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A joint stocktaking of CGIAR work on forest and landscape restoration

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CGIAR RESEARCH PROGRAM ON Policies, Institutions, and Markets
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A joint stocktaking of CGIAR work on forest and landscape restoration

The CGIAR Research Program on Forests, Trees and Agroforestry (FTA)

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This report is part of the collaboration between the three Common Research Programs (CRPs) of the CGIAR Forests, Trees and Agroforestry (FTA), Policies, Institutions and Markets (PIM) and Water, Land and Ecosystems (WLE) under the leadership of Vincent Gitz, Frank Place and Izabella Koziell. The report was prepared by Nathanaël Pingault, Meine van Noordwijk, Alexandre Meybeck, Peter Minang and Vincent Gitz.

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Note: CIAT = International Center for Tropical Agriculture; CIFOR = Center for International Forestry Research; CIMMYT = International Maize and Wheat Improvement Center; CIRAD = Research for Development (CIRAD); ICRAF = World Agroforestry; ICRISAT = International Crops Research Institute for the Semi-Arid Tropics; IFAD = International Fund for Agricultural Development; IFPRI = International Food Policy Research Institute; ILRI = International Livestock Research Institute; IWMI = International Water Management Institute.

1 Introduction

Forest and landscape restoration (FLR) are gaining increased traction on the political agenda. Over the last decade, the number and importance of pledges and commitments on restoration have increased significantly at national, regional and global levels. These include the

- Bonn Challenge (2011)[1]
- New York Declaration on Forests (2014)[2]
- Global Partnership on Forest and Landscape Restoration (GPFLR)[3]
- Land Degradation Neutrality (LDN) Target Setting Programme of the UN Convention to Combat Desertification (UNCCD)[4]
- Great Green Wall Initiative[5]
- African Forest Landscape Restoration Initiative (AFR100)[6]
- Initiative 20x20 in Latin America and the Caribbean[7]
- Asia-Pacific Regional Strategy and Action Plan on Forest and Landscape Restoration to 2030 (APFLR).[8]

On 1 March 2019, the UN General Assembly declared 2021-2030 the UN Decade on Ecosystem Restoration (A/RES/73/284).[9] This Decade could make a huge contribution to address food security, job creation and climate change simultaneously. The UN Environment Programme (UNEP) considers that restoring 350 million hectares (ha) of degraded land by 2030, as committed in the New York Declaration on Forests, could generate USD 9 trillion in various ecosystem services and remove about 13–26 gigatons of greenhouse gases from the atmosphere.[10]

However, despite the high level of political engagement, despite the number of institutions (either public, private or civil society) involved from local to global levels, and beyond some success stories, restoration is not happening at scale. Research is urgently needed to design and develop successful FLR approaches to be implemented at scale in the coming years.

International research institutions, including the CGIAR and its centers, in collaboration with national research systems and local partners on the ground, will play a critical role. This will range from generating knowledge to supporting changes on the ground as part of a "knowledge to action" chain (**Figure 1**), in order to achieve this global restoration effort.

In particular, the CGIAR and its centers need to: (i) identify the priority knowledge gaps faced by the development community; (ii) elaborate and/or assess different restoration options adapted to different contexts, as well as to the objectives and needs of different stakeholders (land users, farmers, etc.); and (iii) recommend ways and means to overcome current technical and institutional barriers and to scale up successful experiences.

1 http://www.bonnchallenge.org

2 http://forestdeclaration.org

3 http://www.forestlandscaperestoration.org

4 https://www.unccd.int/actions/ldn-target-setting-programme

5 https://www.unccd.int/actions/great-green-wall-initiative

6 http://afr100.org

7 https://initiative20x20.org/

8 http://www.fao.org/3/i8382en/I8382EN.pdf

9 https://undocs.org/en/A/RES/73/284

10 https://www.unenvironment.org/news-and-stories/press-release/new-un-decade-ecosystem-restoration-offers-unparalleled-opportunity

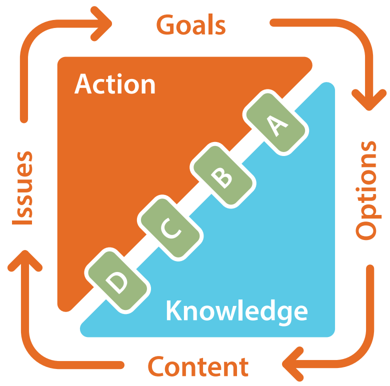

Figure 1. Knowledge to action chains

Note: A: Agenda setting; B: Better and shared understanding; C: Commitment to common principles; D: Devolution of detailed implementation.

Source: Adapted from van Noordwijk (2019); van Noordwijk et al. (2019).

In 2018, three CGIAR Research Programs (CRPs) – Forests, Trees and Agroforestry (FTA); Policies, Institutions and Markets (PIM) and Water, Land and Ecosystems (WLE) – decided to work together to address these needs. There are huge opportunities in bringing the three CRPs together to work on land restoration. Each of these CRPs works on different aspects of land restoration. Pooling this evidence in a user-friendly and accessible manner holds great potential for scaling, and for delivering enhanced impact from our CGIAR research.

The three CRPs organized a joint workshop (31 August – 1 September 2018, Nairobi, ICRAF Headquarters) to explore and define future collaboration on land restoration. As a first step, FTA, PIM and WLE took stock of research by the CGIAR centers and CRPs on landscape restoration, including land restoration and forest restoration. A survey was conducted in the 3 CRPs (FTA, PIM, WLE) and circulated to the other CRPs, inviting contributions (templates in Appendix 1). The answers to this survey (see Appendix 2) reflect the broad range of CGIAR's specific contributions to knowledge, methods, planning, modeling, action on the ground, assessment and evaluation.

This document is a preliminary analysis of the survey results. After a first section on scope, material and methods, it analyses the answers received according to three categories of research for/in development interventions or outputs: case studies and projects; tools for development; analyses and conceptual frameworks (see **Section 2.2** for more details). It also discusses some main results across these functional categories.

2 Scope, material and methods

2.1 Scope

Beyond the narrow approach that considers "restoration" as the return to the initial, pristine, undisturbed state of an ecosystem, the **International Union for Conservation of Nature** (IUCN) and other partners have adopted a wider definition for the Bonn Challenge:[11]

"Forest landscape restoration (FLR) is the ongoing process of ***regaining ecological functionality*** *and* ***enhancing human well-being*** *across deforested or degraded forest landscapes. FLR is more than just planting trees – it is restoring a whole landscape to meet present and future needs and to offer multiple benefits and land uses over time."*

The IUCN and its partners have identified the following guiding principles of FLR: (i) focus on landscapes; (ii) maintain and enhance natural ecosystems within landscapes; (iii) engage stakeholders and support participatory governance; (iv) tailor to the local context using a variety of approaches; (v) restore multiple functions for multiple benefits; and (vi) manage adaptively for long-term resilience.

Building on this IUCN definition, and following the discussions during the Nairobi joint workshop (see **Box 1**), the three CRPs considered a broader scope of land restoration, encompassing any kind of forest and agricultural landscapes all along the "forest transition curve" illustrated in **Figure 2**.

11 https://www.iucn.org/theme/forests/our-work/forest-landscape-restoration; https://infoflr.org/what-flr; http://www.bonnchallenge.org/content/forest-landscape-restoration

Box 1. Defining some common terms

The following definitions were agreed during the joint FTA-PIM-WLE workshop on land restoration (Nairobi, 2018):

- **Degradation**: Loss of functionality of e.g. land or forests, usually from a specific human perspective, based on change in land cover with consequences for ecosystem services.
- **Degraded lands**: Lands that have lost functionality beyond what can be recovered by natural processes and existing land-use practices in a defined, policy-relevant time frame.
- **Restoration**: Efforts to halt ongoing and reverse past degradation, by aiming for increased functionality (not necessarily recovering past system states).

Source: Adapted from FTA/PIM/WLE (2018)

Encompassing any kind of ecosystem, this approach to restoration gives central place to the concept of "ecological functions", i.e. the functions that allow ecosystems to generate various regulating, supporting, provisioning and cultural services (MA 2005; see also **Figure 3**), including those generating economic value.

In this document, in line with the definitions highlighted in **Box 1**, restoration is defined as all the "efforts to secure recovery of ecological functions allowing the long-term productive use of land", contributing to halt and reverse past or ongoing degradation.

These "efforts" cover a broad range of restoration interventions — from land-use practices and land-use changes to physical

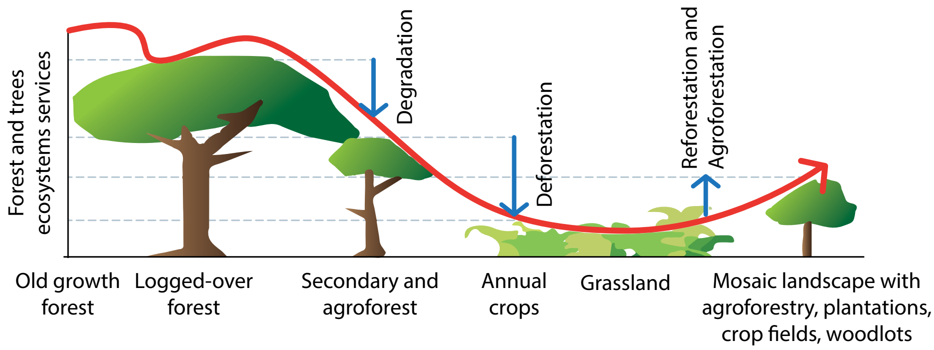

Figure 2. Forest and land-use transition curve

Source: HLPE (2017), adapted from CIFOR (2011).

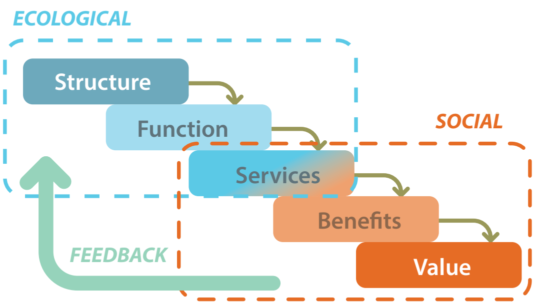

Figure 3. Ecological functions and ecosystem services

Source: Adapted from Namirembe et al. (2017).

infrastructures and institutional changes. As highlighted above, the objective here is to regain ecological functionality and enhance human well-being, not necessarily to go back to the initial ecosystem state or function. Moreover, the final "restored" state of the ecosystem shall be self-sustaining. This means that, in a particular context, given the set of ecological functions to "restore", restoration interventions need to lead to social, economic and ecological benefits lasting in the long-term.

2.2 Material, methods and first results

The initial survey, conducted from 18 July to 15 August 2018, was circulated within FTA, PIM and WLE) and circulated to the other CRPs, inviting their contributions. Researchers were also invited to include information predating the creation of the CRPs. In fact, given the time needed to achieve restoration results, information about old projects was particularly welcome. First results of the survey were presented at the FTA-PIM-WLE workshop organized at World Agroforestry (ICRAF), Nairobi on 31 August – 1 September 2018, as part of a global stocktaking of activities on restoration in the CGIAR.

In all, **77 answers** were received (gathered in **Appendix 2**), testifying to the interest of researchers in this topic. Most answers emanated from the three CRPs: 27 from FTA; 19 from WLE; 8 from PIM; 1 from FTA & PIM; 1 from FTA & WLE; and 1 from PIM & WLE. 20 answers were not explicitly linked to one of these three CRPs: 19 came from ICRAF; 15 from Bioversity; 14 from CIFOR (including 3 in collaboration with CIRAD); 10 from CIAT; 7 from IWMI; 5 from ILRI; 4 from ICRISAT, 1 from CIMMYT; and 1 from IFPRI.

As appropriate, the analysis below refers to specific contributions as numbered in **Appendix 2**.

One answer (#1) describing the reforestation project of Mont Aigoual, Massif Central, in France, while of major interest, has been, at this stage, excluded from the analysis below because this old project (1850-1913) is not yet related to any CGIAR research project and falls out of the CGIAR geographical scope. It will be part of a later review paper. The 76 remaining answers reflect the wide diversity of restoration activities led by the CGIAR all over the world, across the tropics and sub-tropics: 31 answers focused on Africa;

Table 1. Answers by regions and sub-regions

Regions	Number of answers	List of answers
Africa	**31**	
Eastern Africa	15	(#5, #10, #14, #15, #26, #39, #40, #53, #56, #57, #58, #63, #64, #69, #70)
Western Africa	7	(#2, #3, #8, #12, #21, #32, #60)
Others	9	(#27, #33, #47, #54, #59, #61, #62, #73, #76)
Asia	**13**	
South-Eastern Asia	10	(#4, #9, #16, #17, #29, #37, #43, #48, #74, #75)
Southern Asia	3	(#11, #13, #18)
Latin America	**8**	
South America	5	(#20, #24, #30, #31, #42)
Central America	1	(#22)
Others	2	(#23, #41)
Cross-regional or global	**24**	(#6, #7, #19, #25, #28, #34, #35, #36, #38, #44, #45, #46, #49, #50, #51, #52, #55, #65, #66, #67, #68, #71, #72, #77)
Total	**76**	

13 on Asia; 8 on Latin America; and 24 were either cross-regional or global (**Table 1**).

In each region, some countries emerge as places of concentration of projects. **Table 2** shows, for the main countries of concentration, the projects focusing on (or including a component on) these countries.

Initially, this survey aimed to inform the mapping of past and recent restoration activities of the CGIAR. However, out of **76 answers** analysed, only 21 describe past projects. In all, 55 answers describe ongoing projects[12], of which 24 were still at a too early stage (inception, data collection or development phase) to properly assess their impacts, either on the ground and/or in terms of publications. Some answers did not provide enough information to be fully integrated into the analysis at this stage.

Of the answers, 45 focused explicitly on restoration. For 31 answers, the main focus was not restoration but other issues, closely or more indirectly related to restoration. Beyond forest and landscape restoration, other salient topics emerged from the answers. These comprised sustainable land management (18 answers), including 8 that presented tools to monitor and map soil information and 2 focusing more on sustainable water management; genetic diversity and seed supply systems in restoration projects (13 answers); climate change — adaptation and/or mitigation (13 answers); and land tenure security and land governance reform (5 answers).

Most contributions operated at landscape level (30 answers) or across multiple scales (31 answers) — from plot, farm and landscape to national, regional and global levels. This focus may reflect the importance of the landscape level for effective restoration interventions as this level combines an integrated perspective that allows synergies among different ecosystem components and functions with a deep knowledge of, and a fine adaptation to, local conditions.

To facilitate the analysis, the survey distinguished three broad functional categories of contributions. They correspond to the description of three types of research for/in development interventions

12 i.e. projects that were ongoing in August 2018 when the survey was conducted.

Table 2. Answers focusing on or including a component on specific countries

Countries	Number of answers	List of answers
Africa		
Ethiopia	16	(#5, #7, #10, #15, #39, #52, #53, #55, #56, #57, #64, #69, #70, #72, #73, #76)
Kenya	8	(#15, #27, #39, #58, #63, #72, #73, #76)
Tanzania	5	(#14 #26, #39, #40, #72)
Niger	5	(#2, #12, #72, #73, #76)
Burkina Faso	3	(#21, #27, #32)
Senegal	3	(#3, #72, #73)
Asia		
Indonesia	5	(#4, #9, #35, #37, #43)
India	3	(#11, #13, #72)
Vietnam	3	(#43, #74, #75)
Latin America		
Peru	6	(#19, #24, #30, #35, #41, #42)
Colombia	3	(#20, #31, #41)

or outputs, with a dedicated template questionnaire for each of these categories (see **Appendix 1**):

- **Case studies and projects (CSP)**, either pilot projects or up-scaling
- **Tools for development (T4D)**, aimed at facilitating decision making and/or stakeholder negotiations
- **Approaches and conceptual frameworks (ACF)**, including evaluations.

The questions were formulated as open or semi-open questions to collect raw material, allowing further interpretation and exploitation of the answers. An Excel database was constituted for this analysis, gathering and organizing this raw material along the different headings of the questionnaire for each of the three broad functional categories as classified by the respondents.

However, four answers did not use the template questionnaires proposed for this survey. Moreover, in some cases, respondents used a template that was not the one dedicated to the corresponding functional category (see **Appendix 1**). Some also placed a research project in a category that was not considered the most appropriate by the team preparing this analysis. A new categorization is therefore proposed for such cases (15 answers) after internal discussion. As per this new categorization, 39 answers were classified as CSP, 22 as T4D and 12 as ACF. They are presented in more detail in the next sections.

3 Case studies and projects (CSP)

This category gathers 39 answers, either pilot projects or up-scaling, comprising an element of field research. These include experimental plots, trials, local capacity building and implementation, on-the-ground assessments and surveys at different scales.

3.1 Functional sub-categories

The following functional sub-categories of CSP can be distinguished:

3.1.1 Field assessments (12 answers)

This sub-category comprises projects and activities assessing the cost-efficiency of various restoration initiatives (#20); their biophysical or socio-economic impacts/ outcomes/benefits (#4, #19, #56, #58, #69), including their impacts on specific issues such as climate change (#6), water security (#58) or genetic diversity (#21, #42). It also includes two regional analyses of national seed supply systems in Latin America (#41) and Africa (#47).

3.1.2 Capacity building (13 answers)

This sub-category gathers the projects and activities contributing to build capacities at different levels (local, national and regional: see #8) through the promotion of a specific combination of

- innovative tools, techniques and practices, such as sustainable land and water management tools and practices (#14, #57); analytic tools on land degradation dynamics, 13 including mobile tools such as the "Regreening Africa app" for real-time tracking of project indicators (#73); disaster risk reduction methods (#59, #60); adequate tree seed portfolios (#10, #53); and the Integrating Gender and Nutrition within Agricultural Extension Services toolkit (#76);
- institutional changes, such as value chain development (#73), participatory rangeland management (#39), participatory governance mechanisms and/or multi-stakeholder innovation platforms (#9, #11, #14, #40).

3.1.3 Field research/case studies (11 answers)

This sub-category includes case studies aiming at learning from past successes and evaluating possible restoration options. These case studies seek to overcome current barriers and scale up restoration initiatives (#5, #15, #22, #26, #74) or to link broader research frameworks to on-the-ground experiments and implementation (#18). This sub-category also includes five case studies focusing on land tenure security in Madagascar and Ethiopia (#7), Laos (#17, #29) and Myanmar (#16, #48).

3.1.4 Ecological infrastructures piloting or scaling-up (3 answers)

This sub-category includes three projects aiming at building the ecological infrastructures needed for land restoration, such as "green walls" and wind breaks to stop desertification and soil erosion (#2, #3) and water harvesting structures to address water scarcity and land degradation (#13).

13 In particular, this project (#73) uses the Land Degradation Surveillance Framework (LDSF framework) described in project (#77), see Annex.

3.2 Thematic categories: Topics covered

The broad definition of restoration adopted for this survey (see **Section 2.1** on the scope) encompasses any kind of ecosystem. Thus, one could consider that most, if not all, CGIAR research projects contribute, directly or indirectly, to forest and landscape restoration. In particular, all the projects striving for sustainable intensification or sustainable land management can be classified under the first level of restoration intensity (i.e. "ecological intensification", see **Section 6.4.1, Box 2**).

However, it seems useful to distinguish in this synthesis two categories of CSPs:

- "restoration-focused projects" where forest and land degradation is the main entry point and restoration is the main objective.
- "restoration-related projects" that can contribute to forest and landscape restoration while following other objectives (such as sustainable intensification or climate-smart agriculture). In these projects, restoration can appear as a secondary objective or as a co-benefit of the project. These projects can also promote an enabling environment likely to facilitate future restoration efforts.

Of the 39 CSPs analysed, 24 projects have restoration as their main focus, while 15 focus on other issues more or less directly related to restoration.

3.2.1 Restoration-focused projects (24 answers)

These answers can be grouped around five main topics:

Assessing and/or upscaling landscape restoration (12 answers)

A main objective of these projects is to identify and assess restoration practices to learn from (#22, #74) and scale up (#5, #73, #76) successful experiences. For instance, two projects focus on the practice of enclosing degraded lands in Tanzania (#26) and Ethiopia (#56). The projects in this category cover various agroecosystems, including degraded forests and agroforestry in Ethiopia (#5); agroforestry in Vietnam (#74); dry rangelands in Ethiopia (#15); dry forest in Colombia (#20); and steep hillsides and wetlands in the Tana Basin, Kenya (#58). Some projects compare restoration practices and initiatives across different countries or provinces (#19, #22, #69, #73), while others compare the performance of different restoration interventions in the same ecosystem (e.g. #5, #74).

Seeds and genetic diversity (6 answers)

Two projects focus on capacity building and organization of the seed sector. They aim at delivering adequate planting material for forest restoration to enhance productivity, and hence food security and nutrition, income and livelihoods resilience for poor smallholder households (#10, #53). Four projects assess the performance of seed supply systems for landscape restoration at different scales (#21, #41, #42, #47). According to the respondents, four projects are still at a too early stage of development to be fully analysed here (#10, #21, #42, #47).

Climate change and climate-smart restoration (4 answers)

One project uses demonstration and trial plots to identify suitable species for bioenergy production on degraded land that contribute to climate change mitigation, while providing a range of socio- economic and environmental benefits (#4). Another one assesses carbon stocks, greenhouse gas (GHG) fluxes, and rates of sedimentation and subsidence in mangrove and peatland ecosystems across the tropics. This aims to estimate their state of degradation and restoration needs (#6). Two other projects aim at creating climate-smart landscapes through integrated land and water management practices and capacity building at different scales in the Gambia River Basin (#8) and Ethiopia (#57).

Combating desertification and sand fixation (2 answers)

The "Great Green Wall" is a regional initiative for the Sahara and the Sahel, endorsed in 2007 by the African Union Assembly of Heads of States and Governments. It combats desertification and aims to transform the lives of millions of people (#2). Since 1959, around 10,000 ha of trees were planted along 185 kilometers (km) of the coastline between Dakar and St. Louis, Senegal. The project aims to protect local vegetable irrigated production systems (niayes) and road access from sand dune encroachment (#3).

3.2.2 Restoration-related projects (15 answers)

These answers can be grouped around five main topics:

Land tenure security and land governance reform (5 answers)

These projects focus on land tenure security as a critical factor of restoration. They try to link farmers' strategies to strengthen their land rights at local level with land governance reform at the national level (#7, #16, #17, #29, #48). In Myanmar (#16, #48), international donors have used key findings from the research to help guide ongoing land governance reform. In Laos (#17, #29), the research presented land-use planning as a power game, then incorporated it as part of the teaching program in national universities in Laos and Thailand.

Sustainable land management (4 answers)

These projects contribute to capacity building at local level by promoting sustainable practices and technologies and participatory governance mechanisms (#9). They implement or scale up collective approaches such as participatory rangeland management (#39) or joint village land-use planning (#40). They contribute tobuild multi-stakeholder decision-making bodies, such as innovation platforms and village development committees (#11). They focus on agroforestry and forestry systems in Sulawesi Indonesia (#9), arid districts of Western Rajasthan in India (#11) or on rangelands in Ethiopia, Kenya and Tanzania (#39, #40). They all aim at improving incomes and livelihoods of farmers and local communities.

Climate-smart agriculture (3 answers)

Two projects aim at building resilience and adaptation to climate extremes and disasters (BRACED Programme) in agricultural landscapes in Chad (#59) and in cocoa production in Ivory Coast (#60). The last project assesses climate-smart agricultural practices at farm and landscape levels on two sites in Ethiopia (#70).

Smart water management (2 answers)

Smart water management (SWM) can help address water scarcity, recharge groundwater reserves and improve land productivity. Low-cost water harvesting structures can limit surface run-off and ensure a reliable water supply all year long (#13). By monitoring soil moisture and nutrients, SWM tools help farmers optimize fertilizer application and irrigation, thus increasing water productivity and profitability (#14).

Collective farming (1 answer)

This research from the IWMI explores how collective farming can drive agricultural productivity without further marginalizing smallholders who individually cannot participate in the transition from subsistence to commercial agriculture proposed by the government in Nepal. It aims at identifying strengths and weaknesses in the ongoingadoption of collective farming (#18).

4 Tools for development (T4D)

This category gathers 22 answers that aim at elaborating tools that can facilitate decision making and/or stakeholder negotiations e.g. models, guidelines and manuals, indicators and metrics, and soil and water management tools. Two functional sub-categories can be distinguished, namely decision-making supporting tools; and models and maps. The second category can also serve as the first layer for decision-making supporting tools as needed.

4.1 Decision-making supporting tools (8 answers)

This sub-category regroups tools, methods and guidelines, directed at decision makers or restoration practitioners at different levels, to support decision making.

Between 2014 and 2018, Bioversity International developed a tool for guiding species and seed selection to improve the effectiveness of restoration under climate change in Colombia's tropical dry forest (#31). This project needs to be finalized and its results communicated.

Three projects from Bioversity International aim to develop tools for laying the foundations for climate-smart restoration of tropical dry forests in Peru (#30) and Burkina Faso (#32), as well as in savanna zones and forest/savanna mosaic landscapes in Cameroon (#33). All these tools aim at improving the effectiveness of restoration under climate change by considering suitability of species and genetic origin. The project in Burkina Faso (#32) puts a particular emphasis on food tree species for nutrition-sensitive restoration. All these projects started in 2018 and are not advanced enough to be more deeply analysed at this stage.

The FORLAND project (#51), led by ONF-I, also falls under this sub-category. This project, a collaboration with CIRAD and ETH-Zurich, is funded by the European Institute of Innovation & Technology. It will develop a new spatial, participative and easy-to-use land-use decision-making tool, whose first module will focus on landscape restoration. Future modules should include FORLAND Sustainable Forest Management (SFM); FORLAND Environmental, Social and Governance (ESG); and FORLAND REDD+. Similarly, CIAT is developing, first in Ethiopia, a "Landscape Doctor" (#64), i.e. a set of decision tools to be used by planners, investors and other decision-makers for initial diagnosis, as well as for solution design and implementation, considering site and context specificities.

Finally, ICRISAT is developing good practice guidelines for restoring productive capacity of dryland in Niger, as well as tools, methods and guidelines for scaling these good restoration practices (#12). The final objective is to reduce food insecurity and improve livelihoods of poor people in African drylands. To that end, the project aims to restore degraded land, thereby increasing land profitability, as well as landscape and livelihood resilience. Likewise, ICRAF published a working paper in 2018 that presents a decision analysis methods' guide. It can help decision makers enhance the effectiveness of agricultural policy for nutrition and allocate resources more efficiently (#68).

4.2 Models and maps (14 answers)

This sub-category regroups maps and models, measuring at different scales the intensity of degradation (i.e. efforts needed for restoration) or modeling the impacts of different land-use changes or land management practices.

