; Diversification and/or increase of rural incomes	Agroforestry with exotic and native species	NA	165,000	NA	*Adoption level*: 30% of the local population participated	(Sabin et al. 2019)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	PROFEAAC	FFEM	CIFOR (International Research Centre) and CIRAD (French Research Centre)	Deceleration of forest degradation processes; Sustainable wood and NWFP production	Reforestation with native species	3.8	NA	*Maintenance rate*: 34% of planrtations well maintained, 48% fairly-well maintained and 18% non-maintained	NA	(Botulu et al. 2023)
Rwanda	Various public incitation's	Rwanda Ministry of Agriculture and various donors	Public actors	Sustainable wood fuel production; Restoration of soil fertility; Erosion control; Sustainable wood production; Diversification and/or increase of rural incomes	Agroforestry with native and exotic species	NA		NA	*Adoption level*: 42% of respondents own woodlots. *Economics*: 331 USD/year/household which is more than other farmers (297 USD/year/household on average)	(Bucagu et al. 2013; Iiyama et al. 2018a, b; Kiyani et al. 2017; Ndayambaje et al. 2012, 2013; Noeldeke et al. 2022; Stainback et al. 2012)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
Cameroon	Participatory Tree Domestication	EU IFAD USDA	World Agroforestry centre (International Research Centre)	Diversification and/or increase of rural incomes; Restoration of soil fertility; Sustainable wood and NWFP production	Agroforestry with native species	NA	122,500	NA	*Adoption level*: 68.8% of people interviewed planted trees	(Asaah et al. 2011; Degrande et al. 2012; Gyau et al. 2012; Tchoundjeu et al. 2010)
	Study of spontaneous local Practices	NA	Local people	Diversification and/or increase of rural incomes	Agroforestry with exotic and native species (sometimes in association with animals)	NA		*Density*: high density (up to 20,000 stems/ha) *Growth*: 0.9 cm DBH/year for *Canarium schweinfurthii*, 0.5 to 1.2 cm DBH / year for *Polyscias fulva*, 0.55 to 0.8 cm DBH /year for *Entandrophragma candollei* and 1.2 to 2.5 cm DBH / year for *Podocarpus latifolius*	*Adoption level*: 56.2% of interviewed people practiced agroforestry or forest plantation *Economics*: 1.6 to 4.5 USD per wood stick	(Awazi et al. 2020, 2021; Kimengsi and Ngu 2022; Nkamleu and Manyong 2005; Temgoua et al. 2011)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	Mount Cameroon National Park Conservation	GIZ	GIZ (German Cooperation Agency)	Sustain-able NWFP production	Agrofor-estry with native species	NA	71,177	Unavailable	*Adoption level*: 14–22% participation within the targeted communities	(Awung and Marchant 2016)
	"Un parisien, un arbre"	City of Paris	ONFI (French Company)	Sustainable wood fuel production; Sustain-able wood and NWFP production	Reforesta-tion with native and exotic species	202.4	NA	*Mortality rate*: 15%	Unavailable	(Njoukam et al. 2013)
	Banah-Bapouh forest REDD+	AFD	National Participatory Development Program (Cameroo-nian Public Program)	Sustainable forest man-agement and carbon storage	Reforesta-tion with native and exotic species	NA		NA	NA	(Gagou-Kakeu et al. 2020)
	Study of spontaneous local Practices	NA	Local people	Increase of cocoa tree shade; Diversifica-tion and/or increase of rural incomes	Agrofor-estry with native spe-cies (cocoa fields)	NA		*Density*: 102.7 to 274.4 stems/ha with a mean of 109.9 stems/ha	*Economics*: 450 to 1,700 USD/year for farms producing cocoa and fruits in the same plot	(Alemagi et al. 2015; Es-souma et al. 2020; Fole-fack and Darr 2021; Jagoret et al. 2009, 2014)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	CED-Led PES Scheme	UK DFDI; CBPF	Center for Environment and Development (Cameroonian NGO)	Sustainable forest management and carbon storage	Reforestation with native and exotic species	NA		NA	NA	(Gagou-Kakeu et al. 2020)
	IUCN pro-poor REDD+Pilote	DANIDA; CBPF	International Union for the Conservation of Nature (International Institution)	Sustainable forest management and carbon storage	Assisted natural regeneration	NA		NA	NA	(Gagou-Kakeu et al. 2020)
	Pallisco-CIFM reforestation	Pallisco-CIFM	Pallisco-CIFM (French and Cameroonian Company)	Sustainable wood and NWFP production	Reforestation with native species (*Baillonela toxisperma*)	NA	450	*Maintenance rate*: 9% of distributed plants *Mortality rate*: 84%	NA	(Semereab 2006)
	Study of spontaneous local Practices	NA	Local people	Restoration of soil fertility; Sustainable wood and NWFP production	Assisted natural regeneration	NA		*Density*: 8 to 30 stems/ha to 600 to 800 stems/ha depending on the area	*Adoption level*: 67–100% of respondents practised ANR depending on the area *Economics*: an average benefit of 555.32 USD/year	(Carriere 2002; Fondoun and Tiki Manga 2000; Robiglio et al. 2012)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
	DPGT and ESA	Private funds	SODECOTON (Cameroonian Company)	Sustainable NWFP production; Restoration of soil fertility; Diversification and/or increase of rural incomes	Reforestation with native species; Assisted natural regeneration	750 (reforestation)	NA	*Productivity*: 5 to 10 kg of Arabic gum/ha/an	*Economics*: 0.57 to 8.18 USD/ha/year	(Palou Madi et al. 2010)
Cameroon and Gabon	DACEFI	EU	WWF, WWF Gabon, WWF Cameroon, Nature+ (International, Gabonese, Cameroonian and Belgian NGOs) and Gembloux AgroBio Tech (Belgian Research Centre)	Sustainable wood and NWFP production	Agroforestry with native species	10	NA	NA	NA	(Meunier et al. 2013; Sonne and Kana 2012)