This sub-category includes six tools developed by WLE to model and map soil information. These tools comprise soil information maps (#61, #65, #67); a bush encroachment map in Namibia (#62); risk maps of soil nutrient deficiencies in two villages of Western Kenya (#63); and a soil organic content computation tool available in open-access through a mobile phone app (#66). Three tools focus on Africa (#61, #62, #63), while three are applicable anywhere (#65, #66, #67).

Since 2005, ICRAF has developed the Land Degradation Surveillance Framework (LDSF) and applied it in over 250 landscapes (100 km^2 sites) across more than 30 countries (#75, #77). The LDSF provides a field protocol for assessing soil and ecosystem health[14] to help decision makers to prioritize, monitor and track restoration interventions (#75, #77). The nested hierarchical sampling design used in the LDSF is useful for developing predictive models with global coverage, while maintaining local relevance (#77).

One CIFOR project (#23) aims to map the forest biomass accumulation potential as a proxy for climate change mitigation potential in Latin America. It uses a minimum mapping unit of approximately 6 ha. The resulting map, in publication, will be directed to governments and donors interested in prioritizing hotspots in degraded forested landscapes in Latin America. Another project (#54) produced a "vegetation map" that covers eight countries in Eastern and southern Africa. When complemented by a species selection tool, this map can help restoration practitioners to "find the right tree for the right place."

ILRI provides two answers that describe models of rangeland/grazing management developed at local/landscape (#27) and global (#28) scales. Three SWAT[15] models of grazing management (#27) were constructed in collaboration with and based on the knowledge of local and regional partners and institutions in the Lower Tana River Basin (Kenya) and in Yatenga province (Burkina Faso). Government officials (at national and local levels) use these models to develop legislation on rangeland management in consultation with local communities and nongovernmental organizations (NGOs). ILRI also developed a G-Range model of rangeland management (#28), applicable at global scale over long-term horizons. This helps formulate policy decisions based on projected future rangeland conditions and long-term system production potential, under climate change.

Since 2014, in Apurimac (Peru), CIRAD and CIFOR have been developing and applying several methods for analyzing, modeling and mapping the effects of forest-cover change on multiple ecosystem services and their implications for human well-being. They are also developing methods to analyse the trade-offs between these ecosystem services (#24).

IFPRI is developing an analytical model to assess the economics of land degradation (ELD), based on 12 case-study countries[16] (#72). This ELD approach not only considers the conventional market value of crop and livestock products lost because of land degradation but seeks also to capture the loss of terrestrial ecosystem services.

14 Using indicators such as vegetation cover, structure and floristic compositions, tree and shrub biodiversity, historic land use, visible signs of land degradation, and physical and chemical characteristics of soil (including soil organic carbon content and infiltration capacity).

15 Soil & Water Assessment Tools.

16 i.e. Argentina, Bhutan, China, Ethiopia, India, Kenya, Malawi, Niger, Russia, Senegal, Tanzania and Uzbekistan.

5 Approaches and conceptual frameworks (ACF)

This last category, comprising 12 answers, covers more theoretical work. It includes evaluations, conceptual frameworks, systematic literature and/or project reviews, as well as meta-analyses. Two functional sub-categories can be distinguished: (i) conceptual approaches and frameworks; and (ii) systematic reviews.

5.1 Conceptual approaches and frameworks (8 answers)

This sub-category comprises projects and activities aiming at developing or applying integrated, conceptual or theoretical frameworks around FLR and related issues.

It includes four studies focusing on seeds, genetic resources and genetic diversity. One study (2018 –2022) is (i) developing indicators of genetic diversity of native tree species; (ii) building a theoretical framework for planning genetic conservation units for native tree species in South-Eastern Asia, as a foundation of resilient seed systems; and (iii) examining the social barriers to resilient community-based seed system establishment for restoration (#43). Another one (2018 – 2019) develops a theoretical framework for the economic evaluation of genetic diversity in forest landscape restoration using economic simulation models (#46). According to respondents, both projects are still at the inception phase. Another project (#45) is a thematic study for the State of the World's Forest Genetic Resources (FAO 2014). It aims to help restoration practitioners, policy makers and scientists to better understand the importance of genetic diversity for restoring viable and resilient forest ecosystems. It also helps better integrate key genetic considerations into restoration practices, policies and strategies. The fourth answer (#55) presents an integrated flagship approach to manage tree genetic resources in support of forest and landscape restoration — from conservation and domestication to delivery.

One study (#35) proposes an integrated framework to assess or design "climate-smart restoration", based on a review of multiple projects. The objective is to guide decision makers in analyzing the contribution of restoration to climate change strategies and in managing the trade-offs between adaptation and mitigation.

The last three answers refer to conceptual approaches that are not strictly focused on restoration. ICRAF (#37) seeks to improve land management and enhance livelihoods in Indonesia through a farmer-to farmer approach. CIMMYT developed an integrated flagship approach (#36) to boost sustainable intensification of crop systems (wheat and maize). CIAT focuses on sustainable intensification in farming communities, trying to improve on-farm soil fertility; off-farm soil and water conservation; and carbon, water and nutrient cycles in the landscape (#71).

5.2 Systematic reviews (4 answers)

This sub-category includes systematic literature and/or project reviews and meta-analyses on different topics linked to restoration.

Since 2008, CIRAD and CIFOR (#25) have realized several meta-analyses or systematic reviews at different scales — from plot and watershed to region and continent, on the impacts of forest restoration on water flows, soil erosion, soil mass movements and local to regional climate, with the view to guide decision-making on land management and restoration.

Between 2015 and 2017, Bioversity International realized a global survey on seed sourcing practices for restoration (#44). This was based on a review of 136 restoration projects across 57 countries. It identified typologies of projects and of their seed sourcing practices and assessed how these practices affect restoration outcomes (Jalonen et al. 2018).

The two last studies, which focus on landscape restoration, are based on systematic reviews of literature and restoration projects. CIFOR (#34) examines the links between restoration, adaptation to climate change, food security and nutrition. For its part, ICRAF (#38) explores the principles of good governance in restoration projects, as well as related institutional dynamics, development challenges and needed incentives.

These four studies explicitly seek to guide decision making on land management and restoration. To that end, they develop high-level policy recommendations for governments, international organizations, political decision makers or restoration practitioners involved in land management and land restoration.

6 Discussion: Restoration options in contexts

Based on elements identified by respondents during the survey, this section will initiate a discussion toward a categorization of various restoration options in different contexts (which would also need to be categorized). When needed, the discussion will refer to specific contributions as numbered in **Appendix 2**. Where appropriate, this discussion will also use the conceptual framework discussed during the joint Nairobi workshop. In particular, it will draw on the list of questions presented by Meine van Noordwijk and illustrated in **Figure 4**.

6.1 Why? Achieve the final goal of restoration efforts

According to respondents, the final goal of restoration efforts is to ensure the sustainable management of land and natural resources. In this way, they would contribute to enhance human well-being and achievement of the 2030 Agenda for Sustainable Development (UN 2015). In this section, the objectives inferred from the answers are mapped against the 17 Sustainable Development Goals (SDGs).

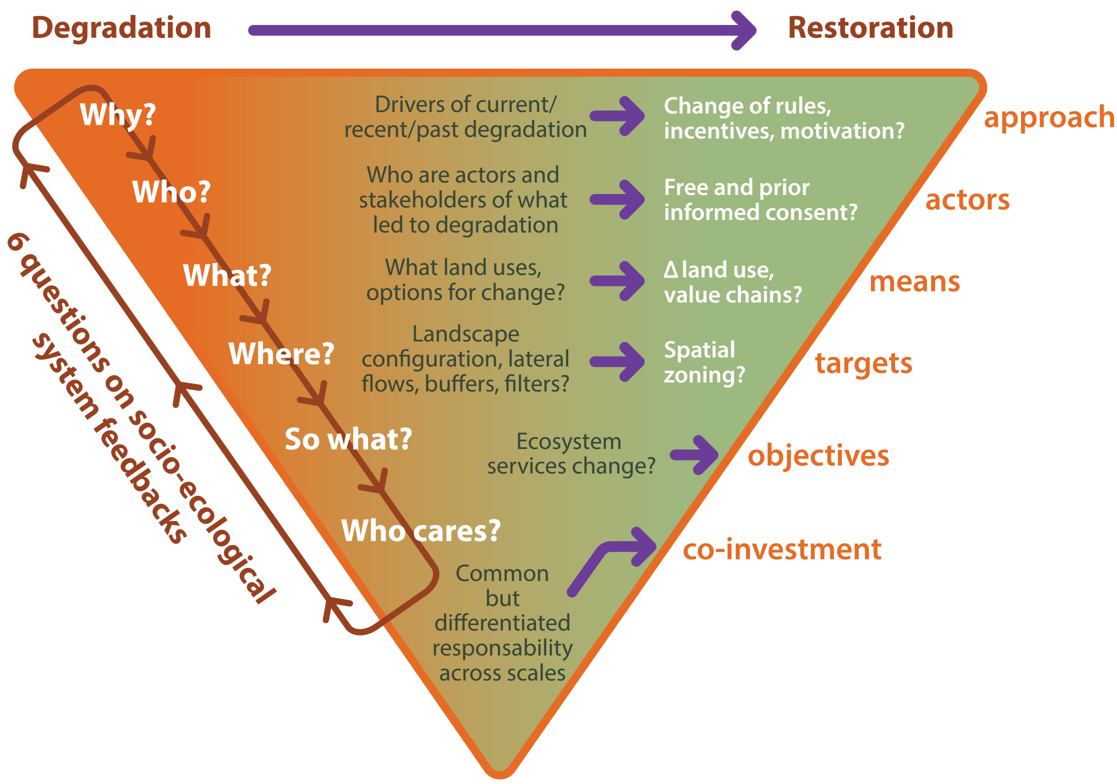

Figure 4. Restoration process

Source: Adapted from Presentation of Meine van Noordwijk in FTA/PIM/WLE (2018), van Noordwijk et al. (2020).

Of course, all restoration projects and activities shall directly contribute to “protect, restore and promote sustainable use of terrestrial ecosystems, (...) halt and reverse land degradation” (SDG15). However, the answers show that forest and landscape restoration is a cross-cutting effort. As such, it is likely to be instrumental to achieve not only SDG15, but also most of the SDGs:

- reduce poverty (#12, #15, #56, #76) and improve income and livelihoods (#29, #34, #36, #37, #56, #69, #70, #73, #74) of poor people (#12, #76) and local/rural communities (#2, #11, #9, #58, #69); and strengthen landscape and livelihoods resilience, including to climate change, in particular for poor and vulnerable communities (#2, #8, #12, #36, #45, #53, #55, #69, #70, #73, #76) [SDG1]
- improve food security and nutrition (#12, #15, #34, #36, #53, #58, #68, #73, #76) and health (#36); and boost land productivity and profitability (#12; #36, #76) [SDG2 & 3]
- build capacities (#8, #9, #10, #11, #14, #39, #40, #52, #53, #57, #59, #60, #62); link knowledge with action (#9) by generating and sharing knowledge adapted to local situation (#10, #14, #27); improve knowledge sharing through nested communities of practices (#76), farmer-to-farmer approaches (#37) or horizontal knowledge transfer (#41); and improve youth inclusivity (#36) [SDG4 & 8]
- address social justice, and improve equity and gender equity (#36, #76) [SDG5 & 10]
- address water scarcity; ensure sustainable water management; improve irrigation water productivity; and profitability (#13, #14, #25, #57, #58) [SDG6]
- protect cultural rural heritage (#2); and strengthen risk management (#36), including for climate extremes and natural disasters (#24, #59, #60) [SDG11]
- combat climate change and its impacts, and promote climate-smart restoration (#30, #31, #32, #33, #35, #57, #70), contributing to adaptation (#6, #8, #34, #35, #59, #60), mitigation (#4, #6, #23, #35), including through bioenergy production (#4) and carbon sequestration in biomass and soil (#23, #66) [SDG13 & 7]
- ensure forest protection and combine both protection and production functions of the ecosystem (#29); ensure zero net land degradation (#72); combat desertification (#2, #3); protect genetic resources and enhance genetic diversity (#10, #21, #31, #41, #42, #43, #44, #45, #46, #47, #52) [SDG15]
- reduce conflicts over land (#40) and natural resource use — e.g. water irrigation (#14) — and increase willingness to engage in collective action (#14), participatory governance mechanisms and multi-stakeholder partnerships (#9, #11, #39, #40) [SDG16 & 17].

6.2 What? Address the drivers of current and past degradation

Multiple drivers of forest and landscape degradation are identified in the answers to the survey. They can be grouped in four broad categories: biophysical drivers; unsustainable land use and land management practices; socio-economic drivers; and policies, infrastructure and institutional drivers.

6.2.1 Biophysical drivers

As stated above, degradation refers to the loss of ecological functionality of a given ecosystem, usually considered from a human perspective. In turn, the loss of ecological functionality can be traced back to different forms of degradation of biophysical components of the ecosystem (soil, water resources, vegetation cover). These are often both a result of land degradation and a driver of further degradation of ecological functionality.

Climate, water availability and poor soil are the main biophysical drivers of land degradation highlighted by respondents. In their answers, respondents mentioned the following drivers or processes of degradation linked to biophysical conditions:

- **Climate and climate change** (#21, #28, #30, #31, #32, #33, #36, #70, #73); increasing temperature and declining moisture index in the ecosystems (#8); drought and high climatic variability (#11); high temporal variations generate surface water runoff and unproductive evaporation (#13); and atmospheric CO_2 increase (#28)

- **Water scarcity** (#13) and groundwater depletion (#36)
- **Soil**: soil health (#36): soil erosion (#5, #36; #57, #59, #60, #64; #69, #70, #73, #75); topography (#73, #75); desertification (#2, #12) and sand dune encroachment (#3); loss of soil organic carbon (#66); nutrient mining/depletion (#57, #60, #63, #64, #69, #70); soil structure and soil water holding capacity (#13); and siltation and sedimentation (#6, #58).

These poor biophysical conditions can combine with, trigger or aggravate further causes of degradation, including:

- erosion of genetic diversity (#45)
- poor agricultural and livestock productivity (#13, #15);
- shrub/wood/bush encroachment (#15, #21, #28, #39, #40, #62); proliferation of invasive species (#39, #40); and pest outbreaks (e.g. cocoa swollen shoot virus, #60)
- fire (#4, #15, #23).

6.2.2 Unsustainable land-use and land management practices

Unsustainable use of natural resources (land and water), and unsustainable management practices in forestry and agriculture can exacerbate forest and landscape degradation (#11). More precisely, among these drivers, the answers highlighted:

- Land-cover change and land clearing (#73): deforestation (#2, #5, #36, #56, #64, #70) and forest degradation; illegal logging (#8); indiscriminate wood cutting (#2); agriculture encroachment on forests and other natural ecosystems (e.g. savannah, rangelands) (#8, #20, #22, #26, #27, #58, #64); and vegetation clearance (#59)
- Unsustainable agriculture practices (#14), including overgrazing (#2, #20, #21, #22, #23, #26, #56, #64, #73) or “intense and disorganized grazing” (#15, #27, #28); use of fire as a land management tool (#2; #36, #73); monoculture (#75); and lack of specific diversity in farming landscape (#53, #76).

6.2.3 Socio-economic drivers

In some places, the wider socio-economic context can reinforce the consequences of poor biophysical conditions or limited natural resources endowment, exacerbating forest and landscape degradation. Although respondents seem to have paid less attention to this category, they identified demographic dynamics, livelihoods and education as the main socio-economic drivers of land degradation. In particular, the respondents mentioned:

- **Demographic** dynamics: overpopulation (#14) and high population density (#11); settlement expansion (#26); out-migration (#11); and abandon of agricultural lands (#4) that might also be a consequence of degradation
- Poor **livelihoods** (#2, #29, #34, #36, #37): poverty (#8, #12, #15, #56) leading to weak local capacities and low landscape and livelihoods resilience (#2, #8, #11, #12, #36, #45)
- Limited **education**: lack of appropriate knowledge, tools, skills and know-how (#14, #18, #39, #40, #54); and sectoral silos perpetuating fragmented extension services (#18).

6.2.4 Policies, infrastructure and institutional drivers

Appropriate infrastructures, from physical infrastructures to more immaterial assets; adequate level of investments; land tenure security; and, more generally, policies building a conducive institutional environment at national and local levels are critical to halt and reverse the effects of past and current land degradation. All these institutional dynamics (#38) can be associated with asymmetries (#18) in power structures and power relationships (#16, #17, #29).

As institutional drivers of forest and landscape degradation, the answers identified in particular:

- Poor **infrastructures**: limited access to markets (#3, #11, #15); lack of appropriate seed supply systems for restoration (#10, #44, #47); and quality and genetic diversity of seed collection and seedlings (#42).

- Unsustainable/limited **investments** to implement restoration at scale (#15; #39, #40, #52, #56, #57): limited public funding for restoration (#3); limited resources for research and modeling (#27); and lack of smallholders' investments in land management practices (#18).
- **Land tenure insecurity** emerges from the survey as a critical driver of forest and land degradation (#5, #7, #16, #17, #29, #39, #40). The answers highlighted the following issues: weak understanding of customary land and tree tenure arrangements (#2); individualization of the commons (#15); inequal access to land: land accumulation by the minority landlords (#18); lack of regulated land market (#18); and large-scale land acquisition for commercial use (#16, #48).
- Weak **governance**: weak regulatory context and institutions (#56), at national and local levels, generating unclear sharing of responsibilities (#3); poor implementation of policy and legislation (#40); institutional barriers to intersectoral dialogue (#24); armed ethnic conflicts (#16); and conflicts over land and natural resources (#14, #40).

  At the local level, respondents highlight weak local institutions (#11); diminishing customary authority (#39, #40); limited engagement with local communities (#3, #56); implementation barriers to efficient local land-use planning (#29); and social barriers to resilient community-based seed system establishment for restoration (#43).

6.3 Who? Act for forest and landscape restoration

In the CSP template (**Appendix 1**), there was no specific demand on the actors responsible for or affected by past and current land degradation or by restoration efforts. In the T4D and ACF templates, one question focused on the effective or potential end-users of the tools and conceptual approaches developed, generally: donors/investors (#23, #31, #39, #57, #64, #69, #77) and development organizations (#57, #69); policy makers and decision makers across sectors at different levels (#24, #30, #31, #33, #35, #45, #64, #68, #69, #77); scientists (#24, #28, #35, #45, #62, #66, #70, #75, #77) and development-oriented researchers (#68); and restoration planners and practitioners (#31, #32, #33, #45, #54, #64), including farmers and extension officers (#63, #71).

The replies give some elements of answer to the following questions around the "Who?":
- "Who does?": who are the actors of past and current degradations and of restoration efforts?
- "Who cares?": who bears the costs, who reaps the benefits, how equitable are restoration interventions (#19)?
- "Used by whom?": who are the end-users of restoration tools and approaches?

To categorize these stakeholders two complementary approaches can be followed, described below.

6.3.1 A rights-based approach

A human rights perspective makes a fundamental distinction between "right-holders" (i.e. citizens, particularly the most vulnerable) and "duty-bearers" (mainly states with the obligation to respect, protect and fulfill citizens' rights). Violations of human rights, by states or non-state actors (including private actors), must also be considered (HLPE 2018).

Land degradation and restoration efforts particularly affect the rights (including right to food; water sanitation and hygiene; and land tenure security) of those people, often among the most vulnerable and food insecure people, that depend exclusively or importantly on natural resources for their subsistence and livelihoods. These include farmers (#2, #11, #16, #58, #74, #75) and farming households (#13, #14, #17, #21, #53, #73, #74, #76), in particular smallholders (#4, #14, #18, #36, #53, #58, #71, #73) and landless households (#18); herders (#2) and pastoralists (#11, #15); hunters (#2); poor people (#8, #12); women (#9, #11, #19, #39, #40); youth (#36); and forest-dependent people[17] and Indigenous peoples.

17 Comprising (i) people living in and around forests, heavily dependent on forest resources for their livelihoods; (ii) people living in proximity to forests, regularly using forest products for their own subsistence and partly for income generation; and (iii) people engaged in such commercial activities as hunting, collecting minerals or forest industries such as forest management and logging (HLPE 2017).

6.3.2 A multi-stakeholder approach

The answers mention actors belonging to the three "spheres of society" (HLPE 2018):

- **Public sector** (#58): UN agencies, such as IFAD (#3, #77); international donors (#16, #77) such as the Global Environment Fund[18] (#34) and the World Bank (#25, #34); regional intergovernmental organizations such as the European Union (#39) or the African Union (#2); governments, including states, sectoral and/or local administrations (#3, #4, #9, #13, #15, #16, #17, #23, #27, #40, #41, #62, #66, #73, #74, #77); national development agencies (#3, #7, #10, #39) and other public agencies (#32); and international and national research institutions or universities (#11, #13, #17, #29, #39, #62, #70, #75, #77)
- **Private sector** (#20, #58, #74): private industries (#4, #11); cooperatives (#18, #39); and private foundations (#13)
- **Civil society organizations** (#9, #48): NGOs (#11, #27, #39, #40, #57, #66, #76, #77) and all other non-profit organizations or bodies, including local/rural communities (#2, #3, #5, #7, #9, #11, #16, #26, #40, #53, #56, #57, #58, #66, #71), village development committees, commodity specific sub-committees for women (#11) and women farming groups (#76).

In that sense, multi-stakeholder partnerships, bodies or innovation platforms mentioned in the answers (#11, #14, #22, #58) cover many kinds of collaborative arrangements among stakeholders from two or more different spheres of society (HLPE 2018). Note that, depending on their statutory objectives and legal status, research institutions and farmers' organizations can fall under any of the three spheres mentioned above.

6.4 How? Design performant restoration interventions

There is no "one-size-fits-all" solution in forest and landscape restoration. Decision makers and practitioners must choose, among a wide range of restoration options, the solution best adapted to the local, biophysical, institutional and socio-economic context. In so doing, they must consider the potential of the land and the needs of local communities.

The Global Partnership on Forest and Landscape Restoration (GPFLR) has proposed for the Bonn Challenge a broad typology of restoration options. This typology is based on three main categories of degraded land: (i) forested land; (ii) protective land and natural buffers;[19] and (iii) agricultural land. Different restoration options are available in each category, including:[20]

- **in forested land**: silviculture (tree planting) vs. natural regeneration
- **in protected land and natural buffers**: watershed protection and erosion control; or mangrove restoration
- **in agricultural land**: agroforestry; or improved fallow.

Building on survey results, it is possible to deepen the analysis. Restoration interventions, from conceptual to more pragmatic approaches, can be categorized in several ways. The first two options (**Sections 6.4.1** and **6.4.2**) are presented briefly, while the third approach receives more attention (**Section 6.4.3**).

6.4.1 By restoration intensity

Bioversity International (#20) is trying to evaluate the cost-efficiency of **active** versus **passive** restoration interventions in Colombian tropical dry forest over 15 years (2015 – 2030). It examines a range of restoration options – from natural regeneration to assisted natural regeneration; and from low diversity to high diversity plantings – to restore native forest vegetation on lands in different stages of degradation.

More precisely, following the proposal of Meine van Noordwijk discussed during the Nairobi joint workshop, restoration interventions could be classified along four levels of **restoration intensity (Box 2)**. These are also linked to increasing degrees of land/forest degradation intensity:

18 http://www.globalenvironmentfund.com/

19 Such as slopes, rivers, wetlands or coastal areas.

20 www.bonnchallenge.org/content/restoration-options

i. ecological intensification (e.g. #9, #11, #14, #15, #36, #39, #40, #57, #59, #60, #70, #73, #74, #76)
ii. recovery/regeneration (e.g. #26, #56)
iii. reparation/recuperation (e.g. #2, #3, #4, #8, #13, #21)
iv. remediation (no answer).

Box 2. Four levels of restoration intensity

i. **Ecological intensification:** where improvements to the resource base are possible *within existing land use* by combining provisioning, regulating and regenerative aspects of agroecosystem functioning, within a context of supportive input and output markets.

ii. **Recovery/regeneration:** where forms of fallow, resting land, exclosures protected from overgrazing, fire control and assisted natural regeneration can bring back conditions within which ecological intensification is possible. This category often entails change in land use, at least temporarily.

iii. **Reparation/recuperation:** where more intense action than recovery/regeneration is performed (e.g. tree planting) with additional external support, e.g. by creating access to nurseries for diversified germplasm, knowledge not locally available, inputs (including soil amendments) not currently used, supporting local institutions (and bridging social capital with institutions outside the landscape) not currently effective and/or changing tenurial relations with the state or private sector.

iv. **Remediation:** where past activities such as mining, soil pollution or deep drainage have created obstacles to safe agricultural production that require intense specific, often externally supported and financed, efforts and economic reparation.

Source: Presentation of Meine van Noordwijk in FTA/PIM/WLE (2018).

6.4.2 By scale and leading/funding partner

Building upon some of the answers, a more pragmatic approach to sort out restoration interventions could be adopted. They could be classified by **scale** (local vs. national, regional and global approach) and **leading or funding partner** (public, private or civil society organization: see **Section 6.3**). See for instance:

- "community-led solutions for sustainable land management in Western Rajasthan in India" (#11)
- a "household-based restoration approach promoted by local association in Burkina (tiipaalga)" (#21).

6.4.3 By domains of intervention

The answers to the survey also suggest another pragmatic approach to the typology of restoration interventions, which could be classified by domains of interventions. Such an analysis could contribute to illustrate and refine the above-mentioned conceptual typology around restoration intensity.

The following categories of restoration projects and activities can be identified, building on replies to the survey and on previous discussions (**Sections 3 to 5**):

Sustainable management practices

This category gathers restoration interventions, mainly at plot and farm level, aiming at improving the management practices of land and other natural resources (water, energy, biodiversity…), in order to improve productivity, resource-use efficiency and resilience (#10). These restoration interventions refer mostly to the first levels of intensity mentioned above — (i) ecological intensification and (ii) recovery/regeneration — and often operate within existing land use.

In this category, the answers mention for instance:

- farmland management (#69); evergreen agriculture (#73); sustainable production (#60); sustainable intensification and productivity enhancement interventions (forestry, agriculture and/or livestock)

(#10, #11, #13, #15, #36, #39, #40, #71); and effective and sustainable tree, crop and livestock production (#76)
- forest practices such as enrichment planting (#42, #74)
- agroforestry practices (#2, #5, #9, #13, #26, #74) at plot or farm level
- soil and water conservation and sustainable management practices (#11, #13, #36, #57, #58, #69): SWM tools, improving water productivity and profitability, and optimizing fertilizer application in irrigated systems (#14); and grass strips (#58)
- bioenergy production on degraded lands for climate change mitigation (#4).

Many answers in that category highlight diversification (#10, #13), as well as specific and genetic diversity as conditions of resilient restoration (#46). They focus on:
- the suitability of species and genetic origin (#30, #31, #32, #33, #53, #76)
- the use of native tree genetic resource (#30, #32, #33, #43, #45)
- the use of improved (drought-tolerant and higher market value) varieties and cultivars (#11)
- the importance of appropriate seed selection and seed sourcing practices (#21, #32, #44) to deliver appropriate seeds and plants (#10, #31, #43, #52) for efficient restoration interventions.

Integrated landscape management

This category comprises restoration interventions, operating mainly at landscape and/or ecosystem level; adopting a holistic and integrated perspective at landscape level; and building on the synergies between different components of the ecosystems (humans, animals, plants, soils and water) to progress toward sustainability. In this category the answers mention (for instance):
- the Ngitili system, a traditional fodder management system in Tanzania (#26)
- community-based silvo-pastoral systems (#11)
- intersectoral landscape management (#24, #74); integrated tree, crop and livestock production systems (#12, #36, #76); integrating forests and agroforestry land uses (#74)
- creation of climate-smart multi-functional landscapes through integrated soil, land and water management at different scales (#8, #57, #59, #60, #70).

This category of interventions generally involves a range of practices. They can also operate at wider scale. For instance, the “Great Green Wall” is a regional initiative that evolved from the idea of a line of trees into the vision of a great mosaic of green and productive landscapes from east to west across the Sahara and the Sahel (#2).

Infrastructures

This category includes the establishment and maintenance/management of infrastructures such as:
- exclosure establishment, improvement and management (#5, #15, #56); and enclosing collective/communal and/or private degraded areas (#26, #56)
- hillside management (#58, #69); and terraces to control soil erosion and water runoff (#58, #69)
- gully rehabilitation practices, including check dams and cut-off drains (#69)
- reforestation and tree planting, e.g. smallholder plantations (#5)
- “green walls” to combat desertification and act as windbreaks (#2, #3)
- low cost water-harvesting structures and decentralized water harvesting techniques to address water scarcity, allowing a more reliable water supply all year long and increasing productivity (#13).

These interventions can be linked to a change in land use and correspond mainly to the last levels of restoration intensity — (iii) reparation/recuperation and (iv) remediation.

This category also includes the establishment of all the physical or immaterial infrastructures needed to improve
- access to land and natural resources, in particular for women (#9, #40);
- access to markets (#3, #11, #15), including road access (#3) or improved value chains (#9).

Access to markets includes access to goods and services, and to input and output markets. Seeds have been mentioned above as a critical input for restoration. Hence, establishing strong national seed supply systems (#41, #47) or gene banks (#52, #55) can play a crucial role for the efficiency of restoration efforts in a country.

Institutional changes and incentives

Technical changes in land use and land management practices will not be enough. Institutional changes, at local and national levels, are needed to support restoration efforts. The answers try to identify good governance principles, institutional dynamics, development challenges and incentives[21] needed in restoration projects (#38, #56).

They call for renewed engagement in restoration through appropriate **resource mobilization** and sustainable level of **investments** (#3, #15, #18, #27, #36, #39, #40).

They highlight **participatory management** approaches (#5, #29, #36, #39, #56), engagement with local communities (#3, #56, #57) — paying a particular attention to women (#11, #39), and smallholder and landless households (#18) — as well as engagement with local and regional partners (#27), as conditions of success for restoration interventions. Such approaches allow the integration of local knowledge (#27) and facilitate local community (and local government) participation and sense of ownership (#11, #39, #40, #48). Participatory governance mechanisms shall be established at different scales (#9, #11). Participatory governance and **collective action** can be facilitated by producers' associations e.g. the livestock keepers' association (#40) and collective farming (#18); multi-stakeholder bodies (#39) and multi-stakeholder innovation platforms (#11, #14); village development committees; and joint village land-use planning (#40), etc.

21 Including taxes and subsidies.

They study the **political, legal and administrative frameworks** (#18, #22), as well as the institutional dynamics behind public, private or public-private restoration initiatives (#22). Many projects aim at delivering policy recommendations for decision makers at different levels (e.g. **Section 5.1**) to influence national policy and legislation (#39, #40).

As mentioned above, the answers identify land tenure security as a critical institutional factor of restoration. To address this issue at national level, restoration interventions should aim at improving land governance by supporting land governance reform (#16, #17, #48); and better regulating the land market (#18) and, in particular, large-scale land acquisition for commercial use (#16, #48). At local level, restoration interventions should aim at protecting access to land and natural resources by improving governance of the commons (#11, #40); and considering and preserving local institutional arrangements (e.g. informal land rental arrangements and customary land rights) (#17, #29, #48). For instance, in Tanzania, access to grazing areas is secured through group Certificates of Customary Rights of Occupancy. These are provided through the Sustainable Rangeland Management Program (2016 – 2020), which is managed by ILRI with the financial support of IFAD, the International Land Coalition and the Tanzanian government (#40).

Knowledge generation, knowledge sharing and capacity building

This category includes all the projects that elaborate conceptual approaches and frameworks **generating** theoretical **knowledge** at different scales (**Section 5**), and apply them in different contexts (**Section 3.1**: "field assessments", "field research/case studies"). It includes all the models and tools, sometimes integrating different forms of knowledge, including local knowledge (#27), that support decision making at different scales (from local to global) by different stakeholders (from farmers, restoration practitioners to government officials) (see **Section 4**). Such projects and activities can also contribute to monitoring and evaluation (#10, #18, #41).

It also includes all the interventions aiming at **sharing knowledge** through integrated extension services, breaking the sectoral silos (#18), and through innovative learning models such as horizontal knowledge transfer (#41), nested communities of practice (#76) or farmer-to-farmer approaches (#37). This category comprises all the restoration projects and activities aiming to raise awareness or **build capacities** at different scales through the appropriate mix of technological and institutional changes (see **Section 3.1.3**).

7 So what? Conclusion

Beyond forest and landscape restoration, this preliminary analysis identified other salient issues closely linked to restoration: sustainable land management (18 answers) and sustainable water management (2 answers); genetic diversity and seed supply systems (13 answers); climate change — adaptation and/or mitigation — (13 answers); land tenure security and land governance reform (5 answers).

From this preliminary analysis, some aspects seem less covered. For instance, if many projects focus on the technical performance of different restoration practices, only a few focus on the economics of land degradation and restoration (e.g. #19, #20, #46, #72). Few projects investigate power structures, power asymmetries and power games, and most of these focus on land tenure security (#16, #17, #18, #29). One answer (#22) focuses on the political economy underlying the official political discourse and seeks possible ways to unlock the investment constraint. To that end, it tries to better understand the dynamics between regulations and incentives in public-, private- and public-private restoration initiatives in Central America.

The answers received identify five critical factors of success for restoration interventions: (i) secure tenure and use rights; (ii) access to markets (for inputs and outputs) and services; (iii) access to information, knowledge and know-how associated with sustainable and locally adapted land use and land management practices; (iv) status of local ecosystem services, often used as a baseline to assess the level of degradation; and (v) potential contribution to global ecosystem services likely to attract international donors.

This preliminary analysis could be a starting point to elaborate a typology of restoration options in different contexts, at different stages of the forest transition curve. In particular, the previous discussion (**Section 6**) provides some first elements contributing to the description of the different contexts where restoration is needed. This description should include an illustration of current national and local conditions (biophysical, socio-economic and institutional); an assessment of current land use and land management practices; and identification of the main causes of degradation (**Section 6.2**) in a given context. **Section 6.4** then suggests some elements of answer to the "How?" question, presenting different kinds of restoration interventions. **Section 6.1** illustrates how the SDGs could constitute an overall framework in which could be inscribed such a typology.

Further collaborative activities could be developed among the three CRPs on the themes highlighted above. This preliminary analysis also identifies some countries concentrating many answers where such collaborations might be easier and fruitful.

8 References

[CIFOR] Center for International Forestry Research. 2011. *Forests, trees and agroforestry: Livelihoods, landscapes and governance*. CGIAR Research Program on Forests, Trees and Agroforestry (FTA) Proposal. Bogor, Indonesia: CIFOR.

[FAO] Food and Agriculture Organization. 2014. *The state of the world's forest genetic resources*. Commission on Genetic Resources for Food and Agriculture. Rome: FAO. http://www.fao.org/3/a-i3825e.pdf

FTA/PIM/WLE. 2018. *Joint CRP (FTA-WLE-PIM) workshop on Land restoration*, held on 31st August and 1st September, 2018 at ICRAF Headquarters in Nairobi. Full proceedings.

HLPE. 2017. *Sustainable forestry for food security and nutrition*. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome. http://www.fao.org/3/a-i7395e.pdf

HLPE. 2018. *Multi-stakeholder partnerships to finance and improve food security and nutrition in the framework of the 2030 Agenda*. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome. http://www.fao.org/3/CA0156EN/CA0156en.pdf

[[ICRAF] World Agroforestry. 2018. *Joint CRP (FTA-WLE-PIM) workshop on land restoration*, held 31 August and 1 September 2018. Proceedings. Nairobi: ICRAF.

Jalonen R, Valette M, Boshier D, Duminil J and Thomas E. 2018. Forest and landscape restoration severely constrained by a lack of attention to the quantity and quality of tree seed: Insights from a global survey. *Conservation Letters* 11(4): e12424. https://doi.org/10.1111/conl.12424

[MA] Millennium Ecosystem Assessment. 2005. *Ecosystems and human well-being: Current state and trends.* Vol. 5. Washington, DC: Island Press.

Namirembe S, Leimona B, van Noordwijk M and Minang PA 2017. Co-investment in ecosystem services: Global lessons from payment and incentive schemes. *In Setting the Stage for Pro-poor Co-investment in Environmental Services in Africa and Asia: A Theory of Change.* Nairobi: ICRAF. 1–18. https://www.worldagroforestry.org/sites/default/files/u884/Ch1_IntroCoinvest_ebook.pdf

[UN] United Nations. 2015. *Transforming our World: The 2030 Agenda for Sustainable Development.* A/RES/70/1. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

van Noordwijk M. 2019. Integrated natural resource management as pathway to poverty reduction: Innovating practices, institutions and policies. *Agricultural Systems* 172:60–71. https://doi.org/10.1016/j.agsy.2017.10.008

van Noordwijk M, Duguma LA, Dewi S, Leimona B, Catacutan D, Lusiana B, Öborn I, Hairiah K, Minang PA, Ekadinata A, et al. 2019. Agroforestry into its fifth decade: Local responses to global challenges and goals in the Anthropocene. *In* van Noordwijk M, ed. *Sustainable Development Through Trees on Farms: Agroforestry in its Fifth Decade.* Bogor, Indonesia: ICRAF. 347–368. http://www.worldagroforestry.org/trees-on-farms

van Noordwijk M, Ekadinata A, Leimona B, Catacutan D, Martini E, Tata HL, Öborn I, Hairiah K, Wangpakapattanawong P, Mulia R, et al. 2020. Agroforestry options for degraded landscapes in Southeast Asia. In Dagar JC, Gupta SR and Teketay D, eds. *Agroforestry for Degraded Landscapes: Recent Advances and Emerging Challenges.* Singapore: Springer.

9 Appendixes

Appendix 1. Survey templates

Appendix 1.1 Restoration project

Name of respondent and e-mail:
Center:
CRP/Flagship (if relevant):

Title:
Starting year:
Ending year:
Place:

1a) Scale:
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

Appendix 1.2 Restoration tool

Name of respondent and e-mail:
Center:
CRP/Flagship (if relevant):

Title:
Year:

1a) Scale:
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)

3) Effective use
Where?
By whom?
For what?

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

5) References

Appendix 1.3 Conceptual approach to restoration

Name of respondent and e-mail:
Center:
CRP/Flagship (if relevant):

Title:
Year:

1a) Scale:
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)

3) Used
Where?
By whom?
For what?

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

5) References

Appendix 2. Answers to the survey

List of the answers

#	New Functional Category	CRP	CGIAR Center	Respondent	Mail	Title
#1	-	FTA	CIFOR	Dr. D. Andrew Wardell	a.wardell@cgiar.org	Restoration of Mt. Aigoual, Massif Central, France
#2	CSP	FTA	CIFOR	Dr. D. Andrew Wardell	a.wardell@cgiar.org	Stebbing's "two green walls" to stop the encroachment of the Sahara
#3	CSP	FTA	CIFOR	Dr. D. Andrew Wardell	a.wardell@cgiar.org	Sand dune fixation
#4	CSP	FTA	CIFOR	Himlal Baral, Ph.D	h.baral@cgiar.org	Socio economic and environmental benefits of bioenergy production on degraded land
#5	CSP		CIFOR	Habtemariam Kassa	h.kassa@cgiar.org	Identifying good practices in forest landscape restoration and enabling conditions for scaling up
#6	CSP		CIFOR	Daniel Murdiyarso	d.murdiyarso@cgiar.org	Sustainable Wetland Adaptation and Mitigation Program (SWAMP)
#7	CSP	PIM	CIFOR	Steven Lawry		Tenure security and resource governance as factors in forest landscape restoration. ("Restoring Forests, Restoring Communities")
#8	CSP		ICRAF	Lalisa Duguma	l.duguma@cgiar.org	Large-scale Ecosystem-based Adaptation in the Gambia River Basin: Developing a climate resilient, natural resource-based economy
#9	CSP		ICRAF	James M Roshetko	jroshetko@cgiar.org	Agroforestry and Forestry in Sulawesi: linking knowledge with action (AgFor) project
#10	CSP	FTA	ICRAF	Lars Graudal	L.Graudal@cgiar.org	Provision of adequate tree seed portfolios to enhance productivity and resilience of forest landscape restoration in Ethiopia (PATSPO), supported by the Norwegian International Climate and Forest Initiative (NICFI)
#11	CSP	Dryland syst.	ICRISAT	Shalander Kumar; Anthony Whitbread	k.shalander@cgiar.org; a.whitbread@cgiar.org	Community led solutions for sustainable land management in Western Rajasthan in India
#12	T4D	WLE	ICRISAT	Vincent Bado	V.Bado@cgiar.org	Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale.

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List of the answers (Continued)

#	New Functional Category	CRP	CGIAR Center	Respondent	Mail	Title
#13	CSP	WLE	ICRISAT	Kaushal K Garg	k.garg@cgiar.org	Analysing impact of various agricultural water management (AWM) interventions on watershed hydrology and various ecosystem trade-offs in Bundelkhand region of Central India
#14	CSP	WLE	ICRISAT	Martin Moyo; Andre van Rooyen	M.Moyo@cgiar.org; AvanRooyen@cgiar.org	Improving water productivity and profitability in small-scale communal irrigation schemes in southern Africa
#15	CSP	Livestock	ILRI	Jason Sircely	j.sircely@cgiar.org	Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale (ILRI component)
#16	CSP	PIM	IWMI	Diana Suhardiman		Linking land tenure security with state transformation processes in Myanmar
#17	CSP	PIM	IWMI	Diana Suhardiman		Linking land tenure security with food security in Laos
#18	CSP	PIM	IWMI	Sanjiv de Silva		Collective Farming for Improving Small Scale Agriculture Performance in Nepal
#19	CSP	FTA/WLE	Bioversity International	Marlène Elias	marlene.elias@cgiar.org	Assessing the socio-economic impacts of restoration initiatives: A cross-regional analysis
#20	CSP	FTA	Bioversity International	Rachel Atkinson; Evert Thomas	r.atkinson@cgiar.org; e.thomas@cgiar.org	Trials to evaluate the cost-efficiency of active versus passive restoration interventions to restore tropical dry forest across a degradation gradient in Colombia
#21	CSP	FTA	Bioversity International	Barbara Vinceti	b.vinceti@cgiar.org	Nutrition-sensitive forest restoration to enhance the capacity of rural communities in Burkina Faso to adapt to change
#22	CSP	FTA /PIM	Bioversity International	Dietmar Stoian	d.stoian@cgiar.org	Overcoming barriers to landscape restoration: Learning from experiences across Central America
#23	T4D		CIFOR	Rosa María Román-Cuesta	R.Roman-Cuesta@cgiar.org	Mitigation potentials in Latin American landscapes through two carbon-intense restoration options: forest expansion and peat restoration
#24	T4D	FTA	CIFOR/ CIRAD	Bruno Locatelli	bruno.locatelli@cirad.fr	Methods and tools to analyse trade-offs between ecosystem services in restoration
#25	ACF	FTA	CIFOR/ CIRAD	Bruno Locatelli	bruno.locatelli@cirad.fr	Meta-analyses on the effects of restoration on water and soils

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List of the answers (Continued)

#	New Functional Category	CRP	CGIAR Center	Respondent	Mail	Title
#26	CSP	FTA	ICRAF	Lalisa Duguma	l.duguma@cgiar.org	Understanding the restoration success in Shinyanga, Tanzania - from a bare degraded land to a rich biodiverse ecosystem
#27	T4D	WLE	ILRI	Jason Sircely	j.sircely@cgiar.org	Enhancing the value of ecosystem services in pastoral systems (EVESPS) project
#28	T4D	CCAFS	ILRI	Jason Sircely	j.sircely@cgiar.org	G-Range global rangelands model
#29	CSP	PIM	IWMI	Diana Suhardiman		Linking land tenure security with food security in Laos
#30	T4D	FTA	Bioversity International	Evert Thomas; Rachel Atkinson	e.thomas@cgiar.org; r.atkinson@cgiar.org	Laying the foundations for climate-smart restoration: a toolbox for Peru's tropical dry forest
#31	T4D	FTA	Bioversity International	Evert Thomas; Rachel Atkinson	e.thomas@cgiar.org; r.atkinson@cgiar.org	A tool for guiding species and seed selection for the restoration of Colombia's tropical dry forest
#32	T4D	FTA	Bioversity International	Barbara Vinceti	b.vinceti@cgiar.org	Laying the foundations for nutrition-sensitive, climate-smart restoration: a toolbox for Burkina Faso's dry forest
#33	T4D	FTA	Bioversity International	Marius Ekue	m.ekue@cgiar.org	Laying the foundations for climate-smart restoration: a toolbox for the mosaic forest/savanna ecotone and savanna zones of Cameroon
#34	ACF		CIFOR	Amy Ickowitz Houria Djoudi	a.ickowitz@cgiar.org; h.djoudi@ cgiar.org	Restoration, Adaptation, Food Security, and Nutrition – what are the links?
#35	ACF	FTA	CIFOR/ CIRAD	Bruno Locatelli	bruno.locatelli@cirad.fr	A framework to understand the multiple (and sometimes conflicting) contributions of restoration to climate change strategies and the opportunities of integrating restoration to adaptation and mitigation strategies
#36	ACF		CIMMYT	Bruno Gerard	b.gerard@cgiar.org	MAIZE: Sustainable Intensification of Maize-based Systems for Improved Smallholder Livelihoods. WHEAT: Sustainable intensification of wheat-based farming systems
#37	ACF		ICRAF	Endri Martini; James Roshetko	emartini@cgiar.org; jroshetko@cgiar.org	Farmer-to-farmer approach
#38	ACF		ICRAF	Peter Minang	a.minang@cgiar.org	Trends of governance in landscape restoration
#39	CSP	PIM	ILRI	Fiona Flintan	f.flintan@cgiar.org	Participatory Rangeland Management
#40	CSP	PIM	ILRI	Fiona Flintan	f.flintan@cgiar.org	Sustainable Rangeland Management Project including Joint Village Land Use Planning

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List of the answers (Continued)

#	New Functional Category	CRP	CGIAR Center	Respondent	Mail	Title
#41	CSP		Bioversity International	Rachel Atkinson; Evert Thomas	r.atkinson@cgiar.org; e.thomas@cgiar.org	Seed supply systems for the implementation of landscape restoration under Initiative 20x20: An analysis of national seed systems in Mexico, Guatemala, Costa Rica, Colombia, Peru, Chile and Argentina
#42	CSP	FTA	Bioversity International	Christopher Kettle	c.kettle@cgiar.org	Evaluation of genetic diversity of brazil nut seedlings used in restoration of degraded lands in Madre di Dios Peru
#43	ACF	FTA	Bioversity International	Christopher Kettle; Riina Jalonen	c.kettle@cgiar.org; r.jalonen@cgiar.org	Developing indicators for Genetic conservation units of native trees to deliver resilient seed supply systems for priority tree species in S E Asia
#44	ACF	FTA	Bioversity International	Riina Jalonen	r.jalonen@cgiar.org	Global survey on seed sourcing practices for restoration
#45	ACF	FTA	Bioversity International	Riina Jalonen	r.jalonen@cgiar.org	Genetic considerations in ecosystem restoration using native tree species. Thematic study for the State of the World's Forest Genetic Resources.
#46	ACF	FTA	Bioversity International	Christopher Kettle; Elisabetta Gotor	c.kettle@cgiar.org; e.gotor@cgiar.org	Developing a theoretical framework for the economic evaluation of diversity in forest landscape restoration
#47	CSP		Bioversity International	Marius Ekue	m.ekue@cgiar.org	Seed supply systems for the implementation of landscape restoration under AFR100: An analysis of national seed systems in 10 SAFORGEN countries
#48	CSP	PIM	IWMI	Diana Suhardiman		Land governance reform and state transformation processes in Myanmar
#49	O		CIFOR	Manuel R. Guariguata		Essential CIFOR past (and some recent) work on reforestation and rehabilitation
#50	O		CIFOR	Manuel R. Guariguata		Work both recently produced and ongoing
#51	T4D		ONF-I / CIRAD/ETH	Coordinators for Cirad: P. Sist and H. Dessard		FORLAND project synthetic sheet
#52	O		ICRAF	Ramni Jamnadass; Roeland Kindt; Lars Graudal	R.Jamnadass@cgiar.org; R.Kindt@cgiar.org; L.Graudal@cgiar.org	The delivery of planting material for productive forest landscape restoration to bridge production gaps and promote resilience

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List of the answers (Continued)

#	New Functional Category	CRP	CGIAR Center	Respondent	Mail	Title
#53	CSP	FTA	ICRAF	Stepha McMullin	s.mcmullin@cgiar.org	Agro-biodiversity and landscape restoration for food security and nutrition in East Africa (Ethiopia and Uganda)
#54	T4D	FTA	ICRAF	Roeland Kindt	R.Kindt@cgiar.org	Vegetation map for Africa including species selection tools
#55	ACF	FTA	ICRAF	Alice Muchugi	A.Muchugi@cgiar.org	The delivery of planting material for productive forest landscape restoration to bridge production gaps and promote resilience within the framework of FTA FP1 and the Genebank Platform
#56	CSP	WLE	IWMI	Wolde Mekuria	w.bori@cgiar.org	Restoration of degraded landscapes following exclosure establishment in communal grazing lands
#57	CSP	WLE	CIAT			Creating climate-smart multifunctional landscapes through integrated soil, land and water management at different scales
#58	CSP	WLE	CIAT	Fred Kizito		Biophysical and socio-economic synthesis of the effectiveness of land restoration towards enhancing food security and livelihoods in smallholder communities
#59	CSP	WLE	ICRAF	Ermias Betemariam	e.betemariam@cgiar.org	Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) Programme
#60	CSP	WLE	ICRAF	Ermias Betemariam	e.betemariam@cgiar.org	Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) Programme
#61	T4D	WLE	ICRAF	Keith Shepherd	k.shepherd@cgiar.org	Africa Soil Information Service (AfSIS)
#62	T4D	WLE	CIAT	John Mutua		Methodology on bush encroachment mapping
#63	T4D	WLE	CIAT	Kristin Piikki; Mats Söderström	Kristin.piikki@slu.se	Digital soil maps for Mukuyu and Shikomoli -web applications and map books.
#64	T4D	WLE	CIAT			Landscape Doctor
#65	T4D	WLE	CIAT	Kristin Piikki; Mats Söderström	Kristin.piikki@slu.se	Package 'mapsRinteractive'
#66	T4D	WLE	CIAT	Rolf Sommer		The CIAT SOC App
#67	T4D	WLE	CIAT	Kristin Piikki; Mats Söderström	Kristin.piikki@slu.se	R package: 'SurfaceTortoise'

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List of the answers (Continued)

#	New Functional Category	CRP	CGIAR Center	Respondent	Mail	Title
#68	T4D	WLE	ICRAF	Keith Shepherd	k.shepherd@cgiar.org	Decision Analysis
#69	CSP	WLE	IWMI	Zenebe Adimassu	z.adimassu@cgiar.org	Highlights of watershed soil and water conservation investments of Ethiopia: impacts, benefits and needs for environment and development
#70	CSP	CCAFS	CIAT			Climate smart villages (CSV)
#71	ACF	WLE	CIAT	Ravic Nijbroek		Scientist
#72	T4D	PIM/WLE	IFPRI	Ephraim Nkonya	e.nkonya@cgiar.org	Global Economic Assessment of Land Degradation and Improvement
#73	CSP		ICRAF	Susan Chomba	s.chomba@cgiar.org	Reversing Land Degradation in Africa by Scaling-up Evergreen Agriculture
#74	CSP	FTA	ICRAF	La Nguyen	l.nguyen@cgiar.org	Developing and Promoting Market-based Agroforestry and Forest rehabilitation Options for Northwest Viet Nam - AFLi2 project
#75	T4D	FTA	ICRAF	Nguyen Mai Phuong		The Land Degradation Surveillance Framework (LDSF) in Son La province, Vietnam
#76	CSP	FTA	ICRAF	Leigh Winowiecki	L.A.Winowiecki@cgiar.org F.Sinclair@cgiar.org	Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale
#77	T4D	FTA	ICRAF	Leigh Ann Winowiecki; Tor-Gunnar Vågen	L.A.Winowiecki@cgiar.org; T.Vagen@cgiar.org	Land Degradation Surveillance Framework (LDSF)

#1

Restoration project case study: Restoration of Mt. Aigoual, Cevennes National Park, France 1850-1913

Name of respondent and e-mail: Dr. D. Andrew Wardell, a.wardell@cgiar.org
Center: CIFOR
CRP/Flagship (if relevant): FTA, Interim FP 3 Coordinator

Title: Restoration of Mt. Aigoual, Massif Central, France
Starting year: 1850s, notably after 1865
Ending year: 1913 (third RTM law adopted 16 August 1913)
Place: Mt. Aigoual, Cevennes mountains, France

Scale:
Landscape: Mt Aigoual, Cevennes National Park. This granite and schist outcrop is a major water catchment area in the Massif Central, located where clouds from the cold Atlantic converge with warm Mediterranean air currents. The heavy rainfall has given the mountain its name: originally "*Aiqualis*" ('the watery one'). In an average year rainfall can measure up to 2250 mm, making it the wettest place in France. Mont Aigoual forms part of the watershed between the Mediterranean and Atlantic. The meteorological observatory was built in 1887 by the French Rivers Authority and Forestry Commission under the direction of forester George Fabre. It is currently occupied by the French meteorological service (*Météo France*) and is the last remaining weather station still inhabited by meteorologists.