Table 1 (continued)

Country	Name	Donor(s)	Implementer(s)	Stated objective(s) of the project	Forest restoration method promoted	Plantation results published		Monitoring		References
						Area (ha)	Number of trees	Technical parameters	Socio-economic parameters	
CAR	PDRSO	AFD and FFEM	FRMi, TEREA, ONFI (French companies) and CIRAD (French Research Centre)	Sustainable wood fuel production; Deceleration of forest degradation processes; Diversification and/or increase of rural incomes	Agroforestry with *Acacia spp.*; Assisted natural regeneration	60 (agroforestry)	1,668 (ANR)	NA	NA	(Kpolita et al. 2022; Sylvatrop & SalvaTerra 2021)

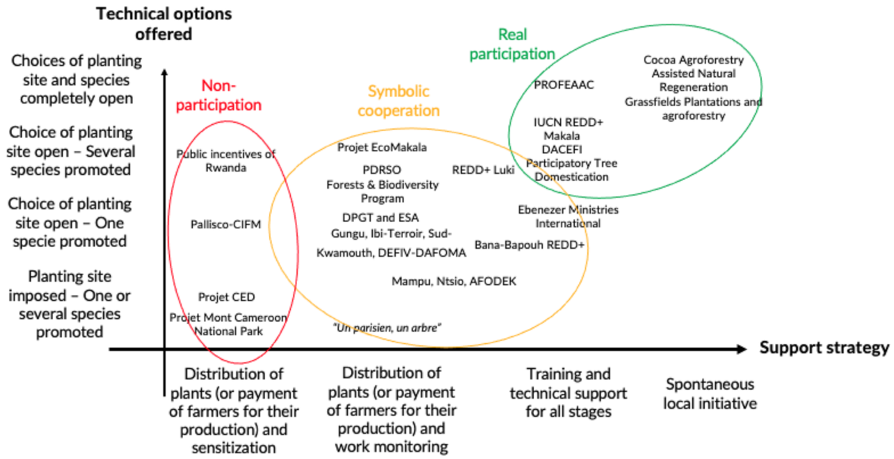

Fig. 4 Classification of the local populations' involvement in forest restoration initiatives in Central Africa (adapted from Bakker et al. (2020) and Arnstein (1969))

North Kivu (5,476 ha, 21%) where the use of exotic species (mostly *Eucalyptus spp.* and *Grevilla spp.*) dominated (Bouyer et al. 2013; Lejeune et al., 2013). Reforestation with native species represented less than 1% of the total (23 ha) (Botulu et al. 2023; Péroches et al. 2019). Finally, some initiatives only reported the number of planted trees (Table 2), mainly through agroforestry and using native species in Cameroon (54%) or a mix of native and exotic species in the DRC (45%).

Monitoring

Only 11 initiatives commented on the monitoring of planted trees, and 13 initiatives on the socio-economic parameters. The criteria used were diverse and hard to compare. Monitoring information included: productivity (6 initiatives), plantation densities (5), mortality rates (3), maintenance rate (3) and growth rates (2). Economic return is the only socio-economic parameter that is usually monitored, but at various scales (tree or field – 4 initiatives; household – 3; value chain – 1) (Table 1). The adoption level of forest or agroforest plantations (or the number of smallholders practicing the technique promoted) was evaluated in seven initiatives.