Driver of degradation addressed/reversed: First law on Restauration des Terrains de Montagnes (RTM) adopted in July 1860. Small-scale reforestation of ca. 2.700 ha and a reforestation manual developed by foresters such as Pessard after 1865. Large-scale deforestation and land degradation emerged by the 1870s due to extensive overgrazing (sheep), charcoal production for glass-making and blacksmithing and firewood collection to sustain the European silk industry during the cold winter months. Siltation of the port in Bordeaux led to a federal decision to commit additional resources to support the implementation of a second Law on RTM promulgated in 1882.

Stage of the forest transition curve: Sandy Mather's forest transition curve ideas were developed based on data spanning 150 years from Mt. Aigoual, Cevennes, France - a formerly degraded, now forested landscape managed as both protection and production forests. Large areas of abandoned chestnut terraces. Small wood-processing industry in Le Vigan.

Entry point:
Biophysical (soil, vegetation): Loss of soil and siltation of the port in Bordeaux associated with storms and torrential rain in the Massif Central.
Economics, livelihoods: Loss of rural livelihoods due to the agrarian crisis in the Cevennes after the 1870s that led to massive out-migration, sale of abandoned agricultural land and reforestation with (Austrian) black pine
Governance, institutions: Opportunistic behaviour by the Eaux et Forets Department to acquire abandoned agricultural land to "create" opportunities for rural employment through reforestation of the abandoned land using the second albeit more restrictive law on RTM adopted in 1882

Short description of the project
The Mt. Aigoual massif forms part of the (now) Cevennes National Park. By the 1870s large-scale out-migration by smallholders who were unable to sustain their livelihoods, enabled the Forestry Department to acquire the abandoned agricultural land to reforest 16.000 ha of land around Mt. Aigoual. Two individuals – forester George Fabre and botanist Charles Flahault from Montpellier University played key and, at times, opportunistic roles in this process. George Fabre studied at the Ecole Nationale Forestiere in Nancy (1866-1868) and worked with Eaux et Forets in Dijon, Mende and Ales. He was Director of Reforestation in the Gard until 1900 and Conservateur in Nimes until his retirement in 1909 by which time Eaux et Forets had 'disowned' him. Flahault was Professor at the Faculty of Sciences after 1883 and founded the Institut de Botanique de Montpellier in 1890. Fabre and Flauhault established the Arboretum de l'Hort de Dieu beside the Observatory.

Results
Impacts: positive, failure, unexpected impacts

16.000 ha of abandoned agricultural land around Mt. Aigoual reforested with *Pinus nigra.* Restrictions – introduced by Eaux et Forets - on the collection and use of deadwood by local communities may have resulted in an increase in the incidence of damaging late fires.

What helped?
The perceived threat of serious economic losses associated with the siltation of the port in Bordeaux (then France's third major port), led to additional political and financial support for the second RTM law. Two individuals of environmental calculation (cf. Latour's *Science in Action*) – a forester and a botanist – also played critical roles in supporting the establishment of a meteorological station, an arboretum and in acquiring abandoned agricultural land for reforestation after 1887 although earlier reforestation efforts had started after 1865.

Main constraints? Socio-economic opportunities in the Cevennes remain limited. Tourism now provides seasonal employment. Large areas of abandoned terraced chestnut plantations but contemporary opposition to road-based transport from environmental groups limits supplying some pulp and paper mills in France which import raw materials from i.a. Venezuela.

Evidence of impact: Reforestation bolstered by establishment of a key meteorological observatory and an arboretum both of which are now recognized tourist attractions bringing more than 150,000 visitors per year. Replanting with a monospecific species restored the degraded land and has enabled the Forestry Department to combine both protection and production functions in a critical watershed.

References:

1. Andréassian, V., 2002. *Impact de l'évolution du couvert forestier sur le comportement hydrologique des bassins versants* *[archive]* ; Université Paris VI, 2002. — 276 p. + annexes (thèse de doctorat en hydrologie, soutenue le 24 septembre 2002).
2. Brochot S., 2001. *L'administration forestière se mettait en scène : les premières archives photographiques (1885-1914) de la restauration des terrains de montagne* *[archive]*. DEA Science politique. Université Pierre Mendès-France, Grenoble, 2001
3. Brugnot, G. and Cassayre, Y., 2002: *De la politique française de restauration des terrains en montagne à la prévention des risques naturels* *[archive]*, Actes du colloque Les pouvoirs publics face aux risques naturels dans l'histoire, Grenoble, March 2001, La MSH Alpes, 11 p.
4. Crécy L.de., 1988. « L'histoire de la RTM. Quelques réflexions d'un praticien », *Revue géographique des Pyrénées et du Sud-Ouest*, T 59
5. Flaugere, A., 1950. Le Massif de l'Aigoual. Revue de la Chambre de Commerce de Nimes, Le Vigan et Uzes.
6. Kalaora, B., and Savoye A., 1985. *La restauration des terrains de montagne de 1882 à 1913, l'Aigoual et sa légende*. Protection de la Nature, Histoire et idéologie, de la nature à l'environnement, Éditions l'Harmattan.
7. Nougarede, O. Pouparder, D. and Laurene, R., 1988. Le reboisement de RTM de l'Aioual en Cevennes : épopée dissidente ou expérience d'avant-garde ? *Revue Géographique des Pyrénées et du Sud-Ouest* Tome 59, Fasc. 1 : 111-124
8. Office National des Forêts, 1990. *Restauration des terrains en montagne dans les Pyrénées.* ONF, Service Restauration des Terrains en montagne, 14 p.
9. Wardell, D.A., 2015. The restoration of Mont Aigoual in the Cevennes National Park. Notes prepared for the CIFOR Board Meeting field visit, October 2015.

#2

Restoration case study: The Anglo-French Forestry Commission 1936-37 and Stebbing's "two green walls", West Africa

Name of respondent and e-mail: Dr. D. Andrew Wardell, a.wardell@cgiar.org
Center: CIFOR
CRP/Flagship: FTA, Interim FP 3 Coordinator

Title: Stebbing's "two green walls" to stop the encroachment of the Sahara

Starting year: late 1890s – Concerns about the process of 'savannization' of forests in West Africa was driven by the centuries-old 'dessication discourse' and the Dust Bowl experience in USA. This led to the establishment of the Anglo-French Forestry Commission in December 1936 to collect the evidence from northern Nigeria and Niger, and propose responses. It was led by Emeritus Professor Stebbing, University of Edinburgh who was the former Director-General of the all-India Forestry Department (1900-1920).
Ending year: 1937
Place: West Africa

Scale:
Landscape: West Africa's Sudano-Sahelian belt in Niger and northern Nigeria

Driver of degradation addressed/reversed: Perceptions of 'native' mismanagement of the land and natural resources due to Stebbing's 3 evils, viz., overgrazing, indiscriminate wood cutting and the use of fire as a customary land management tool. Ex-President Thomas Sankara issued a similar "Trois Luttes" in 1985 as a post-independence repetition of colonial perceptions

Stage of the forest transition curve: Agroforestry - Distinctive West African parklands - producing dryland cereals inc. sorghum, millets, groundnuts etc with economically important species of trees retained on farmer's fields (inc. Vitellaria paradoxa, Parkia spp, Lannea spp and Faidherbia albida) - constitute some of the most stable landscapes in sub-Saharan Africa

Entry point:
Biophysical (soil, vegetation) – Popular perceptions of land degradation and the influence of changes in vegetative cover on hydrological cycles – the so-called 'deforestation-dessication discourse' were discussed for more than four centuries amongst scientists (Grove, 1994). These re-appeared during the (European) colonial period – at a time when forestry science became a 'science of empire' – given the perception that West African forests were being converted into savannas (Jones, 1938; Aubreville,1949; Aubreville, 1962; Fairhead and Leach, 2000; Wardell, 2018). The Anglo-French Forestry Commission was an attempt to gather evidence about the processes of savannization and to propose solutions to address the 'problem'.

Economics, livelihoods – Little effort was made to understand the role of dryland forests in sustaining local livelihoods amongst different user groups including. sedentary farmers, herders, hunters etc.

Governance, institutions – No attempt was made to try and understand customary land and tree tenure arrangements in the countries visited by Anglo-French Forestry Commission.

Short description of the project: Stebbing's proposal was to establish "two green walls" (Rasmussen et al, 2003) to prevent the perceived spread of the Sahara Desert (cf. Stebbing's book - *The Forests of West Africa and the Sahara. A Study of Modern Conditions* published in 1937 - predicted that Kano in northern Nigeria would be under the Sahara by the 1980s). His plans were cut-short with the outbreak of the second World War in 1939. The Forestry Department in the Gold Coast Colony was transformed into a timber production company for the UK and its allies until 1945.

Contrary to Stebbing's assertions of increasing 'desertification', the Anglo-French Forestry Commission concluded, "It seems that dry and wet periods, of short and variable duration, follow each other. They do not demonstrate any tendency towards a permanent change in climate. The vegetation follows this rhythm, with regeneration taking place readily in the wetter years but with greater difficulty in dry years". The Commission failed to record any large-scale sand movement, ancient dunes were anchored by grass and woody vegetation and no agricultural land was threatened by sand. Some authors considered Stebbing's notion of the "encroachment of the Sahara" to be inappropriate (Jones, 1938).

Results: The "two green wall" project was abandoned due to the outbreak of WWII in 1939, the same year that the Belgian colonial administration started the largest single European investment in agricultural/natural resources research in sub-Saharan Africa at the Yangambi station on the Congo River in Congo-Belge.

Impacts: positive, failure, unexpected impacts: The colonial efforts to stop the advance of the Sahara failed but spawned a post-independence equivalent – the so-called Great Green Green Wall (GGW) project. A coalition of organizations have reportedly mobilized more than US$100 million to restore degraded lands across a 15 km wide belt stretching across North, West and the Horn of Africa. Claims that the GGW initiative can be attributed to the travels across the Sahara by a Baha'i's traveller in 1952 (Richard St. Barbe Baker, the so-called 'Man of the Trees', and author of *Sahara Challenge* (1954) and *Sahara Conquest* (1966) and his plans for a 50 km wide "green frontier") have little basis in longer-term historical evidence.

What did it help? The Anglo-French Forestry Commission drew attention to the perceived problem of 'savannization', now more commonly referred to as 'desertification', notably after the creation of the United Nations Sudano-Sahelian Office after the 1977 Nairobi conference. The contemporary Great Green Wall, or Great Green Wall of the Sahara and the Sahel Initiative (French: *Grande Muraille Verte pour le Sahara et le Sahel)* is a flagship initiative to combat the effects of climate change and desertification that is led by the African Union. It aims to transform the lives of millions of people by creating a great mosaic of green and productive landscapes across North Africa, the Sahel and the Horn of Africa. From the initial idea of a line of trees from east to west through the African desert, the vision of a Great Green Wall has evolved into that of a mosaic of interventions addressing the challenges facing the people in the Sahel and the Sahara. As a programming tool for rural development the overarching goal of this sub-regional partnership is to strengthen the resilience of the region's people and natural systems with sound ecosystem management, the protection of rural heritage, and the improvement of the living conditions of the local population.

Main constraints? Simplistic solutions to land degradation – plant trees to stop the process of 'savannization' (or 'desertification') were unlikely to have succeeded even if implemented. Tenure rights to land were ignored in the colonial era (Pogucki's four-volume tenure study commissioned by the Protectorate of the Northern Territories of the Gold Coast Colony emerged after the Anglo-French Forestry Commission in the mid-1950s. This was driven, however, by the interests associated with post-WWII Colonial Welfare and Development Act grants. These were to be used i.a. to produce vegetable oils that ultimately led – as was the case in Tanzania – to a disastrous investment in the Gonja Development Corporation in northern Ghana (Grischow et al, 2017).

Great Green Wall of the Sahara and the Sahel Initiative
Governance, institutions – No attempt was made to try and understand customary land and tree tenure arrangements in the four countries visited by Anglo-French Forestry Commission.

The idea for the 'Great Green Wall' re-emerged in 2002, at the special summit in N'Djamena (Chad) on the occasion of the World Day to Combat Desertfication and Drought. It was approved by the Conference of Leaders and Heads of States members of the Community of Sahel-Saharan States during their 7th ordinary session held in Ouagadougou, Burkina Faso on 1-2 June 2005. The Great Green Wall concept has developed considerably beyond simply planting a band of trees since 2005. Lessons learned from the Algerian Green Dam and the Green Wall of China led to understand the need of an integrated multi-sectorial approach for sustainable results. In 2007, during the eighth ordinary session of the Conference of Heads of State and Governments held on January 29 and 30, 2007 in Addis-Ababa (Ethiopia), African Heads of State and Government endorsed the Great Green Wall for the Sahara and the Sahel Initiative with the objective of tackling the detrimental social, economic and environmental impacts of land degradation and desertification in the region.

Eleven Sahelo-Saharan states (Burkina Faso, Djibouti, Eritrea, Ethiopia, Mali, Mauritania, Niger, Nigeria, Senegal, Sudan and Chad) created the Panafrican Agency of the Great Green Wall (PAGGW). This then led to the development of a Harmonized regional strategy for implementation of the Great Green Wall Initiative of the Sahara and the Sahel that was adopted in September 2012 by the African Ministerial Conference on Environment (AMCEN). In 2014, the EU and FAO, in collaboration with African and other regional partners, launched the *Action Against Desertification* program to build on the GGWSSI. The Drylands Monitoring Week (January 2015) aimed to assess the state of drylands measurement and to initiate collaboration toward large-scale, comprehensive monitoring.

Some localized progress has been made including planning (including choices of vegetation and work with local populations in several countries) and planting/land restoration including in Ethiopia, Senegal, Nigeria, and Sudan.

Evidence of impact:
A rigorous historical analysis helps to reverse popular myths about the more recent roles of ‘individuals (and centres) of environmental calculation’ (drawing on the work of French sociologist Bruno Latour and his seminal book *Science in Action*), and the continued importance of discourses to such centres (or individuals). Centres of ‘desertification’ calculation can be observed at a variety of scales, from the individual to supranational regions for more than a century, and have contributed significantly to the construction and dissemination of scientific, geographical and other forms of knowledge with reference to the ‘desertification’ debate. They play a fundamental role in perpetuating simplistic ideas for political action by groups of actors each with their own vested interests even in the face of contradictory evidence (see, for example, Olsson et al, 2015). Speculation about the climatology of droughts in West Africa is unresolved, as is speculation about the effects of land clearance on rainfall and about land degradation in the Sudano-Sahelian region. Recent findings suggest a consistent trend of increasing vegetation greenness in much of the region. Increasing rainfall over the last few years is certainly one reason, but does not fully explain the change. Other factors, such as land use change migration, may also have contributed.

The repetition of a standard response to quintessential environmental change in the Sahel may also be suggestive of the “poverty of policy options” to address the complexity of land degradation in drylands.

Selected references

1. Anglo-French Forestry Commission, 1973. Rapport de la mission forestière Anglo-Francaise Nigeria-Niger (décembre 1936 – février 1937) *Bois et Forêts des Tropiques* 148: 3-26.
2. Aubréville, A., 1949. *Climats, forêts et désertification de l’Afrique Tropicale*. Société d’Editions Géographiques, Maritimes et Coloniales, Paris. 345 p.
3. Aubréville, A., 1962. ‘Savanisation tropicale et glaciation quaternaire’. *Adansonia* II (1): 233-237.
4. Fairhead, J. and Leach, M., 2000. Dessication and domination: science and struggles over environment and development in colonial Guinea. *Journal of African History* 41: 35-54.
5. Grischow, J.D., Wardell, D.A. and Weiss, H., 2017. ‘Moving the people to save the soil?
6. The Gonja Development Corporation groundnut failure, Protectorate of the Northern Territories
7. of Gold Coast Colony 1947-1957’ Paper presented at the IASC Conference, Utrecht 14 July 2017.
8. Grove, R.H., 1994. A historical review of early institutional and conservationist responses of fears of artificially-induced global climate change: the deforestation-dessication discourse, 1500-1860. *Chemosphere* 29: 1001-1013.
9. Jones, B., 1938. Dessication and the West African colonies. *Geographical Journal* XCI, 401-423.
10. Olsson, L. Eklundh, L. and Ardo, J., 2015. A recent greening of the Sahel – trends, patterns and potential causes. J. Arid Environments Vol. 63, Issue 3: 556-566
11. Pogucki, R.J.H., 1950-51. *Report on land tenure in native customary law of the Protectorate of the Northern Territories of the Gold Coast*. Parts I (1950) and Part II (1951). Accra: Lands Department.
12. Rasmussen, K., Wardell, D.A., Reenberg, A. and Nielsen, T.T., 2003. ‘Ørkenspredning: Lokale processer og global fortælling’. In: Agergaard, J. and Winther, L. (red.) *Geografiernes globalisering – geografi om globalisering*. Akademisk Forlag, Københavns Universitet: 238-260
13. Stebbing, E.P., 1916. Forestry and the war. *Journal of the Society of Arts* 44 (1916): 350-360.

14. Stebbing, E.P., 1935. The Encroaching Sahara. *Geographical Journal* 85: 506-524.
15. Stebbing, E.P., 1937. *The Forests of West Africa and the Sahara. A Study of Modern Conditions*. Chambers: London and Edinburgh.
16. Stebbing, E.P., 1938. The Man-Made Desert in Africa: Erosion and Drought. *Journal of the Royal African Society*: 3-40.
17. Wardell, D.A., Reenberg, A. and Tøttrup, C., 2003. Historical footprints in contemporary land use systems: forest cover changes in savanna woodland in the Sudano-Sahelian zone. *Global Environmental Change* 13 (4): 234-254.
18. Wardell, D.A., 2018. 'Groundnuts and headwaters protection reserves. Tensions in colonial forest policy and practice in northern Ghana'. In: Grove, R. and Damodaran, V. (eds.) *Nature and the British Empire,* Centre for World Environmental History, University of Sussex (in press)
19. See also http://www.fao.org/in-action/action-against-desertification/resources/background-documents/en/

#3

Restoration project case study: Sand dune fixation, Senegalese coast 1908-1988

Name of respondent and e-mail: Dr. D. Andrew Wardell, a.wardell@cgiar.org
Center: CIFOR
CRP/Flagship: FTA, Interim FP 3 Coordinator

Title: Sand dune fixation, Senegalese coast
Starting year: 1908
Ending year: 1990s
Place: a 250 m wide band planted with *Casuarina equisetifolia* along 185 km of the Senegalese coast between Dakar and St. Louis.

Scale: Coastal landscape

Driver of degradation addressed/reversed: Sand dunes advancing at 13 m/year (Grainger, 1990) and threatening customary vegetable production systems in the coastal 'niayes'.

Stage of the forest transition curve: Not relevant as a littoral landscape distinguished by an inland depression where local farmers able to intensively produce irrigated vegetables for urban markets. 9,000 people scattered across 16 large villages affected by sand dune encroachment and potentially limiting production on their 'niayes', as well as disruption of road access to markets.

Entry point:
Biophysical (soil, vegetation) – Coastal sand dune fixation
Economics, livelihoods – Risk of loss of livelihoods due to sand dunes rendering the 'niayes' unproductive.
Governance, institutions – Limited early attention given to governance although later projects did encourage more engagement with local communities by planting individual and collective woodlots and windbreaks.

Short description of the project:
Efforts to address sand dune encroachment were initiated in 1908 during the colonial period (GGAOF). *Casuarina equisetifolia* was introduced in 1925 and early efforts at scale along part of the Senegalese coast were undertaken between 1948-1959. The Forestry Service with support from IFAD continued this and planted 700 ha between 1959-1973. After 1975 three projects funded by CIDA, USAID and UNSO (Sweden) planted 9.600 ha along 185 km of the coastline between Dakar and St. Louis using primarily *Casuarina equisetifolia* with trees protected on the seaward side by woven brushwood panels made of Gueira senegalensis anchored with sticks of *Euphorbia balsamifera*. This stabilized sand dune encroachment and enabled farmers to continue to produce vegetables on their 'niayes'. Additional inland (ca. 3 km) windbreaks were also planted.

Results
Impacts: positive, failure, unexpected impacts (positive or negative)
250 m wide belt of *Casuarina equisetifolia* successfully planted to protect the 'niayes', and some access routes over a period of 30+ years. Limited engagement with local population during the early years.

What has helped?
Large and continuous grants provided by the international community over a long period and a competent Forestry Service enabled a technocentric approach to succeed in stabilizing sand dune encroachment in Senegal. These projects were finalized before the decentralization reforms were completed and hence, it remains unclear who or what structure has responsibility for the management of the planted belt.
Once dunes have been fixed using e.g. *Casuarina equisetifolia*, they need to be fixed permanently by establishing perennial tree or shrub cover. There is no longer the risk of these being destroyed by moving sands, that might otherwise have exposed plant roots or damaged their aerial parts through abrasion. Usable woody species should be drought resistant, need few nutrients, withstand wide variations in temperature (night/day), and resist very strong winds. Such species include the North African Calligonum (shrubs), *Hedysarum argentatum, Lycium vitricalum, Nitraria retusa*, *Polygonum*

equisetiforme, Zygophyllum album, and others such as Callotropis, Balanites, Prosopis, Tamarix, Casuarina, Australian acacias, some eucalypts, etc.

Main constraints?
Limited government funding and little engagement by the local population may restrict longer-term efforts to maintain the coastal belt to prevent future sand dune encroachment. Risks that sand dunes remain active even 15 years after stabilization (see Ba et al, 2004).

Evidence of impact:
250 m wide belt of *Casuarina equisetifolia* successfully planted to protect the 'niayes'. A total of 10.300 ha restored over a period of 30+ years An additional 1.000 ha of inland dunes protected and/or to act as wind breaks were planted with *Acacia holosericea* and *Eucalyptus camaldulensis*

Lessons learned (USAID, 2014)
In terms of USAID's own review of lessons learned and refining the vision for integrated natural resource management programming, eleven key lessons emerged after 30 years viz.,

1. Integrate agriculture and NRM
2. Give more attention to the role of trees and forests in sustainable landscape management
3. Increase attention to climate change and resilience
4. Incorporate wildlife, livestock and rangeland management
5. Revise outlook on fuelwood and energy
6. Support decentralization reforms
7. Support continued forest policy reform
8. Revisit forest management planning
9. Move away from donor dependency
10. Improve monitoring and evaluation
11. Maintain the triple bottom line

References

1. Ba, R., Uyovbisere, E.O. and Momodu, A.B., 2004. Impact of sand duen stabilization structures on soil and yield of millet in the semi-arid region of NW Nigeria. *Environmental Monitoring Assessment* 99 (1-3): 181-196
2. Dia, A., 200 . La fixation des dunes au Senegal. In : Diaw, A.T. (Ed.) Gestions des ressources cotieres et littorales du Senegal: actes de l'atelier : 201-210.
3. FAO, 1985. *Sand dune stabilization, shelterbelts and afforestation in dry zones*. FAO Conservation Guide # 10. FAO, Rome
4. Grainger, A., (1990) 2009, *The Threatening Desert: Controlling Desertification*. IIED (1990) and Earthscan, London.
5. USAID, 2014. *Synergies of Nature, Wealth and Power. Lessons from USAID Natural Resource Management Investments in Senegal*. USAID, Washington June 2014.

#4

Restoration project

Name of respondent and e-mail: Himlal Baral, Ph.D/ h.baral@cgiar.org
Center: CIFOR
CRP/Flagship (if relevant): FTA

Title: Socio economic and environmental benefits of bioenergy production on degraded land in Indonesia
Starting year: 2015
Ending year: 2020
Place: Indonesia

1a) Scale:
Plot : Demonstration trial plot of energy species
Farm
Landscape

1b) Driver of degradation addressed/reversed
Fire and haze degraded productive lands in Indonesia both mineral and peat soil types. The lands were utilized as smallholder agriculture plantation (rubber) and forest. After the fire, the lands were abandoned and smallholders were looking other alternatives to reinvest on their degraded lands

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation) (1)
Economics, livelihoods (2)
Governance, institutions (3)
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
The project aims to identify suitable species for bioenergy production on degraded land that contribute to climate change mitigation while providing a range of socio economic and environmental benefits. It is carried out in Central and East Kalimantan provinces by establishing trial plots of a number of bioenergy species. The project also conducted spatial analysis of degraded their potential for bioenergy production, and socio-economic study to understand smallholder's perception of bioenergy production on degraded land in Indonesia. The project is supported by Korea National Institute of Forest Science (NiFOS) and collaborates with local and national institutions such as University of Muhammadiyah Palangkaraya U (UMP) in Central Kalimanan and Mulawarman University (UNMUL), in East Kalimantan, and Balai Besar Penelitian Bioeteknologi dan Pemulian Tanaman Hutan (BBPPBPTH), FORDIA in Yogyakarta.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
It's too early to measure the impact of the project, however, data from the first two year trial plot in Buntoi village on degraded peatland shows that nyamplung has the highest (above 95%) survival rate and good growth performance compared to three other energy species: *Caliandra calotyirsus* (kaliandra), *Glirisedia sepium* (gamal) and *Reutalis trisperma* (kemiri sunan). This indicates that nyamplung is adaptable to water logged and high salinity which could be considered for peatland restoration. Based on this result, nyamplung is scaled up being planted on wider trial plots on degraded peatland and mineral soil in Central and East Kalimantan, respectively. The new plots also shows good survival and growth but data hasn't been analyzed as they are established in beginning of 2018.

The project has attracted other institutions both private government sectors as well as smallholders. Through this project, CIFOR established partnerships with two bioenergy companies to conduct assessment of potential bioenergy production on degraded land in Sumatera island. In addition, one large corporation is interested to to collaborate with CIFOR for offsetting their industrial CO_2 emission through tree planting in South Sumatera's degraded land.

What has helped?
Bringing the idea about the project to wider audiences through CIFOR website, CIFOR publication, national and international workshops and conferences, personal communication, partner outreach activities

Main constraints?

- Partnership process with government institution took very long time due to their bureaucratic processes which is affected to the project implementation.

Evidence of impact

- Several organisations expressed their interest to collaborate with CIFOR and partnerships are underway such as – Clean power Indonesia, Akuo Energy, Indorama corporation

4) References

No	Title	Link	Type	Date
1	Socio-economic and environmental benefits of bioenergy production in degraded land in Indonesia	https://www.cifor.org/peatlands/socio-economic-and-environmental-benefits-of-bioenergy-production-in-degraded-land-in-indonesia/	Project info	
2	Sustainable bioenergy systems to restore ad valorize degraded land	https://www.cifor.org/library/6062/sustainable-bioenergy-systems-to-restore-and-valorize-degraded-land/	CIFOR Brief	
3	Exploring the potential of bioenergy in Indonesia for multiple benefits	https://www.cifor.org/library/6617/exploring-the-potential-of-bioenergy-in-indonesia-for-multiple-benefits	CIFOR Brief	
4	Sustainable forest management for land rehabilitation and provision of biomass-energy	https://www.cifor.org/library/6384/sustainable-forest-management-for-land-rehabilitation-and-provision-of-biomass-energy/	CIFOR Brief	
5	Bioenergy in Indonesia: Exploring science for policy at an international workshop at CIFOR	https://forestsnews.cifor.org/48299/bioenergy-in-indonesia?fnl=en	Event coverage	21 February 2017
6	Forests and energy; What's the connection?	https://forestsnews.cifor.org/48995/forests-and-energy-whats-the-connection?fnl=en	Forest News	
7	The power of peatlands : Sustainable bioenergy from tropical peat forests	https://forestsnews.cifor.org/49684/the-power-of-peatlands?fnl=	Forest News	
8		https://forestsnews.cifor.org/49846/kekuatan-lahan-gambut?fnl=	Forest News-Bahasa Indonesia	
9	Growing new energy	https://forestsnews.cifor.org/45603/growing-new-energy?fnl=en	Forest News	
10	CIFOR talks landscape restoration and bioenergy at Indonesia's House of Regional Representatives	https://www.cifor.org/corporate-news/cifor-talks-landscape-restoration-and-bioenergy-at-indonesias-house-of-regional-representatives/	Forest News	
12	Bioenergy to restore Indonesia's peatlands?	https://www.cifor.org/corporate-news/workshop-bioenergy-to-restore-indonesias-peatlands/	Corporate News	4 Dec 2017
13	Spatial assessment of degraded lands for biofuel production in Indonesia	E. Wiraguna; W.Jaung; B.Leksono; C.S.Goh; Y.Artati; B. Okarda; L.B. Prasetyo; R. Syahru; S.M.Lee and H. Baral	Journal article	Submitted to *Land Use Policy*

14	Landowner perception of biofuwl production on degraded land in Central Kalimantan	Y.Artati; W.Jaung; K. Juniwaty; S. Andini; S.M.Lee and H. Baral	Journal article	In review, ready for submission to *Renewable and Sustainable Energy Review*
15	Combining bioenergy production and soil rehabilitation in Indonesia: A review of potential species and energy yields	N. Borchard; M. Buusu; A. Hartwig; S. Abel; M. Ulrich; S.M. Lee; J. Zeitz and H. Baral	Journal article	In review
16	Integrating bioenergy and food production on degraded landscapes in Indonesia for improved socio-economic and environmental outcomes	S.A.Rahman;H. Baral; R. Sharma; Y.B. Samsusin; M. Meyer; M. Lo; Y. Artati; T.I. Simamora; S. Andini; B. Leksono; J. Rooshetko; S. M. Lee and T. Sunderland	Journal article	In review
	Online newspaper			
17	Antara Sumatera Selatan. 26 Oktober 2017. Prediksi krisis energi sebuah ancaman atau tantangan. Accessed 19 January 2018.	https://sumsel.antaranews.com/berita/321832/prediksi-krisis-energi-sebuah-ancaman-atau-tantangan		
18	Antara Sumatera Selatan. 6 May 2017. Peneliti: Sumsel kaya potensi bioenergi. Accessed 19 January 2018.	https://sumsel.antaranews.com/berita/315188/peneliti-sumsel-kaya-potensi-bioenergi		
19	Republika. 5 May 2017. Sumsel kaya potensi bioenergi. Accessed 19 January 2018.	http://nasional.republika.co.id/berita/nasional/daerah/17/05/05/oph343284-sumsel-kaya-potensi-bioenergi		

#5

Restoration project:

Name of respondent and e-mail: Habtemariam Kassa, h.kassa@cgiar.org
Center: CIFOR
CRP/Flagship (if relevant): The study was conducted as a CIFOR Ethiopia Office project

Title: Identifying good practices in forest landscape restoration and enabling conditions for scaling up
Starting year: 2014
Ending year: 2015
Place: Ethiopia

1a) Scale:
Plot
Farm
Landscape –
National level (undertaken in five regional states focusing on participatory forest management in Oromia Region, Area exclosure (in Tigray Region), smallholder plantations (in Amhara Region), agroforestry systems (in Southern Region), and management of forest in dryland areas (in Benishnagulgumuz Region)

1b) Driver of degradation addressed/reversed
The project was not meant to reverse drivers of degradation but to identify good practices in restoration of degraded forests and forestlands and identifying enabling conditions for scaling up.

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry

The study covered all the different stages in the forest transition curve – from natural forests to smallholder plantations on agricultural lands.

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

We looked at the process and outcomes of restoration initiatives. For different landscapes different weights were given to biophysical and livelihood outcomes. We also assessed the sustainability of community engagement in restoration initiatives.

2) short description of the project (2-5 lines)
The project was designed to identify effective forest management practices (from degrading natural forests to plantation of woodlots on degraded agricultural landscapes), areas that require improvement and enabling conditions for scaling up these selected practices.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact
We concluded that largely community members and experts at local level were happy with the conservation outcomes (in terms of reducing erosion and deforestation). But productivity of landscapes restored and economic returns to land managers were found to be much lower than the expectation of communities. Also, uncertainties in terms of tenure security were also identified as major challenges that need to be addressed.

4) References

Kassa et al. 2015. Enhancing the role of the forestry sector in building climate resilient green economy: strategy for scaling up effective forest management practices

#6

Restoration project

Name of respondent and e-mail: Daniel Murdiyarso (d.murdiyarso@cgiar.org)
Center: CIFOR
CRP/Flagship (if relevant):

Title: Sustainable Wetland Adaptation and Mitigation Program (SWAMP)
Starting year: 2011
Ending year: 2018
Place: Global

1a) Scale:
Plot
Farm
✓ Landscape

1b) Driver of degradation addressed/reversed

1c) Stage of the forest transition curve
✓ Forested landscape
Agriculture
Agroforestry

1d) Entry point:
✓ Biophysical (soil, vegetation)
Economics, livelihoods
✓ Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
Assess Carbon stocks, rate of GHG fluxes, rate of sedimentation and rate of subsidence in mangrove and peatland ecosystems across the tropics. In the first 4 years the efforts was dedicated to get background information from relatively intact ecosystems. In year 5 and 6, the assessments were carried out in degraded ecosystem to estimate restoration efforts needed

3) results
Impacts?: positive, failure, unexpected impacts (positive or negative)
What has helped?: Emission factors generated from research
Main constraints?: Access to the sites and collaborators availability
Evidence of impact?: Adoption of methods and numbers generated to develop Reference Level

4) References

1. Basuki I, Kauffman JB, Peterson J, Anshari G, Murdiyarso D. 2018. Land cover changes reduce net primary production in tropical coastal peatlands of West Kalimantan, Indonesia. Mitig Adapt Strateg Glob Change. https://doi.org/10.1007/s11027-018-9811-2.
2. Bhomia RK, van Lent J,. Rios JM, Hergoualc'h K, Coronado ENH, Murdiyarso D. 2018. Impacts of *Mauritia flexuosa* degradation on the carbon stocks of freshwater peatlands in the Pastaza-Marañón river basin of the Peruvian Amazon. Mitig Adapt Strateg Glob Change. https://doi.org/10.1007/s11027-018-9809-9.
3. Lilleskov E, McCullough K, Hergoualc'h K, del Castillo Torres D, Chimner R, Murdiyarso D, Kolka R, Bourgeau-Chavez L, Hribljan J, del Aguila Pasquel J, Wayson C. 2018. Is Indonesian peatland loss a cautionary tale for Peru? A two-country comparison of the magnitude and causes of tropical peatland degradation. Mitig Adapt Strateg Glob Change. https://doi.org/10.1007/s11027-018-9790-3.
4. Kurnianto S, Selker J, Kauffman JB, Murdiyarso D, Peterson JT. 2018. The influence of land-cover changes on the variability of saturated hydraulic conductivity in tropical peatlands & Mitig Adapt Strateg Glob Change https://doi.org/10.1007/s11027-018-9802-3.

5. Saragi-Sasmito MF, Murdiyarso D, June T, Sasmito SD. 2018. Carbon stocks, emissions, and aboveground productivity in restored secondary tropical peat swamp forests Mitig Adapt Strateg Glob Change https://doi.org/10.1007/s11027-018-9793-0.
6. Murdiyarso D, Saragi-Sasmito MF, and Rustini A. 2017. Greenhouse gas emissions in restored secondary tropical peat swamp forests. Mitig Adapt Strateg Glob Change. https://doi.org/10.1007/s11027-017-9776-6.
7. Hergoualc'h K, Hendry DT, Murdiyarso D, Verchot LV. 2017. Total and heterotrophic soil respiration in a swamp forest and oil palm plantations on peat in Central Kalimantan, Indonesia. Biogeochemistry. DOI 10.1007/s10533-017-0363-4.
8. Warren M, Hergoualc'h K, Kauffman JB, Murdiyarso D, and Kolka R. 2017. An appraisal of Indonesia's immense peat carbon stock using national peatland maps: uncertainties and potential losses from conversion. *Carbon Balance Manage 12:12.* DOI 10.1186/s13021-017-0080-2.
9. Kauffman BJ, Arifanti VB, Trejo HH, García MCJ, Norfolk J, Cifuentes M, Hadriyanto D, and Murdiyarso D. 2017. The jumbo carbon footprint of a shrimp: carbon losses from mangrove deforestation. *Front. Ecol. Environ*.; doi:10.1002/ fee.1482.
10. Taufik M, Torfs PJJF, Uijlenhoet R, Jones PD, Murdiyarso D, and Van Lanen HAJ. 2017. Amplification of wildfire area burnt by hydrological drought in the humid tropics. *Nature Climate Change.* DOI: 10.1038/NCLIMATE3280.
11. Gumbricht T, Roman-Cuesta RM, Verchot L, Herold M, Wittmann F, Householder E, Herold N and Murdiyarso D. 2017. An expert system model for mapping tropical wetlands and peatlands reveals South America as the largest contributor. Global Change Biology. DOI: 10.1111/gcb.13689
12. Bukoski JJ, Broadhead JS, Donato DC, Murdiyarso D, Gregoire TG. 2017. The Use of Mixed Effects Models for Obtaining Low-Cost Ecosystem Carbon Stock Estimates in Mangroves of the Asia-Pacific. PLOS ONE | DOI: 10.1371/ journal.pone.0169096.
13. Parker RJ, Boesch H, Wooster MJ, Moore DP, Webb AJ, Gaveau D, and Murdiyarso D. 2016. Atmospheric CH4 and CO2 enhancements and biomass burning emission ratios derived from satellite observations of the 2015 Indonesian fire plumes. Atmos. Chem. Phys., 16, 10111–10131.
14. Huijnen V, Wooster MJ, Kaiser JW, Gaveau DLA, Flemming J, Parrington M, Inness A, Murdiyarso D, Main B, and van Weele M. 2016. Fire carbon emissions over maritime Southeast Asia in 2015 largest since 1997. Scientific Report 6:26886. DOI: 10.1038/srep26886.
15. Bhomia RK, Mackenzie RA, Murdiyarso D, Sasmito SD, Purbopuspito J. 2016. Impacts of Land Use on Indian Mangrove Forest Carbon Stocks: Implications for Conservation and Management. Ecological Application 26(5), 1396-1408 doi: 10.1890/15-2143.
16. Kolka RK, Murdiyarso D, Kauffman JB, and Birdsey RA. 2016. Tropical wetlands, climate, and land-use change: adaptation and mitigation opportunities Wetlands Ecol. Manage. DOI 10.1007/s11273-016-9487-x.
17. MacKenzie RA, Foulk PB. Klump JV, Weckerly K, Purbopuspito J, Murdiyarso D, Donato DC, Nam VN. 2016. Sedimentation and belowground carbon accumulation rates in mangrove forests that differ in diversity and land use: a tale of two mangroves. Wetlands Ecol. Manage. DOI 10.1007/s11273-016-9481-3.
18. Nam VN. Sasmito SD, Murdiyarso D, Purbopuspito J, MacKenzie RA.2016. Carbon stocks in artificially and naturally regenerated mangrove ecosystems in the Mekong Delta. Wetlands Ecol. Manage. DOI 10.1007/s11273-015-9479-2.
19. Sasmito SD, Murdiyarso D, Friess DA, Kurnianto S. 2015. Can mangroves keep pace with contemporary sea level rise? A global data review. Wetlands Ecology and Manage. DOI: 10. 1007/s11273-015-9466-7.
20. Alongi DM, Murdiyarso D, Fourqurean JW, Kauffman JB, Hutahaean A, Crooks S, Lovelock CE, Howard J, Herr D, Fortes M, Pidgeon E, Wagey T. 2015. Indonesia's blue carbon: a globally significant and vulnerable sink for seagrass and mangrove carbon. Wetlands Ecology and Manage. DOI 10.1007/s11273-015-9446-y.
21. Murdiyarso D, Purbopuspito J, Kauffman JB, Warren MW, Sasmito SD, Donato DC, Manuri S, Krisnawati H, Taberima S, Kurnianto S (2015) The potential of Indonesian mangrove forests for global change mitigation. Nature Climate Change, 5 (12), 1089-1092. DOI: 10.1038/NCLIMATE 2734.
22. Gaveau DLA, Salim MA, Hergoualc'h K, Locatelli B, Sloan S, Wooster M, Marlier ME, Molidena E, Yaen H, De Fries R, Verchot L, Murdiyarso D, Nasi R, Holmgren P, and Sheil D.

2014. Major atmospheric emissions from peat fires in Southeast Asia during non-drought years: evidence from the 2013 Sumatran fires. Scientific Reports 4 : 6112, DOI: 10.1038/srep06112.
23. Kurnianto S, Warren M, Talbot J, Kauffman B, Murdiyarso D, And Frolking S 2014. Carbon accumulation of tropical peatlands over millennia: A modeling approach. Global Change Biology (2014), doi: 10.1111/gcb.12672.
24. Murdiyarso D and Tacconi L. 2013. A hazy climate: will anyone do the right thing? The Jakarta Post, 22 June 2013.
25. Warren MW, Kauffman JB, Murdiyarso D, G. Anshari, K. Hergoualc'h, S. Kurnianto J. Purbopuspito, E. Gusmayanti, M. Afifudin, J. Rahajoe, L. Alhamd, S. Limin, and A. Iswandi. 2012. A cost-efficient method to assess carbon stocks in tropical peat soil. Biogeoscience 9:4477–4485.
26. Donato DC, Kauffman JB, Murdiyarso D, Kurnianto S, Stidham M, and Kanninen M. 2011. Mangroves among the most carbon-rich forests in the tropics. Nature Geoscience, 4:293-297. DOI: 10.1038/NGEO1123

#7

Restoration project

Name of respondent and e-mail: Steven Lawry
Center: CIFOR
CRP/Flagship (if relevant): PIM flagship 5, (The Governance of Natural Resources)

Title: Tenure security and resource governance as factors in forest landscape restoration. ("Restoring Forests, Restoring Communities")
Starting year: 2017
Ending year: 2021
Place: Global, and field research currently focused on Madagascar and Ethiopia

1a) Scale: Landscape, farm
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed: The research addresses tenure security and insecurity as factors in adoption of FLR practices

1c) Stage of the forest transition curve: Principally forested landscapes, but also agroforestry
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
(1) Governance, institutions
(2) Economics, livelihoods
(3) Biophysical (soil, vegetation)
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)

Research examines various aspects of the relationship between tenure security, resource governance arrangements at multiple levels, and the improvements in social and environmental outcomes linked to landscape-level forest restoration initiatives. In 2017, conceptual work was carried out in conjunction with GIZ and other partners. A journal article (under review) was produced, as was a CIFOR Infobrief. In 2018, field research on the topic was launched in Madagascar and Ethiopia, with PIM and GIZ support.

In addition, in 2017 CIFOR colleagues in the cross-cutting gender program organized a workshop and produced a study on gender factors in FLR adoption. The study is cited in the references section below.

3) **results.** Very early stages. Evaluation of a number of ROAM (Restoration Opportunities Assessment Methodology) assessments of restoration readiness found superficial consideration of tenure and governance factors.
Impacts: Our collaboration with GIZ has raised awareness within GIZ of tenure and governance factors in uptake of FLR practices, leading directly to funding by GIZ projects in Madagascar and Ethiopia of support for research on tenure and governance factors in program implementation.

What has helped?
Main constraints?
Evidence of impact

4) References

1. R. McLain, M. Guariguata, and S. Lawry (2017) "Implementing Forest Landscape Restoration Initiatives: Tenure, Governance, and Equity Considerations." A paper prepared for a workshop on "Accelerating Restoration of Degraded Forest Landscapes: The role of tenure security and

local forest governance in catalyzing global restoration initiatives" held in Bonn, Germany on 3 November 2017, co-sponsored by GIZ and PIM. https://www.cifor.org/wp-content/uploads/2017/11/Implementing%20FLR.pdf

2. R. McLain, S. Lawry, M. Guariguata, J. Reed, "Toward a Tenure-Responsive Restoration Opportunities Assessment Methodology for the Forest Landscape Restoration Agenda," (journal article under review by *Land Use Policy*.)
3. Forest New Blog: "Restoring forest landscapes: A question of community rights." November 2, 2017. https://forestsnews.cifor.org/52358/restoring-forest-landscapes-a-question-of-community-rights?fnl=en
4. R. McLain, S. Lawry, M. Guariguata, J. Reed (2018). "Toward a Tenure-Responsive Restoration Opportunities Assessment Methodology and FLR Agenda." CIFOR Infobrief (completed and to be published in conjunction with journal article on same topic).

2017 CIFOR work on gender issues in FLR

5. Bimbika Sijapati Basnett, Marlène Elias, Markus Ihalainen and Ana Maria Paez Valencia "Gender matters in Forest Landscape Restoration: A framework for design and evaluation" https://www.cifor.org/library/6685/gender-matters-in-forest-landscape-restoration-a-framework-for-design-and-evaluation/

#8

Restoration project

Name of respondent and e-mail: Lalisa Duguma l.duguma@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant):

Title: Large-scale Ecosystem-based Adaptation in the Gambia River Basin: Developing a climate resilient, natural resource-based economy
Starting year: 2018
Ending year: 2019 (with prospects of extension up to 2022)
Place: The Gambia

1a) Scale:
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed
Illegal logging;
Clearance of forests and savannah for agriculture;
Climate change (increasing temperature and declining moisture index in the ecosystems)

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation) 2
Economics, livelihoods 1
Governance, institutions 3
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)

The project "Large-scale Ecosystem-based Adaptation in the Gambia River Basin: developing a climate resilient, natural resource-based economy" (hereafter EbA project) is one of the large-scale ecosystem-based adaptation projects in The Gambia. With a duration of six years, it will support the growing need for the communities to adapt to the adverse effects of climate change. Most of the population of the country is poor and hence capacity for resilience is very low. To hasten the implementation of the resilience agenda, it is important to build national, regional and local capacities for the adaptation process to be effective and sustainable.

The project aims to restore about 7000 ha of forest lands and 3000 ha of agricultural areas.
3) results
Impacts: positive, failure, unexpected impacts (positive or negative) This project just started and it is expected to have positive impacts in general.
What has helped?
Main constraints?
Evidence of impact

4) References
https://www.iied.org/gcf-funding-boosts-ecosystem-based-adaptation-gambia

https://www.greenclimate.fund/-/large-scale-ecosystem-based-adaptation-in-the-gambia-river-basin-developing-a-climate-resilient-natural-resource-based-economy

#9

Restoration related project

Name of respondent and e-mail: James M Roshetko, jroshetko@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant):

Title: Agroforestry and Forestry in Sulawesi: linking knowledge with action (AgFor) project
Starting year: 2011
Ending year: 2017
Place: Sulawesi, Indonesia

1a) Scale:
Plot –with partner organization and farmers at plot scale
Farm - with partner organization and farmers at farm scale
Landscape - with local governments, technical agencies and farmers at landscape scale

1b) Driver of degradation addressed/reversed

- improved sustainable farm management through capacity building and market links;
- improved sustainable landscape and ecosystem management through participatory governance (local communities, civil society organizations, and governments)

1c) Stage of the forest transition curve
Forested landscape (some work in natural and secondary forests)
Agriculture -
Agroforestry – ***agroforestation*** (primarily here)

1d) Entry point:
Biophysical (soil, vegetation) **#3**
Economics, livelihoods **#1**
Governance, institutions **#2**
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
AgFor sought to achieve *improved equitable and sustainable agroforestry and forestry-based livelihoods' systems for rural communities in Sulawesi* through improving awareness, access and skills related to natural resources and agriculture; developing equitable participatory governance mechanisms; and integrating management of sustainable landscapes and ecosystems.

3) results

- 636,972 people (52% women) improved their income as a result of adopting AgFor-promoted technologies.
- Average annual household income increased by 14% in South Sulawesi and 18% in Southeast Sulawesi.
- 65% of non-AgFor participants in the project area reported increased incomes after adopting AgFor technologies observed or learned from neighbours.
- An additional 5135 households in provinces outside the project area increased their incomes after adopting AgFor's technologies learned during cross-visits.
- 780,273 ha were placed under improved sustainable natural resource management, including agroforestry, agricultural and forestry systems.
- Six models of participatory governance operated at 15 sites; and six environmental services' schemes operated at six sites.
- 73 communities in 10 districts benefited from vulnerability assessments, livelihoods and conservation agreements and environmental services' schemes.
- Seven district livelihoods and conservation strategies, three livelihoods and conservation agreements, and three provincial ecosystem management synergy options were developed
- 23 peer-reviewed documents, 30 working papers, 24 conference papers and 14 policy briefs were published from AgFor research findings

- A main constraint was high demand for assistance, as well as, the time required to develop livelihood-conservation agreements, models of participatory governance (community forestry agreements), and improved value-chain (marketing) arrangements

4) References

Roshetko JM, Dahlia L, Purwanto E, Moeliono M, Widayati A, Purnomosidhi P, Mahrizal, Wau D, Perdana A, Martini E, Gaol A, Paramita E, Suyanto, Khususiyah N, Dewi S, Manurung G, Yuliani L, Rohadi D, Manalu P, Umar A, Millang S. 2017 (revised February 2018). *Agroforestry and forestry in Sulawesi: linking knowledge with action (AgFor) project*. End of Project Report. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program; Center for International Forestry Research; Bau Bau, Indonesia: Operation Wallacea Trust; Makassar, Indonesia: Faculty of Forestry, Hasanuddin University.

Full list available.

#10

Restoration project

Name of respondent and e-mail: Lars Graudal, L.Graudal@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant):FTA, FP1

Title: Provision of adequate tree seed portfolios to enhance productivity and resilience of forest landscape restoration in Ethiopia (PATSPO), supported by the Norwegian International Climate and Forest Initiative (NICFI)
Starting year: 2017
Ending year: 2020/21
Place: Ethiopia

1a) Scale: All three
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed: Address a 'bottleneck', rather than a 'driver' *per se*. Planned outcome: Tree Seed Sector in Ethiopia enabled to provide high quality tree seeds of priority species for large scale restoration plantings. Planned impact: Ethiopia's national forest landscape restoration targets for the next 20 years are reached.

1c) Stage of the forest transition curve: All
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation): 3 (resilience: potential for adaptation)
Economics, livelihoods: 2 (priority species for productivity)
Governance, institutions: 1 (capacity building)
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
Intensification and diversification by providing guidance and material of what to plant where in FLR. A multiple tree species programme providing: (1) organizational set-up of the sector, (2) species specific knowledge of what to plant where, (3) buildup and establishment of the tree genetic resources for the future, and (4) capacity of the sector to monitor and deliver within the context of FLR.

3) results: Too early in the project stage to report (inception in September 2017), plans are being followed.
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

Information Note by ICRAF, Tree Productivity and Diversity Team: The delivery of planting material for productive forest landscape restoration to bridge production gaps and promote resilience, August 2018 (#52)

#11

Restoration project

Name of respondent and e-mail: Shalander Kumar and Anthony Whitbread
k.shalander@cgiar.org; a.whitbread@cgiar.org
Center: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
CRP/Flagship (if relevant): CRP Dryland Systems/ South Asia Flagship

Title: Community led solutions for sustainable land management in Western Rajasthan in India

Starting year: 2014
Ending year: 2016
Place: Jodhpur, Barmer and Jaisalmer districts of Western Arid Rajasthan, India
1a) Scale: Multiscale interventions
Plot √
Farm √
Landscape √
1b) Driver of degradation addressed/reversed
Endogenic: Unsustainable natural resource use (land and water), inherent land degradation and poor quality & shortage of water, weakening local institutions and high population density
Exogenic: Drought/high climatic variability, poor market integration, migration

1c) Stage of the forest transition curve
Forested landscape: Not so dense forest which is concentrated mostly on sacred pastures called 'oran' and few reserve forest
Agriculture: More than 80% area as rainfed system under very low rainfall 180-380 mm per annum and cropping season's maximum temperature reaches up 45^0C.
Agroforestry: The multipurpose trees are invariably the important component of the farming systems. The farming systems are essentially a park land system.

1d) Entry point:
Biophysical (soil, vegetation): Soil and water conservation and efficient use at plot, farm and landscape level; integration of drought tolerant and higher market value cultivars; community based silvo-pasture systems, quantitative and participatory methods for identification and targeting of context specific interventions
Economics, livelihoods: Farm income remains the key basis for selecting resilient interventions; creating and strengthening crop-fodder-medicinal herbs-livestock value chains
Governance, institutions: The participatory approach was facilitated by creating regional multi-stakeholder innovation platforms (IP), village development committees (VDCs) and commodity specific sub-committees for women. The members of an IP included local NARES, NGOs, private industry, CG centers and farmers. Linking industry with medicinal herb growers for buy back and quality check; bye laws governing common pastures and their social enforcement.

2) short description of the project (2-5 lines)
ICRISAT with partners applied an integrated systems approach for sustainable land management (SLM) in most venerable arid districts of western Rajasthan. We considered community participation and appropriate institutions as integral part of the strategy to restore production from degraded lands in profitable ways for farmers and pastoralists to sustainably improve their livelihoods and the capacity of land to produce in the future. The efforts have targeted private as well as common lands (in particular common pastures) and interactions between both.

3) Results
Impacts: positive
What has helped?
Critical for upscaling was the acknowledgement of heterogeneity within communities and agro-ecosystems. Household characterization was used to define homogenous typologies which helped to understand the potential, expectations and the limitations of the stakeholders and accordingly target SLM interventions. Ex-ante quantitative and participatory tools also helped in prioritizing and better targeting landscape and farm type specific potential interventions.

Innovation platforms and VDCs played a key role in building local capacity and were used for the identification of major constraints, possible solutions, their prioritization and implementation at district, village and hamlet level. The IPs and VDCs also provided feedback on SLM practices as part of the iterative process that allowed adjusting strategy, choice of interventions and outputs.