Involvement of the Local Populations

When ranking the 26 initiatives according to the support strategy and the technical options offered, it appears that most initiatives had significant planting objectives and favored a high level of intervention (plant distribution, mechanical tillage, etc.) over a high level of empowerment of participants (Fig. 4). In this case, cooperation with the local population is symbolic, according to Arnstein's (1969) typology of participation.

In this vein, only a few articles or reports mentioned a process to obtain the prior consent of participants, as well as land arrangements or a benefit-sharing plan to ensure the sustainability of the initiative. Four initiatives supported the creation of a simple management plan and included these three parameters (Gagou-Kakeu et al. 2020; Meunier et al. 2013; Péroches et al. 2019; Sonne and Kana 2012). Five other initiatives supported existing or new associations or farmers groups, with the objective of managing benefit sharing and access to land (Awung and Marchant 2016; Bisiaux et al. 2009; Lejeune et al., 2013; Njoukam et al. 2013; Sabin et al. 2019).

Discussion

In this study, we aimed to (i) contextualize, (ii) characterize technical approaches and (iii) analyze project strategies of local populations participation in forest restoration initiatives in Central Africa. First, we found 26 initiatives mainly supported by international cooperation funds and implemented by international NGOs and Research Centers and located in four "restoration hot spots": (i) the Grassfields area in Cameroon, (ii) the dense forest area of Cameroon, (iii) the periphery of Kinshasa in DRC and (iv) the Great Lakes region straddling the South and North-Kivu in DRC and Rwanda. However, as the systematic review process is often thought to exclude large amounts of information that have gone unpublished in peer-reviewed journals (Greenhalgh et al. 2018), more initiatives (notably public and spontaneous local practices or recent initiatives) have likely been undertaken but have never been described in the scientific literature. Two illustrative cases are (i) the extensive teak plantations in the Central African Republic (CAR) and (ii) the World Bank (WB) and Central African Forest Initiative (CAFI) restoration programs. Teak plantations in CAR were initially established and maintained by the forest administration and are now managed independently by the local populations. However, there is a notable lack of information about these plantations beyond what can be gleaned from field observations and common knowledge. WB and CAFI programs implemented by local NGOs are also poorly documented (Péroches, *pers. com.*). Additional research would be needed to improve the recognition of forest restoration, more particularly spontaneous practices of local populations in Central Africa, and to elucidate the factors impeding their identification. Second, our results show that agroforestry is the most promoted technic, often with exotic species, as *Acacia spp.*, and that all types of initiatives of forest restoration are globally poorly monitored. Finally, and more importantly, we demonstrate that cooperation with local populations is often symbolic.

Concentration of Initiatives in a Limited Geographical Area

The 26 forest restoration initiatives identified in this systematic review did not fully represent the diversity of forest types (Réjou-Méchain et al. 2021) and socio-ecosystems (Marien and Bassaler 2013) found in Central Africa. The vast majority of our case studies were located in four areas in Cameroon and the DRC, confirming the findings of larger studies (Martin et al. 2021; Ota et al. 2017) and the forest transition theory, which states that forest plantations are more likely to develop in highly degraded areas (Mather 1992). Among these four areas, there are three historically degraded areas: the Grassfields of Cameroon (Temgoua et al. 2011), the Great Lakes region and the periphery of Kinshasa (Gond et al. 2016; Vancutsem et al. 2021). The fourth area (Center, South and East Cameroon) has been under increasing pressure since 2010 (Vancutsem et al. 2021).

Poor Monitoring that Hampers long-term Support

Overall, forest restoration initiative monitoring in Central Africa is weak, because of the short duration of interventions (rarely more than five years) and the absence of implementation of a common framework, such as the AFR100 monitoring principles (AFR100, 2023), to evaluate the results of these reforestation initiatives based on their technical and socio-economic dimensions.

Even though information on the planted areas, the surviving and growth rates, the carbon storage, or the added value produced by planters are quantified in some documents, the lack of complete and homogeneous data complicates the evaluation of restoration strategies and success. This limitation is not specific to the region and was previously identified as a global priority by Gnacadja and Vidal (2022), Holl and Brancalion (2020, 2022) and Martin et al. (2021). The criteria presented here could form the basis of a more standardised framework (see Table 1; Fig. 4) complementary to the AFR100 principles (AFR100, 2023).