Main constraints?

- The selection and combination of SLM interventions implemented in systems context are location specific. It takes time until they show results. The multi-stakeholder platform development process is facilitation intensive and are challenges for adoption at scale.
- Community participation which key for SLM project is a most challenging unless we fully understand the social-ecological systems and market forces.
- Short term projects for SLM will have low probability of success.

Evidence of impact

The integrated resources management with focus on enhancing farm income and resilience resulted in increased millets and legume yields by 12-150% and common pastures' productivity by 2.5 to 4 times. Farm type specific integration of medicinal plants with linkage to industry for buy back led to doubling of farm income per ha from rainfed poor soils. Improved small ruminant value chains resulted in increased productivity and price realization by 25-30%. The increased income from the degraded land incentivized the farmers to make increased investment in land management.

4) References

http://www.hindustantimes.com/jaipur/ desert-farmers-on-the-path-to-economic-self-reliance/article1-1353429.aspx
http://drylandsystems.cgiar.org/content/community-led-solutions-india%E2%80%99s-drylands

#12

Restoration project: Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale.

Name of respondent and e-mail: Vincent Bado, V.Bado@cgiar.org
Center: ICRISAT
CRP/Flagship (if relevant): WLE

Title: Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale.
Starting year: 2015
Ending year: 2019
Place: Niger

1a) Scale:
Plot:
Farm: X
Landscape: X

1b) Driver of degradation addressed/reversed. Soil and desertification

1c) Stage of the forest transition curve
Forested landscape
Agriculture: X
Agroforestry: X

1d) Entry point:
Biophysical (soil, vegetation): 1
Economics, livelihoods: 2
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
The goal of the project is to reduce food insecurity and improve livelihoods of poor people living in African drylands by restoring degraded land, and returning it to effective and sustainable tree, crop and livestock production, thereby increasing land profitability and landscape and livelihood resilience. The project aims at developing good practice guidelines for restoring productive capacity of dryland and Tools, Methods and Guidelines for Scaling

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

Vincent B. Bado and A. Bationo (2018). Integrated Management of Soil Fertility and Land Resources in Sub-Saharan Africa: Involving Local Communities. Advances in Agronomy, Volume 150: 1-33. https://doi.org/10.1016/bs.agron.2018.02.001

#13

Restoration project

Name of respondent and e-mail: Kaushal K Garg; k.garg@cgiar.org
Center: ICRISAT
CRP/Flagship (if relevant): WLE

Title: Analyzing impact of various agricultural water management (AWM) interventions on watershed hydrology and various ecosystem trade-offs in Bundelkhand region of Central India

Starting year: 2011
Ending year: 2016
Place: Jhansi, Bundelkhand region, Uttar Pradesh, Central India (Yamuna sub-basin of Ganga basin)

1a) Scale:
Plot
Farm
Landscape: 1250 ha of watershed (hydrological unit) covering three villages (Parasai, Chatpur, Bachauni) in Jhansi district

1b) Driver of degradation addressed/reversed
Bundelkhand region of Central India largely suffer with high water scarcity, land degradation, poor agricultural and livestock productivity. The region receives 850 mm annual rainfall but due to high temporal variation, large amount of rainfall generate surface runoff and available moisture is lost as unproductive evaporation, resulted into poor land and water use efficiency. The soils of the region have low water holding capacity; and groundwater aquifer is characterized by poor specific yield; however groundwater is the major source of the water to meet its domestic and agriculture demands.

In this watershed, 12 low-cost water-harvesting structures nearly with 100,000 cubic meter storage capacity were constructed. Moreover, efforts were also taken towards various agro-forestry interventions (*e.g.*, teak plantation on field bunds, intercropping of crop-orcharge system, fodder grasses on field bunds, ber-budding, rejuvenation of old-fruit trees with improved grafting technique, etc.) and productivity enhancement interventions. Water harvesting interventions increased groundwater table (2-5 m) across the watershed boundary; intensified cropping intensity (from 80-100% to 150-180%); increased crop yield (by 50-80%) and household income (50-200%) in four year period. It is realized that **decentralized water harvesting** technique (rejuvenating traditional rainwater harvesting system and other rainwater harvesting interventions) is the key to address the issues of water scarcity, land degradation and can strengthen rural livelihood system which need to scaled-up to unlock the potential of the Bundelkhand region.

1c) Stage of the forest transition curve
Forested landscape
Agriculture: *Parasai-Sindh* watershed is the agriculture dominating areas with more than 90% land is under agricultural use.
Agroforestry: Low-water requiring tree-species, for example, teak which is deciduous in nature and highly suitable for the region was planted along the field bunds and also as intercropping in different crops (groundnut). Moreover, *ber*-trees (berries) those were old and poor yielding were rejuvenated by grafting techniques benefited farmers.

1d) Entry point:
Biophysical (soil, vegetation): 1
Economics, livelihoods: 3
Governance, institutions: 2
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the project (2-5 lines): This project was developed and executed by ICRISAT and consortium partner (ICAR-CAFRI, Jhansi) with the goal to develop a learning site (1250 ha covering three villages) in Jhansi district with support of the CSR funding (Coca cola India Foundation). Number of runoff harvesting structures were constructed by following ridge to valley

approach; and other productivity enhancement interventions (agriculture and livestock) were promoted.

3) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?

Evidence of impact
This watershed has fully developed as a model site of learning for all interested in sustainable rainwater management in rainfed regions. The project has enabled the community an impressive 100,000 cubic meter storage capacity resulted into harvesting more than 200,000 cubic meter surface runoff every year. The spillover of this massive effort has resulted in significant groundwater recharge. This is also evident in terms of increased crop intensification (more than 100 ha fallow lands has been converted into productive agricultural land), better crop diversification, higher household income and such other socio-economic and ecosystem benefits. After realizing the impact of these interventions, more than 2000 visitors from India and abroad including a number of dignitaries (policy makers and many officials of development departments) have visited this watershed within last two years. This initiative has shown the potential of rainwater harvesting interventions in Bundelkhand region which could be scaled up for creating larger impacts and helping the communities for overcoming critical challenges plaguing this region.

4) References
Kaushal K. Garg, Ramesh Singh, Suhas P. Wani, O.P. Chaturvedi, Inder Dev, Mukund D. Patil, R. Sudi and Anand K. Singh, (forthcoming), Improving Water Availability and Diversification of Cropping Systems in Pilot Villages of North and Southern India. *In* Corporate social responsibility: win-win propositions for community, corporates and agriculture, edited by Suhas P. Wani and K.V. Raju; CABI : Boston, MA : CABI, [2018]

#14

Restoration project

Name of respondent and e-mail: Martin Moyo (M.Moyo@cgiar.org) and Andre van Rooyen (AvanRooyen@cgiar.org)
Center: ICRISAT
CRP/Flagship (if relevant): WLE

Title: **Improving water productivity and profitability in small-scale communal irrigation schemes in southern Africa**
Starting year: 2013
Ending year: On-going
Place: Mozambique, Tanzania and Zimbabwe

1a) Scale:
Plot and Farm

1b) Driver of degradation addressed/reversed

Overpopulation, lack of knowledge and bad agricultural practices

1c) Stage of the forest transition curve
Agriculture

1d) Entry point:
1. Governance, institutions
2. Biophysical (soil, vegetation)
3. Economics, livelihoods

(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
ICRISAT has been involved in a research for development project funded by the Australian Government through the Australian Centre for International Agricultural Research (ACIAR) and the CGIAR, Water, Land and Ecosystems Research Program and implemented in Mozambique, Tanzania and Zimbabwe. The project '*Increasing Irrigation Water Productivity in Mozambique, Tanzania and Zimbabwe through on-farm monitoring, adaptive management and Agricultural Innovation Platforms,* was implemented in six irrigation schemes between 2013 and 2017 (Project Number FSC-2013-006).

The project was developed to test a specific combination of technical and institutional change methods to increase irrigation water productivity and profitability in African smallholder irrigation schemes. The two-pronged approach of this project consists of smart water management (SWM) tools; the Chameleon and FullStop Wetting front Detector (WFD) that were introduced to monitor soil moisture and nutrients to facilitate farmer learning to increase productivity. The chameleon tool measures moisture at different depths in the soil profile and displays the result as coloured lights; blue (wet), green (moist) or red (dry) and the Full Stop soil wetting front detector and solute collection device helped in monitoring nutrients in the soil. Farmers used these to learn the best combination of fertiliser application and irrigation for their crops on their soils, and so increased their yields. Simultaneously, Agricultural Innovation Platforms (AIPs) were introduced to bring key stakeholders together to develop solutions to a range of challenges: from scheme management to input supply, production and marketing. The core premise behind the project is that small-scale communal irrigation schemes have failed to realise returns on investment. A critical reason for this is that these irrigation systems have not been recognized as complex socio-ecological systems operating under a diversity of constraints.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact
Evidence from schemes in Zimbabwe indicate that the SWM tools that were introduced by the project are people-centred, allowing experiential learning suitable for small-scale irrigators (Moyo et al.,

forthcoming). Although only 23% and 33% of the irrigators at Silalatshani (n=84) and Mkoba (n=54) schemes, respectively owned the tools, awareness of these is at 90%. Irrigators have a clear understanding that the tools help improve irrigation efficiency: that is, to use water more wisely and make it possible for farmers to irrigate at the point of need as well as creating awareness of the soil moisture content within the root zone. 73% of households at Silalatshani and 46% at Mkoba reduced irrigation frequency. Farmers are now irrigating only every second week rather than every week, using fewer siphons for shorter durations. While this reduced the total amount of water used, it also saved time/labour; now often invested in irrigation infrastructure maintenance, agronomic management activities, or other income related activities.

The tools created an ideal learning system, providing much needed knowledge to small-scale irrigators and irrigators also understand that the tools help improve soil fertility management. Both yields and income increased despite reducing the water supply and a reduction in fertiliser. Approximately half the farmers reduced their fertilizer use, as nutrients are not leached beyond the root zone. Yields of major irrigated crops increased by 25% or more for 86% and 76% of households at Mkoba and Silalatshani, respectively, while 43% and 56% of these irrigators report income increases of 25% or more. An example outcome of the project efforts by ICRISAT has been reported in the blogs and publications like the ones below:

- http://news.trust.org/item/20170824133536-1vboy/
- https://wle.cgiar.org/african-smallholders-can-double-their-yields-half-water

The improved profitability and reliability of supply has reduced conflicts, both among irrigators and within households, and resulted in an increased willingness to engage in collective actions such as system maintenance, fee payment and fence building. This project clearly illustrates that there are relatively simple interventions to increase water use efficiency, reduce nutrient leaching and increase crop yields, if these technologies are embedded in a larger learning environment where other important feedback mechanisms such as labour constraints and market opportunities are contextualised.
While these interventions in six schemes have succeeded with direct involvement from project staff, new research has now commenced in the Transforming Irrigation in Southern Africa project (LWR/2016/137) to learn and assess how these measures can be scaled out and up. There is a need to understand how to enable each national government irrigation agency to apply research lessons to their policies and practices. Further, engagement with multilateral African institutions is underway to draw on the research findings to improve their policies and practices.

However, an external review of the overall project found that the research has enabled smallholder farmers and related stakeholders to ‘achieve success in a traditionally difficult sector’. A key achievement has been that at five schemes, yield has improved two- to four-fold and farmer incomes have increased. In four schemes, unused irrigation plots covering an average of 27% of the command area were brought back into production. The frequency of water application was reduced by two-thirds at five schemes, and as a result, the supply of water to canal tail-end farmers improved so that they can produce crops reliably. As much as 70% of labour was saved from reduced irrigation frequencies and this time was often redirected into more intensive agriculture or small businesses. In focus groups the farmers reported greater social harmony among farmers and within households. Farmers began accessing certified seeds and using quality fertilisers at most of the schemes. A number of more profitable crops and crop varieties were grown. Through the AIPs, farmers enhanced access to crop processing facilities and markets. Maintenance of five of the irrigation schemes by farmers increased. Surveys showed that approximately 25% of the more than 1,700 scheme farmers were directly engaged in the project in the three countries, and another 55% received scheme-level aggregated benefits see: http://aciar.gov.au/files/fsc_2013_006_final_report.pdf

4) References

1. Moyo, M, Maya, M, van Rooyen, A & Dube, T. forthcoming, Increasing irrigation water productivity in Mozambique, Tanzania and Zimbabwe through on-farm monitoring, adaptive management and Agricultural Innovation Platforms: End of project survey report for Zimbabwe, Unpublished.

A special issue of the International Journal of Water Resources Development (Volume 33, Number 5, 2017: The productivity and profitability of small scale communal irrigation systems in South-eastern

Africa, http://www.tandfonline.com/toc/cijw20/33/5) is dedicated to reporting some of the main findings from this project. The findings have been further communicated during two special sessions at the World Water Congress in Cancun in May 2017 and one at the Stockholm Water Week in September 2017. **The publications from the** International Journal of Water Resources Development Special Issue on this project include the following:

2. **Wheeler S., Zuo A.**, Bjornlund H., Mdemu M., Rooyen A., Munguambe P. (2017) "An overview of extension use in irrigated agriculture and case studies in south-eastern Africa", International Journal of Water Resources Development, 33 (5), 755-769. http://dx.doi.org/10.1080/07900627.2016.1225570
3. de Sousa W., Ducrot R., Munguambe P., Bjornlund H., Machava A., Cheveia E., Faduco J. (2017) "Irrigation and crop diversification in the 25 de Setembro irrigation scheme, Mozambique", International Journal of Water Resources Development, 33 (5), 704-724. http://dx.doi.org/10.1080/07900627.2016.1262246
4. Mdemu M.V., Mziray N., Bjornlund H., Kashaigili J.J. (2017) "Barriers to and opportunities for improving productivity and profitability of the Kiwere and Magozi irrigation schemes in Tanzania", International Journal of Water Resources Development, 33 (5), 725-739. http://dx.doi.org/10.1080/07900627.2016.1188267
5. Moyo M., van Rooyen A., Moyo M., Chivenge P., Bjornlund H. (2017) "Irrigation development in Zimbabwe: understanding productivity barriers and opportunities at Mkoba and Silalatshani irrigation schemes", International Journal of Water Resources Development, 33 (5), 740-754. http://dx.doi.org/10.1080/07900627.2016.1175339
6. Manero A. (2017) "The limitations of negative incomes in the Gini coefficient decomposition by source", Applied Economics Letters, 24 (14), 977-981. http://dx.doi.org/10.1080/13504851.2016.1245828
7. Manero A. (2017) "Income inequality within smallholder irrigation schemes in Sub-Saharan Africa", International Journal of Water Resources Development, 33 (5), 770-787. http://dx.doi.org/10.1080/07900627.2016.1152461
8. Bjornlund H., van Rooyen A., Stirzaker R. (2017) "Profitability and productivity barriers and opportunities in small-scale irrigation schemes", International Journal of Water Resources Development, 3 (5). 690-704. http://dx.doi.org/10.1080/07900627.2016.1263552
9. Martin Moyo. 2017. Promoting Climate –Resilient Water Management Agricultural Practices in Southern Africa. 2017 FANRPAN Regional Multi-Stakeholder High-level Food and Nutrition Security Policy Dialogue. Durban, South Africa 15-17 August 2017.
10. Martin Moyo and André F. van Rooyen. 2017. Breaking productivity barriers and utilizing opportunities: the use of Agriculture Innovation Platforms in small-scale irrigation schemes. World Water Congress, Cancun, Mexico 29 May-2 June 2017.
11. André F. van Rooyen & Martin Moyo. 2017. The transition of *dysfunctional* irrigation schemes towards Complex Adaptive Systems: The role of Agricultural Innovation Platforms. World Water Congress, Cancun, Mexico 29 May-2 June 2017.

#15

Restoration project

Name of respondent and e-mail: Jason Sircely, j.sircely@cgiar.org
Center: ILRI
CRP/Flagship (if relevant): Livestock

Title: Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale (ILRI component)
Starting year: 2015
Ending year: 2019
Place: Ethiopia, Kenya

1a) Scale:
Plot — experimental trial plots
Farm — upscaling in communal lands
Landscape — Participatory rangeland management (PRM), as influenced by trial plot results

1b) Driver of degradation addressed/reversed
Primarily intense, disorganized grazing. Secondary drivers vary by site, including shrub encroachment, fire prohibition, poor exclosure productivity, unsustainable restoration investments.

1c) Stage of the forest transition curve
Forested landscape — NA
Agriculture — 1 site (Amhara, Ethiopia)
Agroforestry — 1 site (Amhara, Ethiopia)
Most sites are non-forest areas, located in Kajiado, Wajir, and Turkana Counties, Kenya, and Borana Zone of Ethiopia

1d) Entry point:
Biophysical (soil, vegetation) — 3
Economics, livelihoods — 1
Governance, institutions — 2
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
The primary mandate of the project is to create tools for scaling land restoration in drylands, by using action research to generate evidence for success/failure of options in different contexts (ecological, social). In pastoral sites, institutions are characterized and supported to improve management, as coupled with on-the-ground experimental range restoration trials designed to inform feasible up-scaling to entire communal grazing lands. The effectiveness of rangeland management institutions is being assessed via remote sensing. In the one highland site, Amhara, Ethiopia, on-the-ground experimental exclosure improvement trials inform local institutional decisions on exclosure improvement and management.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative) —
All of the above

What has helped? —
Strong partnerships with strong local institutions. Practical options for land restoration linked directly to livelihoods and nested within existing management systems.

Main constraints? —
Pastoral areas: high livestock density, transaction costs involved in range management, market access.
Highland site (Amhara): high livestock density, land use pressure, individualization of the commons, reliance on animal traction, market access.

Evidence of impact —

Highland site (Amhara): From the first year of on-the-ground trials (2017), up-scaling from trial plots to the largest feasible area in each exclosure has resulted in 7.7 ha of improved grass establishment. Members of exclosure user groups total 3,948 in 29 locations across 7 woredas (districts).

Pastoral sites: Experimental range restoration trials have restored: 74.7 ha in Kajiado, 5.0 ha in Wajir, 2.2 ha in Turkana (but rain failed), 50.0 ha in Borana. Resident members of our partner rangeland management institutions number 2,700 in Kajiado, 2,347 in Wajir, 5,583 in Turkana, and 2,619 in Borana.

4) References
Most results are preliminary, analyses for Amhara are ongoing, data collection remains ongoing. Protocols and initial, qualitative assessment reports are available on request.

Summaries of the context and use of local knowledge in Amhara:
https://cgspace.cgiar.org/handle/10568/77007
https://cgspace.cgiar.org/handle/10568/88995

#16

Restoration project

Name of respondent and e-mail: Diana Suhardiman
Center: IWMI
CRP/Flagship (if relevant): PIM Flagship 5

Title: Linking land tenure security with state transformation processes in Myanmar
Starting year: 2017
Ending year: 2021
Place: Myanmar

1a) Scale: It links farm level (farmers' strategy to strengthen their land rights) with landscape (ongoing land governance reform processes at national level)
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed
Large-scale land acquisition for commercial use by the previous military government and its business connections results not only in farmers' losing their farmlands and access to communal forest, it also accelerates the chain on land degradation, in particular the speed of deforestation in Myanmar. Focusing on land governance reform processes, this research contributes to unpack the existing power structure and power relationships sustaining the chain of land degradation, while providing potential entry points towards more sustainable land governance.

1c) Stage of the forest transition curve: Across all three stages
Forested landscape
Agriculture
Agroforestry

1d) Entry point: Governance and institutions
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the project (2-5 lines)
The research project looks at land restoration as an integral part of land governance reform processes. It highlights the need to incorporate customary land rights in the current discussion on land governance reforms in Myanmar, towards rights-based approaches in land governance. Taking Karen State as a case study, it brings to light the farmers' and local community's role as grass-roots forces shaping and reshaping the overall process of state transformation.
3) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The research has helped shed light on the National Land Use Policy implementation framework for the country-wide implementation in general and within the context of ethnic state in particular
Main constraints? Unclear messages from the government on the direction of reform processes and ongoing armed conflict in ethnic states make it difficult to link national level policy formulation processes with local community's development needs and aspirations
Evidence of impact: Key findings from the research has been used by international donors to help guide the ongoing process of land governance reform in general, and in informing institutional framework for National Land Use Policy implementation in particular.

4) References

1. -Suhardiman, D., Bright, J., Palmano, C. The Politics of Legal Pluralism in the Shaping of Spatial Power in Myanmar's Land Governance. Under review in Political Geography.
2. -Suhardiman, D., Kenney-Lazar, M., Meinzen-Dick, R. The contested land governance landscape in Myanmar. Under review in Critical Asian Studies.

#17

Restoration project

Name of respondent and e-mail: Diana Suhardiman
Center: IWMI
CRP/Flagship (if relevant): PIM Flagship 5

Title: Linking land tenure security with food security in Laos
Starting year: 2017
Ending year: 2021
Place: Laos

1a) Scale: It links farm level (local land use planning processes) with landscape (ongoing land governance reform processes at national level)
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed
The research highlights key policy gaps in the government's efforts to achieve 70% of forest cover in 2020. It shows that this target can only be achieved if the current problem pertaining to the overlapping boundaries of forest and agriculture lands is resolved. It argues that resolving these boundaries is not only important for the country's land management, it is also crucial to get farmers' buy in in land restoration efforts. As approximately 20% of farm households in the country (mostly the poor oftentimes with no access to lowland agricultural land) is located in protected forest area, it is pertinent that forest protection target is achieved without further marginalization of the poor (by ethnicity and gender).

1c) Stage of the forest transition curve: Across all three stages
Forested landscape
Agriculture
Agroforestry

1d) Entry point: Governance and institutions (1); Economics and livelihoods (2); Biophysical (3)
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the project (2-5 lines)
The research links local land use planning processes with national land governance reform processes. It presents land use planning as a function of power and contested arena of power struggles, driven primarily by sectoral ministries' development targets and powerful local actors' interests. It illustrates the current disjuncture between formal land use planning processes and actual land use and tenure arrangements across scales and its implications for land restoration and farmers' livelihoods options
3) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The research has shed light on the need to link current delineation of agricultural and forest land with local institutional arrangements surrounding the use of these lands (e.g. centrality of informal land rental agreement in forest conservation measures).
Main constraints? Target oriented development policy and programs oftentimes do not give sufficient space for shaping local land use planning in line with customary land rights and practices, resulting in the plan non-implementation afterwards.
Evidence of impact: The presentation of land use planning as power struggles as a game, which can be used by various key stakeholders to facilitate decision making processes. The game is currently adopted by TABI and has been incorporated as part of teaching program in national universities in the region (Laos and Thailand).

4) References

-Suhardiman, D., Keovilignavong, O., Kenney-Lazar, M. The Territorial Politics of Land Use Planning in Laos. Under review in Land Use Policy.

#18

Restoration project

Name of respondent and e-mail: Sanjiv de Silva
Center: IWMI
CRP/Flagship (if relevant): PIM Flagship 5

Title: Collective Farming for Improving Small Scale Agriculture Performance in Nepal
Starting year: 2017
Ending year: 2018
Place: Nepal

1a) Scale: It links farm level to emerging national policy priorities around increasing land productivity across agricultural landscapes.
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed
One driver of land degradation the lack of investments by smallholder farmers (who make up the majority of farmers) in land management practices. This has also let to large amounts of shallow unproductive land, underpinned by land accumulation by the minority landlords, and a lack of a regulated land market.
1c) Stage of the ~~forest~~ transition curve: Across agriculture.
Forested landscape
Agriculture
Agroforestry

1d) Entry point: Governance and institutions (1); Economics and livelihoods (2); Biophysical (3)
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the project (2-5 lines)
The research explores how collective farming can simultaneously drive agricultural productivity without further marginalising smallholders who individually cannot participate in the transition from subsistence to commercial agriculture proposed by the government. Policy, legal and administrative frameworks are studied and linked to on-ground experiments in collective farming involving smallholder and landless households to identify strengths and weaknesses in the current adoption of collective farming.

3) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The research has highlighted the critical gulf between policies and strategies that position collective action (groups and cooperatives) as primary mechanisms for delivering rural development investments on the one hand, and the paucity of both capacities and coordination mechanisms to address the muti-dimensional practical challenges of implementing collective approaches on the ground.
Main constraints? Planning processes heavily under-estimate the resources required to build self-sustaining collective action entities. An absence of a systematic monitoring and evaluation mechanism prevents communication of lessons from field to centralized policymakers and planners. The sectoral silos perpetuate fragmented extension when members of collective initiatives require integrated technical backstopping given the multiple variables (e.g. skills, equipment, irrigation, inputs and markets) needed for impacting productivity, and concurrently struggle amongst themselves to navigate diverse entrenched social identities and resulting power asymmetries.
Evidence of impact: None at present as the study has been recently completed.

4) References
Dupre-Harbord, Justin, de Silva, Sanjiv and Raut Manita. Collective Farming for Improving Small Scale Agriculture Performance in Nepal: A Review. Project Report.

#19

Restoration project

Name of respondent and e-mail: Marlène Elias – marlene.elias@cgiar.org
Center: Bioversity International
CRP/Flagship (if relevant): FTA and WLE

Title: Assessing the socio-economic impacts of restoration initiatives: A cross-regional analysis
Starting year: 2018
Ending year: 2020
Place: Malaysia, Peru, Cameroon

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Multiple drivers, as assessing impacts across a variety of restoration initiatives

1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) -- 3
Economics, livelihoods – 1
Governance, institutions -- 2
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
The thrust of the research is to understand why restoration initiatives 'succeed', or not, from a socio-economic perspective. Who bears the costs, who reaps the benefits, how equitable are interventions, what is local people's sense of satisfaction with different approaches to FLR, what is the link with ecological outcomes – and in sum, what good practices can inform future initiatives. Data will be collected through FGDs with local participants (men and women) and key informant interviews with project staff.
3) results – still at data collection stage
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

#20

Restoration project

Name of respondent and e-mail: Rachel Atkinson r.atkinson@cgiar.org, Evert Thomas e.thomas@cgiar.org
Center: Bioversity International
CRP/Flagship (if relevant): FTA
Title: Trials to evaluate the cost'efficiency of active versus passive restoration interventions to restore tropical dry forest across a degradation gradient in Colombia
Starting year: 2015
Ending year: 2030
Place: Colombia
1a) Scale:
Plot
Farm
Landscape x
1b) Driver of degradation addressed/reversed
Agriculture and cattle ranching
1c) Stage of the forest transition curve
Forested landscape x
Agriculture x
Agroforestry
1d) Entry point:
Biophysical (soil, vegetation) -- 1
Economics, livelihoods –
Governance, institutions --
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
Trials to test the cost-efficiency of different restoration interventions (from natural regeneration over assisted natural regeneration and low diversity to high diversity plantings) to restore native forest vegetation on lands in different stages of degradation (very degraded to secondary forest)
3) results – **still at data collection stage – trees take a while to grow**
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? **Strong collaboration with private sector**
Main constraints? **None**
Evidence of impact
The dam building company responsible for carrying out restoration of dry forest on >10,000 has used the experimental plots to showcase current restoration efforts and is using the experimental approach as a reference for guiding future restoration approaches.

#21

Restoration project

Name of respondent and e-mail: Barbara Vinceti – b.vinceti@cgiar.org
Center: Bioversity International
CRP/Flagship (if relevant): FTA

Title: Nutrition-sensitive forest restoration to enhance the capacity of rural communities in Burkina Faso to adapt to change
Starting year: 2016
Ending year: 2020
Place: Burkina Faso

1a) Scale:
Plot x
Farm x
Landscape

1b) Driver of degradation addressed/reversed
encroachment, grazing, climate change

1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) -- 1
Economics, livelihoods – 2
Governance, institutions -- 3
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
The thrust of the research is to compare to what extent tree diversity is promoted and restored through different tree diversity through different planting activities in selected sites in the central region of Burkina Faso. In particular, the household-based restoration approach promoted by local association in Burkina (tiipaalga) is compared with other planting activities initiated by individual farmers, in order to understand what factors influence their choices of tree species. In addition, the type and diversity of seed sources utilized are compared across different farmers, to understand if diverse and sufficient amounts of seed are available or seed supply is a major constraint in forest restoration.
3) results – still at data analysis stage
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

#22

Restoration project

Name of respondent and e-mail: Dietmar Stoian – d.stoian@cgiar.org
Center: Bioversity International
CRP/Flagship (if relevant): FTA and PIM (largely prospective)

Title: Overcoming barriers to landscape restoration: Learning from experiences across Central America
Starting year: 2018
Ending year: 2020
Place: Guatemala, Honduras, Costa Rica, Panama

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Multiple drivers of deforestation/degradation (e.g. cattle ranching, oil palm, sugarcane, pineapple) and diverse public and private enabling conditions for reversal through restoration initiatives

1c) Stage of the forest transition curve
Forested landscape x
Agriculture x
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) -- 3
Economics, livelihoods – 2
Governance, institutions -- 1
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
Along a gradient from enabling to disabling conditions, we want to assess the prospects of diverse public, private and public-private restoration initiatives in four Central American countries, where a tipping point has been reached in Costa Rica while Guatemala, Honduras and Panama lag behind to varying degrees. In particular, we want to better understand the interplay between regulations and incentives provided through political-legal frameworks on the one hand, and private initiatives and investments on the other. We also seek for insight into the political economy underlying the official policy and rhetoric and what actually drives decisions on the ground. The findings will inform realistic approaches to effective landscape restoration in Central America and beyond.

3) Results – some data available, most data yet to be collected
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

#23

Restoration tool

Name of respondent and e-mail: Rosa María Román-Cuesta, R.Roman-Cuesta@cgiar.org
Center: CIFOR
CRP/Flagship (if relevant): Flagship 5

Title: 'Mitigation potentials in Latin American landscapes through two carbon-intense restoration options: forest expansion and peat restoration'
Year: 2017-2018 year of research.
Time period under analysis in the research: ca. 1800-2017 for vegetation. 1800 as potential vegetation, 2017 as current vegetation. 2010 for agriculture; 2007-2017 for fire; 2005 for livestock.

1a) Scale:
Plot
Farm
Landscape: Continental, landscape, minimum mapping unit ca. 6 ha. Can include analyses at farm level if larger than 6 ha.

1b) Driver of degradation addressed/reversed: We quantify and locate fire and livestock intensities as drivers of land degradation and as risks of restoration reversal. We include food security and natural grasslands as safeguards. (i.e. change to forest in cropland areas, and in natural grasslands/savannas is not allowed)

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry
ANSWER: **.....**variable. Depending where in which country. All gradients are included after excluding safeguards and areas of high reversal risk.

1d) Entry point:
Biophysical (soil, vegetation): Carbon sink potentials of aboveground biomass in forests and soil carbon in peatlands
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
Our goals are 1. to assess the maximum mitigation potential of Latin American landscapes in a 40-year period through the two most carbon-intense restoration activities: forest expansion from non-assisted second-growth forests, and peatland avoided emissions from fire and drainage, 2. to understand how this potential is spatially distributed, and 3. to contrast our estimates against other land use mitigation options. We produce a 250-m map of forest biomass accumulation potential (BAP) ($Mg.ha^{-1}$), synonym of Mitigation potential. To create the map we use the Atlas of Forest Landscape Restoration Opportunities (AFLRO) from WRI which contrasts current deforested and degraded forests against their potential baselines. We assign carbon densities to the existing range of forest biomes and conditions using a carbon density map (Avitabile et al. 2016). We apply four safeguards to veil for food protection (cropland area) (ESA-CCA land cover maps 2010), biodiversity conservation of natural grasslands (natural savannahs and grasslands through WWF biomes), and reversal risks of fire (MODIS fire hotspots) and grazing (Robinson et al. 2014's spatial distribution of livestock densities). We use Gumbricht et al. (2017) maps for peatland distribution and use draining percentages from Joosten et al. (2012), and fire from MODIS hotspots.

3) Used------------------ **Under publication**
Where?
By whom? By Governments and donors interested in prioritizing hotspot of mitigation potential in degraded forested landscapes in Latin America

For what? Quantify carbon sink potential, if original vegetation was restored. Ex-ante Carbon assessments in restoration projects, as well as quantitative support for Bonn Challenge, NDCs, NAMAs pledges in terms of GHGs.

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
We hope these results will help raise awareness that mitigation potentials are lower than initially thought. Our study shows an interesting reduction of 30% in mitigation potential when considering safeguards and reversal potentials.
What has helped?
Main constraints?
Evidence of impact

5) References

1. Roman-Cuesta et al. (under submission) 'Mitigation potentials in Latin American landscapes through two carbon-intense restoration options: forest expansion and peat restoration' Global Change Biology.

References used in the manuscript :

2. Avitabile, et al. (2016). An integrated pan-tropical biomass map using multiple reference datasets. Global Change Biology, 22, pp. 1406–1420.
   Achard, et al. (2014).: Determination of tropical deforestation rates and related carbon losses from 1990 to 2010. Global Change Biology, 20, 2540-2554.
3. Alencar et al. (2006) Fire in the Brazilian Amazon in ENS and non-ENSO years: Area Burned and Committed Carbon Emissions. Earth Interactions, 10, 1-17.
4. Anderson, K.: The inconvenient truth of carbon offsets. Nature News, 484, 7, 2012.
5. Anderson, K.: Duality in climate science. Nature Geoscience, 8, 898–900, 2015.
6. Baccini et al. (2017) Tropical forests are a net carbon source based on aboveground measurements of gain and loss. Science 10.1126/science.aam5962.
7. Bernal, B., Sidman, G., Murray, L. and Pearson, T.R.H. 2017. Global Forest GHG Emissions and FLR CO2 Removals Databases. Report to IUCN. Available at: https://infoflr.org/what-flr/global-emissions-and-removals-databases
8. Canadell, J., Schulze. D (2014). Global potential of biospheric carbon management for climate mitigation. Nature Communications, 5, 5282-5293.
9. Chazdon et al. (2016) Carbon sequestration potential for second-growth regeneration in the Latin American tropics. Science Advances,2, e1501639.
10. Ciais, et al. (2013): Carbon and Other Biogeochemical Cycles. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
11. Cole et al. (2014) Recovery and resilience of tropical forests after disturbance. Nature Communications, 5, 3906.
12. Cowie S (2017) Brazil's worst month ever for forest fires blamed on human activity. The Guardian, 29th Sept, 2017. https://www.theguardian.com/world/2017/sep/28/brazil-forest-fires-deforestation-september-record-amazon
13. CONABIO. Comision Nacional para el Uso y el Manejo Sostenible de la Biodiversidad de Mexico. (2017). Sitios prioritarios para la restauracion. Available at: http://www.conabio.gob.mx/informacion/gis/
14. Ciais et al. (2008) Carbon accumulation in European forests. Nature Geosciences 1, 425–429.
15. Dixon et al. (2014) Distribution mapping of world grassland types. Journal of Biogeography, 11, 2003-2019.
16. FAO, 2012. GLOBAL ECOLOGICAL ZONES FOR FAO FOREST REPORTING: 2010 UPDATE. Forest resources Assessment Working Paper, 179. Data available at: http://www.fao.org/geonetwork/srv/en/main.home Report available at: http://www.fao.org/docrep/017/ap861e/ap861e00.pdf
17. Fearnside, P.M. 2017. Deforestation of the Brazilian Amazon. In: H. Shugart (ed.) Oxford Research Encyclopedia of Environmental Science. Oxford University Press, New York, USA. doi:10.1093/acrefore/9780199389414.013.102
18. Forest Resources Assessment (FRA) (2015). http://www.fao.org/forestry/fra/fra2015/en/

19. Fuss et al. (2014) Betting on negative emisisons. Nature Climate Change 4, 850–853.
20. Fuss et al. (2016) Research priorities for negative emissions. Environ. Res. Lett. 11 115007.
21. Gaveau et al. (2014). Major atmospheric emissions from peat fires in Southeast Asia during non-drought years: evidence from the 2013 Sumatran fires. Scientific Reports, 4, 6112. DOI:10.1038/srep06112
22. Grassi et al. (2017) The key role of forests in meeting climate targets requires science for credible mitigation. Nature Climate Change 7, 220–226.
23. Griscom et al. (2017) Natural Climate Solutions. PNAS,144, 11645-11650.
24. Gumbricht et al. (2017) An expert system model for mapping tropical wetlands and peatlands reveals South America as the largest contributor. Global Change Biology, 23, 3581–3599.
25. Hansen et al. (2013) High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342, 850-853.
26. Holl, L (2016) Research directions in tropical forest restoration. Annals of the Missouri Botanical Garden, 102(2):237-250.
27. Houghton et al. (2012) Carbon emissions from land use and land-cover change. Biogeosciences, 9, 5125-5142.
28. Houghton et al. (2015) A role for tropical forests in stabilizing atmospheric CO2. Nat Clim Chang 5:1022–1023.
29. IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland
30. IUCN (2017). International Union for the Conservation of Nature. The Bonn Challenge: catalysing leadership in Latin America. Forest Brief, No.14. Available at: https://www.iucn.org/sites/dev/files/content/documents/iucn-forest-brief-no-14_20x20_final_print8pags_en_web.pdf
31. Joosten H (2010) The Global Peatland CO2 Picture: Peatland status and drainage related emissions in all countries of the world. Wetlands international. Available at: http://www.wetlands.org/WatchRead/tabid/56/mod/1570/articleType/ArticleView/articleId/2418/The -Global-Peatland-CO2-Picture.aspx.
32. Kottush and Schaffartzik (2017) Sustainable Palm Oil? Insights from Material Flow and Land Use Analysis in Brazil's Production Hotspot. GAIA, 26, 129 –135.
33. Laestadius et al. (2011) Mapping opportunities for forest landscape restoration, *Unasylva 238*, 62, 47.
34. Maginnis S, and Jackson W (2007) What is FLR and how does it differ from current approaches? Rietbergen-McCracken, S. Maginnis & A. Sarre (editors), The Forest Landscape Restoration Handbook. Earthscan, Palmer, L. 2014. London.
35. Metz et al. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)
36. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
37. Nabuurs, G.J., O. Masera, K. Andrasko, P. Benitez-Ponce, R. Boer, M. Dutschke, E. Elsiddig, J. Ford-Robertson, P. Frumhoff, T. Karjalainen, O. Krankina, W.A. Kurz, M. Matsumoto, W. Oyhantcabal, N.H. Ravindranath, M.J. Sanz Sanchez, X. Zhang, 2007: Forestry. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
38. Pan et al. (2011) A Large and Persistent Carbon Sink in the World's Forests. Science,333, 988-993.
39. Pearson et al. (2017) Greenhouse gas emissions from tropical forest degradation: an underestimated source. Carbon Balance Manage (2017) 12:3 DOI 10.1186/s13021-017-0072-2
40. Pienaar, L.V. and K.J. Turnbull. 1973. The Chapman-Richards Generalization of Von Bertalanffy's Growth Model for Basal Area Growth and Yield in Even-Aged Stands. Forest Science 19 (1): 2-22.
41. Potapov et al. (2011). Global map of forest cover and condition. World Resources Institute: Washington, DC. Online available at: http://www.wri.org/applications/maps/flr-atlas/#
42. Poorter, L., Bongers, F., Aide et al. (2016) Biomass resilience of Neotropical secondary forests. Nature, 530, 211-214.

43. Richards, F.J. 1959. A flexible growth function for empirical use. Journal of Experimental Botany 10,290-300.
44. Roman-Cuesta et al. (2016) Hotspots of gross emissions from the land use sector: patterns, uncertainties, and leading emission sources for the period 2000–2005 in the tropics. Biogeosciences, 13, 4253-4269.
45. Roucoux et al. (2017). Threats to intact tropical peatlands and opportunities for their conservation. Conservation Biology. DOI: 10.1111/cobi.12925
46. Santoro, et al. (2015). Forest growing stock volume of the northern hemisphere: Spatially explicit estimates for 2010 derived from Envisat ASAR. Remote Sensing of Environment, 168, 316-334.
47. Smith et al. (2014): Mitigation of Climate Change, Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, edited by: Edenhofer, O., Pichs-Madruga, R., Sokona, Y. E., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlomer, S., von Stechow, C., Zwickel, T., and Minx, J. C., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
48. Smith et al. (2016) Biophysical and economic limits to negative CO2 emissions Nat. Clim. Change, 6, 42–50.
49. Tobon et al. (2017). Restoration planning to guide Aichi targets in a megadiverse country. Conservation Biology, 31,5, 1086–1097.
50. UNEP (2017). The Emissions Gap Report 2017. United Nations Environment Programme (UNEP), Nairobi
51. Veldman et al. (2015). Where Tree Planting and Forest Expansion are Bad for Biodiversity and Ecosystem Services. BioScience, 65, 1011–1018.
52. Zaloumis N., and Bond W (2016) Reforestation or Conservation? The attributes of old growth grasslands in South Africa. Proc. Phil. Trans. R. Soc. B 371: 20150310. http://dx.doi.org/10.1098/rstb.2015.0310

#24

Restoration tool

Name of respondent and e-mail: Bruno Locatelli, bruno.locatelli@cirad.fr
Center: CIRAD and CIFOR
CRP/Flagship (if relevant): FTA flagship 5

Title: Methods and tools to analyze tradeoffs between ecosystem services in restoration
Year: Since 2014

1a) Scale: **Landscape**
Plot
Farm
Landscape: Yes

1b) Driver of degradation addressed/reversed: **Any**

1c) Stage of the forest transition curve: **Any**
Forested landscape: Yes
Agriculture: Yes
Agroforestry: Yes

1d) Entry point: **Biophysical and Economics**
Biophysical (soil, vegetation): 1
Economics, livelihoods: 2
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
We developed and applied several methods for analyzing, modeling and mapping the effects of forest cover change on multiple ecosystem services and their implications for human wellbeing. We also developed methods to analyze the tradeoffs between ecosystem services resulting from changes in landscape management.

3) Effective use
Where? Apurimac, Peru
By whom? Scientists in collaboration with local and regional decision makers from different sectors
For what? For starting an intersectoral discussion on landscape management from an analysis of tradeoffs between ecosystem services

4) results
Impacts: **positive**, failure, unexpected impacts (positive or negative)
What has helped? Landscape with strong and conflicting stakes (water, agriculture, tourism, conservation, disaster risk reduction, etc.)
Main constraints? Institutional barriers to dialogue between sectors.
Evidence of impact: Not yet

5) References

1. Vallet A., Locatelli B., Levrel H., Wunder S., Seppelt R., Scholes R.J., Oszwald J., 2018. Relationships between ecosystem services: Comparing methods for assessing tradeoffs and synergies. Ecological Economics 150: 96-106. doi:10.1016/j.ecolecon.2018.04.002
2. Fedele G., Locatelli B., Djoudi H., Colloff M.J., 2018. Reducing risks by transforming landscapes: Cross-scale effects of land-use changes on ecosystem services. PLoS ONE 13(4): e0195895. doi:10.1371/journal.pone.0195895
3. Locatelli B., Lavorel S., Sloan S., Tappeiner U., Geneletti D., 2017. Characteristic trajectories of ecosystem services in mountains. Frontiers in Ecology and the Environment 15(3): 150-159. doi:10.1002/fee.1470
4. Fedele G., Locatelli B., Djoudi H., 2017. Mechanisms mediating the contribution of ecosystem services to human well-being and resilience. Ecosystem Services 28A: 43-54. doi: 10.1016/j.ecoser.2017.09.011

5. Vallet A., Locatelli B., Levrel H., Brenes Pérez C., Imbach P., Estrada Carmona N., Manlay R., Oszwald J., 2016. Dynamics of ecosystem services during forest transitions in Reventazón, Costa Rica. PLOS ONE 11(7): e0158615. doi:10.1371/journal.pone.0158615
6. Labrière N., Locatelli B., Vieilledent G., Kharisma S., Gond V., Basuki I., Laumonier Y., 2016. Spatial congruence between carbon and biodiversity across forest landscapes of northern Borneo. Global Ecology and Conservation 6: 105-120. doi:10.1016/j.gecco.2016.01.005
7. Labrière N., Laumonier Y, Locatelli B., Vieilledent G., Comptour M., 2015. Ecosystem services and biodiversity in a rapidly transforming landscape in northern Borneo. PLOS ONE 10(10): e0140423. doi:10.1371/journal.pone.0140423
8. Locatelli B., Imbach B., Wunder S., 2014. Synergies and trade-offs between ecosystem services in Costa Rica. Environmental Conservation 41(1): 27-36. doi:10.1017/S0376892913000234

#25

Restoration tool

Name of respondent and e-mail: Bruno Locatelli, bruno.locatelli@cirad.fr
Center: CIRAD and CIFOR
CRP/Flagship (if relevant): FTA flagship 5

Title: Meta-analyses on the effects of restoration on water and soils
Year: since 2008

1a) Scale: **From plot and watershed to region and continent.**
Plot: Yes
Farm: Yes
Landscape: Yes

1b) Driver of degradation addressed/reversed: **Any**

1c) Stage of the forest transition curve: **Any**
Forested landscape: Yes
Agriculture: Yes
Agroforestry: Yes

1d) Entry point: **Biophysical**
Biophysical (soil, vegetation): Yes
Economics, livelihoods: No
Governance, institutions: No
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
We reviewed the existing knowledge on the impacts of forest restoration on water flows, soil erosion, soil mass movements and local to regional climate using meta-analysis or systematic review approaches. Findings can guide decision-making on land management and restoration.

3) Effective use
Where? Globally
By whom? Such reviews are largely cited, including by news outlets, blogs and social media (example here).
For what? For research, policy design and project design. Examples of citations include The World Bank Group Forest Action Plan (2016-2020) and country proposals to the adaptation fund (e.g., Ecosystem Based Adaptation to Climate Change in Seychelles).

4) results
Impacts: positive, failure, unexpected impacts (positive or negative). **NA**
What has helped? **NA**
Main constraints? **NA**
Evidence of impact **NA**

5) References

1. Bonnesoeur V., Locatelli B., Guariguata M., Ochoa-Tocachi B., Vanacker V., Mao Z., Stokes A., Mathez- Stiefel S.L., 2018. Impacts of forests and reforestation on hydrological services in the Andes: a systematic review. Forest Ecology and Management (accepted).
2. Ellison D., Morris C.E., Locatelli B., Sheil D., Cohen J., Murdiyarso D., Gutierrez V., van Noordwijk M., Creed I.F., Pokorny J., Gaveau D., Spracklen D., Bargués Tobella A., Ilstedt U., Teuling A.J., Gebreyohannis Gebrehiwot S., Sands D.C., Muys B., Verbist B., Springgay E., Sugandi Y., Sullivan C.A., 2017. Trees, forests and water: Cool insights for a hot world. Global Environmental Change 43:51-61. doi:10.1016/j.gloenvcha.2017.01.002
3. Labrière N., Locatelli B., Laumonier Y., Freycon V., Bernoux M., 2015. Soil erosion in the humid tropics: A systematic quantitative review. Agriculture, Ecosystems & Environment 203: 127-139. doi:10.1016/j.agee.2015.01.027

4. Locatelli B., Vignola R., 2009. Managing watershed services of tropical forests and plantations: Can meta-analyses help? Forest Ecology and Management 258(9): 1864-1870. doi:10.1016/j.foreco.2009.01.015

#26

Restoration tool

Name of respondent and e-mail: Lalisa Duguma l.duguma@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant): FTA – Landscape flagship and Climate change flagship

Title: Understanding the restoration success in Shinyanga, Tanzania - from a bare degraded land to a rich biodiverse ecosystem
Year: 2015- ongoing

1a) Scale:
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed
Clearance for farms,
overgrazing,
settlement expansion

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation) 1
Economics, livelihoods
Governance, institutions 2
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
A local practice of enclosing the degraded areas as a collective property as well as private plots was adopted with agroforestry practices playing vital role in boosting the supply of wood and non-wood products to the agropastoral community. The practice selected is called Ngitili - it is a traditional fodder management system widely practiced by pastoral communities of Tanzania.
3) Effective use
Where? It was applied in Shinyanga region Tanzania.
By whom? By the local communities living in districts of Northern Tanzania.
For what? To restore degraded landscapes

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The fact that the restoration tool is a traditional practice has helped the adoption process. The community knew how to manage it.
Main constraints? Free-riders who want to benefit from the labor of the community groups; and ensuring the sustainability of the practices through local resource mobilization
Evidence of impact: close to 270,000 ha of land restored in Shinynaga region over about 25 years.

5) References

1. Duguma L. A., Minang, P. A., Kimaro, A. A., Otsyina, R., and Mpanda, M., 2013. Climate Smart Landscapes: Integrating Mitigation, Adaptation and Development in Shinyanga Region, Tanzania. ASB Policy Brief No. 40, ASB Partnership for the Tropical Forest Margins. Nairobi, Kenya.
2. Duguma, L. A., Minang P. A., & van Noorwidjk, M. 2014. Climate Change Mitigation and Adaptation in the Land Use Sector: From Complementarity to Synergy. Environmental Management, 54(3), 420-432
3. Duguma, L. A., and Minang, P. A., 2015. Leveraging landscapes: A systems approach to drivers of change. In Minang et al(Eds.). Climate-Smart Landscapes: Multifunctionality in

Practice. World Agroforestry Centre (ICRAF). Nairobi, Kenya. pp.135-149. DOI: 10.13140/2.1.1880.2242.

4. Duguma, L. A., Minang, P. A., Mpanda, M., Kimaro, A., & Alemagi, D. 2015. Landscape restoration from a social-ecological system perspective. In Minang et al (Eds.). Climate-Smart Landscapes: Multifunctionality in Practice, 63-73. Nairobi, Kenya: World Agroforestry Centre (ICRAF).

#27

Restoration tool

Name of respondent and e-mail: Jason Sircely, j.sircely@cgiar.org
Center: ILRI
CRP/Flagship (if relevant): Livestock, WLE

Title: Enhancing the value of ecosystem services in pastoral systems (EVESPS) project
Year: 2014-2017

1a) Scale:
Plot — NA
Farm — NA
Landscape — Lower Tana River Basin, Kenya and Province du Yatenga, Burkina Faso

1b) Driver of degradation addressed/reversed
Kenya: intense and disorganized grazing
Burkina: expansion of croplands into rangelands, intense and disorganized grazings

1c) Stage of the forest transition curve
Forested landscape — NA
Agriculture — Burkina (savanna woodland, not forest)
Agroforestry — Burkina (savanna woodland, not forest)

Yatenga was rangeland and now mostly cropped, Tana River remains a large intact rangeland. Both areas have seen major influx of farmers from nearby areas in recent decades.

1d) Entry point:
Biophysical (soil, vegetation) — 3
Economics, livelihoods — 1
Governance, institutions — 2
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
Three SWAT models were constructed with spatiotemporally dynamic livestock populations, to provide for modeling of grazing management. The models were constructed using collaborative processes with resident members of local institutions and regional partners (APESS, a Burkinabe NGO, and Tana River County), and all simulation scenarios were created based on spatial stakeholder inputs. Local and regional partners' involvement in constructing the model and vetting of the model results enabled alignment of local knowledge with numerical simulation modeling.

3) Effective use
Where? — SWAT models constructed: 2 models for the White and Black Volta portions of Province du Yatenga, Burkina Faso; 1 model for the lower Tana River Basin of Tana River and Kitui Counties, Kenya
By whom? — (a) Government and NGO technical staff, and (b) provincial and county officials
For what? — (a) Government and NGO technical staff: for consultation with communities on rangeland management, and (b) provincial and county officials in formulating regional grazing management legislation, direction of regional policy implementation, and to provide evidence to national policymakers underscoring management decisions and policies.

4) results
Impacts: positive, failure, unexpected impacts (positive or negative) —
Positive.

What has helped? —
Use of local knowledge in model construction and scenario development.

Main constraints? —

The results require long presentations to farmers and herders. Without ongoing engagement there is no guarantee of long-term influence of the results in management and policy. Limited resources available for model evaluation and refinement mean that uncertainty remains an ethical concern for management recommendations and policy formulation.

Evidence of impact —
Influence of the model results on local planning processes accomplished and documented through project reports. Influence on Tana River County planning and legislation accomplished and documented through project reports.

5) References
https://cgspace.cgiar.org/handle/10568/91682

#28

Restoration tool

Name of respondent and e-mail: Jason Sircely, j.sircely@cgiar.org
Center: ILRI
CRP/Flagship (if relevant): CCAFS

Title: G-Range global rangelands model
Year: 2013-2014

1a) Scale:
Plot — NA
Farm — NA
Landscape — NA

Global scale, with potential for application at regional and national levels

1b) Driver of degradation addressed/reversed
Intense grazing, climate change, atmospheric CO_2 increase, woody encroachment

1c) Stage of the forest transition curve
Forested landscape — NA
Agriculture — NA
Agroforestry — NA

Global rangelands

1d) Entry point:
Biophysical (soil, vegetation) — 3
Economics, livelihoods — 2
Governance, institutions — 1
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
G-Range is an intermediate complexity simulation model primarily useful for global scale application over long time horizons. Its biogeochemical foundation from CENTURY is applied according to dynamic spatial cover of herbaceous and woody plants, and bare ground. Its main purpose is to capture and project rates for major ecosystem processes and services, especially forage and browse production, according to scenarios describing changes in management, climate, and atmospheric CO_2.