Partnering with Local Populations

Although some spontaneous local initiatives were included in our analysis (Carrière, 2002; Jagoret et al. 2009; Temgoua et al. 2011), our results showed that external initiatives were predominant and that strategies were mostly based on high intervention levels and less on empowering farmers to sustainable tree planting (Fig. 4). The majority of initiatives structured their actions around entrusting local populations with the task of planting rather than fostering partnerships. For example, several initiatives pay beneficiaries to produce plants in nurseries for themselves or to prepare their own fields (Bouyer et al. 2013; GIZ 2020a; Sylvatrop & SalvaTerra 2021). This practice can achieve rapid tree planting but is not usually associated with the continuation and reproduction of the system (Sylvatrop & SalvaTerra 2021), except if payments and mutual commitment are made over time (Wunder 2007) which is not the case in the initiatives reviewed here. The quick and ambitious results awaited by international donors to justify their contribution largely explain these strategic choices. Nevertheless, it has been demonstrated that forest restoration efficiency is improved when there is a reliable partnership with farmers which prioritises their preferences (Shyamsundar et al. 2022; Jha et al. 2021; Seghieri et al. 2021). Such a partnership usually requires several preconditions. Firstly, the trajectories and interests of smallholders should be deeply analysed and made explicit (Herbohn et al. 2023; Mansourian et al. 2022; Ota et al. 2020). If we assume that, in the future, farmers will be planters and the fact that existing spontaneous initiatives are not described, we suggest the creation of a systematic approach to characterise smallholder farming systems and restoration practices in their context, similar to agrarian diagnosis. This multidisciplinary method requires an in-depth study of the landscape conditions, land management, natural resources using rights, existing markets, existing breeding and cropping systems and dynamics of farming systems in this context (including the allocation of production factors: capital, labour force and land) (Cochet 2015). This method can be combined with others, such as participatory landscape analysis or interactive cartography, which have already been tested in the DRC (Dubiez et al. 2013; Larzillière et al. 2013). Secondly, the prior consent of beneficiaries regarding the technical and institutional characteristics of a forest restoration initiative should be systematically obtained on a collective and individual basis. The Free, prior and informed consent (FPIC) is still too often a formal procedure applied on a collective scale when in reality it concerns individual practices. Thirdly, trade-offs between local stakeholders and project managers should be analysed, discussed and agreed upon. This is likely to involve a revision of the objectives of donors and project managers to better accommodate the legitimate objectives of local stakeholders. Fourthly, once consent has been obtained, it will be necessary to clarify and contractually establish both the land and use rights arrangements between the parties and the sharing of the goods, services and benefits expected from the restoration. Finally, building and sustaining partnerships requires supportive local leadership and encouragement from government authorities. These factors are rarely present prior to intervention and take a long time to develop. Unfortunately, the current short duration of forest restoration initiatives does not allow for the development of this secure framework for local populations.

Simple tree-planting or Forest Restoration??

Most of the initiatives identified in Central Africa focus primarily on the production of tree products and economic objectives for smallholders, rather than on restoring a native forest ecosystem. In fact, agroforestry with exotic species was the most promoted technic, and the main expected benefits were sustainable wood fuel production, positive impacts on soils and the diversification or enhancement of rural incomes. In particular, exotic species are chosen because their seeds are readily available, they grow quickly, they are productive (even on degraded soils) and, in the case of *Acacia spp.*, they fix atmospheric nitrogen (Bisiaux et al. 2009; Bouyer et al. 2013; Proces et al. 2017).

A productive or economic objective seems necessary to motivate smallholders to restore the native forest on their land. In the rural complex earlier described, the reforestation initiatives undertaken by smallholders do not necessarily target the recovery of the initial forest ecosystem because the primary objective of these planters is to produce wood and food products for their own consumption or to get incomes for their household. These local actions could be complemented by more ambitious restoration strategies/initiatives undertaken by other actors (public or private) targeting environmental objectives at a large scale in areas where the land tenure has been secured.

Conclusion

In Central Africa, forest restoration by farmers was predominantly conducted in degraded areas in Cameroon and the DRC. Initiatives were focused on productive and economic purposes (notably wood fuel production and diversification of smallholders' incomes). The areas that were reported as restored predominantly exhibited management practices involving agroforestry and forest plantations featuring exotic species, such as *Acacia spp.* and *Eucalyptus spp.*. Notably, we identified geographic variation between the dense forest area of Cameroon, the periphery of Kinshasa, the Great Lakes region, and the Grassfields area. The majority of the initiatives were based on a high level of intervention rather than the empowerment of planters for sustainable tree planting. Furthermore, there was little information regarding monitoring, which prevented the evaluation of the various options based on their environmental or socio-economic dimensions.

Developing true partnerships with local populations appears to be the main challenge for those supporting forest restoration initiatives in Central Africa. This would require in-depth exchanges with local authorities and farmers, together with a comprehensive analysis of their territories and farming systems, as well as the establishment of clear contracts clarifying the roles of these two stakeholders in securing land tenure, tree ownership and the expected sharing of goods, services and benefits to be derived from these reforestation initiatives.

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Declarations

Conflict of interest The authors declare no conflict of interest.

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