3) Effective use
Where? — Rangelands globally—deserts to tundra
By whom? — Researchers
For what? — Use in formulating policy decisions based on projected future rangeland condition and long-term system production potential, data inputs to other modeling frameworks (e.g., IMPACT), among other uses

4) results
Impacts: positive, failure, unexpected impacts (positive or negative) —
NA

What has helped? —
For rangelands, integrating biogeochemistry and vegetation change is essential for long-term projections, since each is affected independently by global change drivers, and each influences one another to create non-linear dynamics in rangeland systems. This is the core advantage of G-Range over other existing ecosystem simulators applicable to rangelands.

Main constraints? —

The main utility of the current implementation of G-Range is large-scale, long-term forecasts useful to decision-making at global, sometimes regional, and in some cases national scale. Using the model for specific questions at fine scales can involve significant tweaking to parameterization and input layers to limit uncertainty in model outputs.

Evidence of impact —
Primarily international public goods, namely publication of G-Range forecasts to 2050 and documentation.

5) References
http://www2.nrel.colostate.edu/projects/grange/index.php
https://cgspace.cgiar.org/handle/10568/35129
https://cgspace.cgiar.org/handle/10568/90404
https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.13995

#29

Restoration tool

Name of respondent and e-mail: Diana Suhardiman
Center: International Water Management Institute/IWMI
CRP/Flagship (if relevant): PIM Flagship 5

Title: Linking land tenure security with food security in Laos
Year: 2017-now (ongoing)

1a) Scale: Farm and landscape within the context of local land use planning
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed
The research unpacks power structure and power relationship sustaining the current chains of land degradation (e.g. sectoral egoism, elite capture, target oriented development perspectives).

1c) Stage of the forest transition curve: Across all three stages
Forested landscape
Agriculture
Agroforestry

1d) Entry point: Governance, institutions (1), Economic, livelihoods (2), and Biophysical (3)
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
In collaboration with The Agro Biodiversity Initiatives (TABI) the research looks at how to further strengthen participatory Forest Agricultural Land Use Planning Allocation and Management (pFALUPAM), in particular by unpacking local institutional arrangements (e.g. informal land rental arrangements, customary land rights) that serve as implementation barriers for local land use plan to become effective.

3) Effective use
Where? Villages in Nambak District, Luang Prabang Province, Laos
By whom? In collaboration with TABI, provincial and district government in Luang Prabang
For what? Land use planning for forest protection while also ensuring local community's livelihood options

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The research has shed light on the need to link current delineation of agricultural and forest land with local institutional arrangements surrounding the use of these lands (e.g. centrality of informal land rental agreement in forest conservation measures).
Main constraints? Target oriented development policy and programs oftentimes do not give sufficient space for shaping local land use planning in line with customary land rights and practices, resulting in the plan non-implementation afterwards.
Evidence of impact: The presentation of land use planning as power struggles as a game, which can be used by various key stakeholders to facilitate decision making processes. The game is currently adopted by TABI and has been incorporated as part of teaching program in national universities in the region (Laos and Thailand).

5) References

1. -Suhardiman, D., Keovilignavong, O., Kenney-Lazar, M. Territorial Politics of Land Use Planning in Laos. Submitted to Land Use Policy
2. -Suhardiman, D., Signs, M. Unraveling power play in land use planning. WLE Blog, 20 July 2018

#30

Restoration tool

Name of respondent and e-mail: Evert Thomas e.thomas@cgiar.org, Rachel Atkinson r.atkinson@cgiar.org
Center: Bioversity International
CRP/Flagship (if relevant): CRP Forests, Trees and Agroforestry (FTA) / flagship project 1 (FP1) / cluster of activities 3 (CoA3)

Title: Laying the foundations for climate-smart restoration: a toolbox for Peru's tropical dry forest
Year: 2018-2020

1a) Scale:
Plot x
Farm x
Landscape x

1b) Driver of degradation addressed/reversed
Developing tools to improve effectiveness of restoration under climate change by considering suitability of species and genetic origin
1c) Stage of the forest transition curve
Forested landscape x
Agriculture x
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) 1
Economics, livelihoods 3
Governance, institutions 2
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
To develop an innovative, climate-smart restoration toolbox that will support decision-making to plan and implement restoration interventions from plot to landscape level using native tree genetic resources. The project will also increase human capacity for climate-smart forest restoration in Peru.
3) Effective use
Where? **Tropical Dry forest, Peru**
By whom? **Decision makers at any level**
For what? **Better planning for restoration**

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact
In development
5) References

#31

Restoration tool

Name of respondent and e-mail: Evert Thomas e.thomas@cgiar.org, Rachel Atkinson r.atkinson@cgiar.org
Center: Bioversity International
CRP/Flagship (if relevant): CRP Forests, Trees and Agroforestry (FTA) / flagship project 1 (FP1) / cluster of activities 3 (CoA3)

Title: A tool for guiding species and seed selection for the restoration of Colombia's tropical dry forest
Year: 2014-2018

1a) Scale:
Plot x
Farm x
Landscape x

1b) Driver of degradation addressed/reversed
Developing tools to improve effectiveness of restoration under climate change by considering suitability of species and genetic origin
1c) Stage of the forest transition curve
Forested landscape x
Agriculture x
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) 1
Economics, livelihoods 3
Governance, institutions 2
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
Develop a scalable approach which is intended to assist restoration practitioners of tropical dry forest in Colombia with the identification of appropriate tree species and sources of forest reproductive materials. Decision making combines information on (i) suitability modeling under current and future climate conditions; (ii) the intended future use of the forest under restoration; (iii) locally prevailing stress conditions; (iv) functional trait diversity of tree species; and (v) the genetic quality of forest reproductive materials.
3) Effective use
Where? Tropical Dry forest, Colombia
By whom? Restoration planners, donors and decision makers at any level
For what? Better planning for restoration
4) results
Impacts: **positive**, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints? Needs to be finalised and advertised that it is available for use
Evidence of impact
References: http://www.restool.org/
Thomas, E. *et al.* The importance of species selection and seed sourcing in forest restoration for enhancing adaptive potential to climate change: Colombian tropical dry forest as a model. *CBD Tech. Ser.* **89,** 122–132 (2017).

#32

Restoration tool

Name of respondent and e-mail: Barbara Vinceti – b.vinceti@cgiar.org
Center: Bioversity International
CRP/Flagship (if relevant): CRP Forests, Trees and Agroforestry (FTA) / flagship project 1 (FP1) / cluster of activities 3 (CoA3)

Title: Laying the foundations for nutrition-sensitive, climate-smart restoration: a toolbox for Burkina Faso's dry forest
Year: 2018
Year: 2020

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Developing tools to improve effectiveness of restoration under climate change by considering suitability of species and genetic origin, with a particular emphasis on food tree species

1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) - 1
Economics, livelihoods - 2
Governance, institutions - 3
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
To develop an innovative, climate-smart restoration toolbox that will support decision-making to plan and implement restoration interventions from plot to landscape level using native tree genetic resources in Burkina Faso. Particular emphasis will be place in documenting characterizing food tree species, for their inclusion in the restoration tool.

3) Effective use
Where? Burkina Faso
By whom? National Tree Seed Center, forest practitioners, national and international projects and initiatives on forest restoration, in selecting species and adapted seed sources to be used
For what? better planning for restoration and tree planting in general

4) results – still in the development phase

#33

Restoration tool

Name of respondent and e-mail: Marius Ekue m.ekue@cgiar.org
Center: Bioversity International (Cameroon)
CRP/Flagship (if relevant): CRP Forests, Trees and Agroforestry (FTA) / flagship project 1 (FP1) / cluster of activities 3 (CoA3)

Title: Laying the foundations for climate-smart restoration: a toolbox for the mosaic forest/savanna ecotone and savanna zones of Cameroon
Year: 2018-2020

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Developing tools to improve effectiveness of restoration under climate change by considering suitability of species and genetic origin

1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) 1
Economics, livelihoods 2
Governance, institutions 3
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
To develop an innovative, climate-smart restoration toolbox that will support decision-making to plan and implement restoration interventions from plot to landscape level using native tree genetic resources. The project will also increase human capacity for climate-smart forest restoration in Cameroon.

3) Effective use
Where? Mosaic forest/savanna, woodland, savanna in **Cameroon**
By whom? Decision makers (e.g. MINFOF) and restoration practitioners (e.g. ANAFOR) at any level
For what? Better planning for restoration

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact
In development
5) References

#34

Conceptual approach to restoration

Name of respondent and e-mail: a.ickowitz@cgiar.org, h.djoudi@ cgiar.org
Center: CIFOR
CRP/Flagship (if relevant): FP4 and FP5

Title: Restoration, Adaptation, Food Security, and Nutrition – what are the links?
Year: 2018

1a) Scale: Tropics and Sub-tropics
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed : N/A

1c) Stage of the forest transition curve : across
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods x
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)
Livelihoods

2) Short description of the approach (2-5 lines)
This is a review study with two parts: a review of actual GEF and World Bank funded projects on restoration as well as a rigorous literature review. We investigate whether and to what extent restoration focused projects are linked to food security, nutrition and livelihood's safety net and adaptation, both in theory and in practice.

3) Used: This is a study done for background and context to understand how restoration projects have thus far operated. It is on-going. When completed, we will develop recommendations which we hope will be used by national policy makers as well as international organizations engaged in restoration work.
Where?
By whom?
For what?

4) Results: not yet. study on-going
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

#35

Conceptual approach to restoration

Name of respondent and e-mail: Bruno Locatelli, bruno.locatelli@cirad.fr
Center: CIRAD and CIFOR
CRP/Flagship (if relevant): FTA flagship 5

Title: A framework to understand the multiple (and sometimes conflicting) contributions of restoration to climate change strategies and the opportunities of integrating restoration to adaptation and mitigation strategies
Year: Since 2011

1a) Scale: **Landscape**
Plot
Farm
Landscape: Yes

1b) Driver of degradation addressed/reversed: **Any**

1c) Stage of the forest transition curve: **Any**
Forested landscape: Yes
Agriculture: Yes
Agroforestry: Yes

1d) Entry point: **All**
Biophysical (soil, vegetation) 3
Economics, livelihoods 2
Governance, institutions 1
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
We reviewed how tropical reforestation (or more generally restoration) can contribute to climate change adaptation and mitigation and proposed an integrated framework to assess or design "climate-smart restoration". We also analyzed the potential and the current integration of adaptation and mitigation in forest policies and projects in several countries or project portfolios.

3) Used
Where? In multiple climate change projects on the ground (Peru and global portfolios), multiple countries (policy analysis in Peru, Brazil, Indonesia), and globally (climate funds).
By whom? Scientists with decision makers
For what? For understanding better how restoration can be integrated into climate change policies. For guiding decision makers in analyzing the contribution of restoration to climate change strategies and managing the tradeoffs between adaptation and mitigation.

4) Results
Impacts: **positive**, failure, unexpected impacts (positive or negative)
What has helped? We have widely communicated on this topic of adaptation-mitigation integration at different levels.
Main constraints? Adaptation and mitigation have traditionally been separated. Some discussions on adaptation-mitigation synergies are seen as too conceptual by some decision makers.
Evidence of impact : Our publications on this topic were cited more than 40 times in a UNEP report on joint adaptation and mitigation in agriculture and forestry (2016) and cited multiple times in other important documents, such as the Peruvian strategy on forests and climate change (2016), an IUCN document on "Synergies between climate mitigation and adaptation in forest landscape restoration" (2015), and an IUFRO-WRI project flyer on "Forest landscape restoration as a strategy for mitigating and adapting to climate change" (2015).

4) References

1. Locatelli B., Catterall C.P., Imbach P., Kumar C., Lasco R., Marín-Spiotta E., Mercer B., Powers J.S., Schwartz N., Uriarte M., 2015. Tropical reforestation and climate change: Beyond carbon. Restoration Ecology 23(4): 337-343. doi:10.1111/rec.12209
2. Locatelli B., Pavageau C., Pramova E., Di Gregorio M., 2015. Integrating climate change mitigation and adaptation in agriculture and forestry: Opportunities and trade-offs. WIREs Climate Change 6(6): 585-598. doi:10.1002/wcc.357
3. Locatelli B., Evans V., Wardell A., Andrade A., Vignola R., 2011. Forests and Climate Change in Latin America: Linking Adaptation and Mitigation. Forests 2(1): 431-450. doi:10.3390/f2010431
4. Di Gregorio M., Nurrochmat D.R. Paavola J., Maya Sari I., Fatorelli L., Pramova E., Locatelli B., Brockhaus M., Dewi S.D.K., 2017. Climate Policy Integration in the land use sector: Mitigation, adaptation and sustainable development linkages. Environmental Science and Policy 67: 35-43. doi:10.1016/j.envsci.2016.11.004
5. Kongsager R., Locatelli B., Chazarin F., 2016. Addressing climate change mitigation and adaptation together: A global assessment of agriculture and forestry projects. Environmental Management 57(2): 271-282. doi:10.1007/s00267-015-0605-y
6. Locatelli B., Fedele G., Fayolle V., Baglee A., 2016. Synergies between adaptation and mitigation in climate change finance. International Journal of Climate Change Strategies and Management 8(1): 112-128. doi:10.1108/IJCCSM-07-2014-0088
7. Pramova E., Locatelli B., Djoudi H., Somorin O., 2012. Forests and trees for social adaptation to climate variability and change. WIREs Climate Change 3: 581-596. doi:10.1002/wcc.195

#36

Conceptual approach to restoration

Name of respondent and e-mail: Bruno Gerard b.gerard@cgiar.org
Center: CIMMYT
CRP/Flagship (if relevant): MAIZE and WHEAT FP4
MAIZE: Sustainable Intensification of Maize-based Systems for Improved Smallholder Livelihoods
WHEAT: Sustainable intensification of wheat-based farming systems

Title:
Year: 2017-

1a) Scale:
Plot Field Agronomy:
- Conservation Agriculture
- Water use efficiency in both irrigated (Asia and Mexico) and rainfed (East and Southern Africa, LAC) maize and wheat based systems
- Nutrient use efficiency
- Labor use efficiency
- GxExM
- GHG emission reduction
- Yield enhancement and stability, CC adaptation

Farm
- Integration/promotion of improved management practices at farm level
- Multi-level, multi-criteria assessments at farm level for farm/site specific SI options/opportunities (targeting and integration of field level technologies and options based)
- Structural and functional typologies for better targeting of technologies

Landscape
- SI indicators and metrics at landscape scale
- Land sparing and diversification opportunities through increase yields of staple cereals
- Series of collective/participatory approaches and actions at landscape level in large flagship projects such as CSISA, MasAgro, SIMLESA, CCAFS Climate Smart Villages
- Collective land planning in one watershed
- Agroforestry in maize based systems of Ethiopia and Rwanda
- Landscape level assessment of the role of forests in Ethiopian agro-ecosystems (with CIFOR)

1b) Driver of degradation addressed/reversed
Soil erosion and soil health is present in all our projects
Indirectly, deforestation through intensification (land sparing but somehow difficult to assess)
Ground water depletion in South Asia
Air quality through alternatives to crop residue burning in South Asia

1c) Stage of the forest transition curve
Various: It depends on geographies of intervention:
Forested landscape (ESA, fragmented landscapes with co-existence of agricultural land and forests)
Agriculture (South Asia)
Agroforestry (East and Southern Africa)

1d) Entry point:
Our approach is by design multi-disciplinary so our R4D framework attempts to integrate entry-points
1) Biophysical (soil, vegetation)
2) Economics, livelihoods
3) Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
Flagship approach (high level implemented in suite of projects)

Strategic efforts to boost cereal productivity can increase smallholders' food and income security, while also improving livelihoods, natural resource integrity, equity, nutrition and health, and resilience against biophysical or socioeconomic shocks. These are all urgent development priorities. However, most smallholder farmers' livelihoods do not depend exclusively on cereals. Their farming systems are characterized by complex strategies that integrate crop, tree and livestock production, with increasing reliance on off-farm income, and a strong risk management component that can hamper the adoption of innovations that focus on cereals alone.
Our FP4 work encompasses (a) production of more food, feed, fuel and/or fiber per hectare, labor and/or capital used, by closing yield gaps and increasing yield per unit of time and area; (b) conservation of critical agroecosystem regulatory and provisioning services; and (c) farming system resilience to shocks and stresses, including those posed by climate change and market shocks. It also seeks to address social justice, gender equity, and youth inclusivity and human well-being

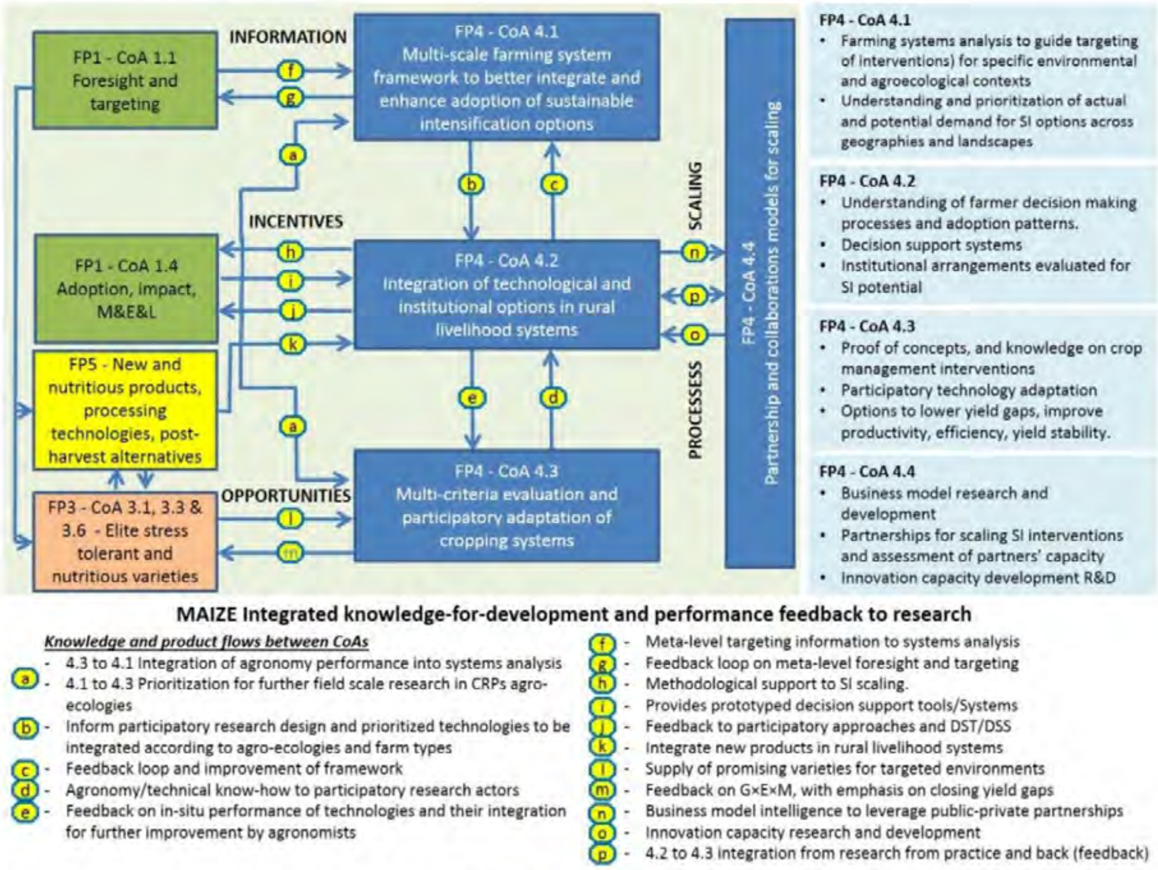


Figure 2.6: FP4 CoAs and knowledge/product flows and feedback loops with FP1, FP3 and FP5. CoA 4.1 and 4.3 provide targeting information and cropping systems opportunities, respectively, and operate at different analytical scales (region, landscape, farm and field), while integrating research results from CoAs 1.1, 3.1 and 3.3. CoA 4.2 operates as the central node by which farmer decision-making and instructional incentives can be assessed, providing feedback to CoA 1.4. This results in the identification of scalable research products and technologies that are extended through research results that inform scaling processes in CoA 4.4.

3) Used
Where?
Wheat and Maize based systems
By whom?
Large range of partners and institutions
For what?
Scaling

4) Results
a) Impacts: positive, failure, unexpected impacts (positive or negative)
Overall positive. Documented through multiple project reports and CRP reports but mostly focused on crop productivity and livelihood through adoption of improved crop management practices. Impact

assessment on soil conservation and indirect impact on deforestation are challenging from a methodology standpoint. What has helped?
Diverse and strong partnership. Co-construction in participatory approaches. Integrated approaches. Good funding level
b) Main constraints?
Projects timeframe, methods and resources for impact assessment
c) Evidence of impact
Documented through project and CRP reports.

4) References

Subset of MAIZE and WHEAT FP4 publications (2016 – today) selected relevant to soil conservation/soil health, water management, forestry and agroforestry or other environmental aspects.

1. Araya, T., Nyssen, J., Govaerts, B., Deckers, J., Sommer, R., Bauer, H., Gebrehiwot, K., Cornelis, W.M., 2016. Seven years resource-conserving agriculture effect on soil quality and crop productivity in the Ethiopian drylands. Soil Tillage Res. 163, 99–109. doi:10.1016/j.still.2016.05.011
2. Arshad, M., Amjath-Babu, T.S., Krupnik, T.J., Aravindakshan, S., Abbas, A., Kächele, H., Müller, K., 2017a. Climate variability and yield risk in South Asia's rice–wheat systems: Emerging evidence from Pakistan. Paddy Water Environ. 15, 249–261. doi:10.1007/s10333-016-0544-0
3. Aryal, J.P., Jat, M.L., Sapkota, T.B., Khatri-Chhetri, A., Kassie, M., Rahut, D.B., Maharjan, S., 2018a. Adoption of multiple climate-smart agricultural practices in the Gangetic plains of Bihar, India. Int. J. Clim. Chang. Strateg. Manag. 10, 407–427. doi:10.1108/IJCCSM-02-2017-0025
4. Aryal, J.P., Sapkota, T.B., Stirling, C.M., Jat, M.L., Jat, H.S., Rai, M., Mittal, S., Sutaliya, J.M., 2016. Conservation agriculture-based wheat production better copes with extreme climate events than conventional tillage-based systems: A case of untimely excess rainfall in Haryana, India. Agric. Ecosyst. Environ. 233, 325–335. doi:10.1016/j.agee.2016.09.013
5. Baudron, F., Duriaux Chavarría, J.-Y., Remans, R., Yang, K., Sunderland, T., 2017. Indirect contributions of forests to dietary diversity in Southern Ethiopia. Ecol. Soc. 22. doi:10.5751/ES-09267-220228
6. Bera, T., Sharma, S., Thind, H.S., Sidhu, H.S., Jat, M.L., 2018. Soil biochemical changes at different wheat growth stages in response to conservation agriculture practices in a rice-wheat system of north-western India. Soil Res. 56, 91–104.
7. Chávez-Romero, Y., Navarro-Noya, Y.E., Reynoso-Martínez, S.C., Sarria-Guzmán, Y., Govaerts, B., Verhulst, N., Dendooven, L., Luna-Guido, M., 2016. 16S metagenomics reveals changes in the soil bacterial community driven by soil organic C, N-fertilizer and tillage-crop residue management. Soil Tillage Res. doi:10.1016/j.still.2016.01.007
8. Cheesman, S., Thierfelder, C., Eash, N.S., Kassie, G.T., Frossard, E., 2016. Soil carbon stocks in conservation agriculture systems of Southern Africa. Soil Tillage Res. 156, 99–109.
9. Choudhary, M., Datta, A., Jat, H.S., Yadav, A.K., Gathala, M.K., Sapkota, T.B., Das, A.K., Sharma, P.C., Jat, M.L., Singh, R., Ladha, J.K., 2018a. Changes in soil biology under conservation agriculture based sustainable intensification of cereal systems in Indo-Gangetic Plains. Geoderma 313, 193–204. doi:10.1016/j.geoderma.2017.10.041
10. Choudhary, M., Jat, H.S., Datta, A., Yadav, A.K., Sapkota, T.B., Mondal, S., Meena, R.P., Sharma, P.C., Jat, M.L., 2018b. Sustainable intensification influences soil quality, biota, and productivity in cereal-based agroecosystems. Appl. Soil Ecol.
11. Choudhary, M., Sharma, P.C., Jat, H.S., Dash, A., Rajashekar, B., McDonald, A.J., Jat, M.L., 2018. Soil bacterial diversity under conservation agriculture-based cereal systems in Indo-Gangetic Plains. 3 Biotech 8. doi:10.1007/s13205-018-1317-9
12. Corbeels, M., Cardinael, R., Naudin, K., Guibert, H., Torquebiau, E., 2018. The 4 per 1000 goal and soil carbon storage under agroforestry and conservation agriculture systems in sub-Saharan Africa. Soil Tillage Res.
13. Das, T.K., Saharawat, Y.S., Bhattacharyya, R., Sudhishri, S., Bandyopadhyay, K.K., Sharma, A.R., Jat, M.L., 2018. Conservation agriculture effects on crop and water productivity, profitability and soil organic carbon accumulation under a maize-wheat cropping system in the North-western Indo-Gangetic Plains. F. Crop. Res. 215, 222–231. doi:10.1016/j.fcr.2017.10.021
14. Ditzler, L., Klerkx, L., Chan-Dentoni, J., Posthumus, H., Krupnik, T.J., Ridaura, S.L., Andersson, J.A., Baudron, F., Groot, J.C.J., 2018. Affordances of agricultural systems

analysis tools: A review and framework to enhance tool design and implementation. Agric. Syst. 164, 20–30. doi:10.1016/j.agsy.2018.03.006

15. Duncan, A.J., Bachewe, F., Mekonnen, K., Valbuena, D., Rachier, G., Lule, D., Bahta, M., Erenstein, O., 2016. Crop residue allocation to livestock feed, soil improvement and other uses along a productivity gradient in Eastern Africa. Agric. Ecosyst. Environ. 228, 101–110. doi:10.1016/j.agee.2016.05.011
16. Duriaux Chavarría, J.-Y., Baudron, F., Sunderland, T., 2018. Retaining forests within agricultural landscapes as a pathway to sustainable intensification: Evidence from Southern Ethiopia. Agric. Ecosyst. Environ. 263, 41–52. doi:10.1016/j.agee.2018.04.020
17. Fisher, M., Holden, S.T., Thierfelder, C., Katengeza, S.P., 2018. Awareness and adoption of conservation agriculture in Malawi: what difference can farmer-to-farmer extension make? Int. J. Agric. Sustain. doi:10.1080/14735903.2018.1472411
18. Jat, H.S., Datta, A., Sharma, P.C., Kumar, V., Yadav, A.K., Choudhary, M., Choudhary, V., Gathala, M.K., Sharma, D.K., Jat, M.L., Yaduvanshi, N.P.S., Singh, G., McDonald, A., 2017. Assessing soil properties and nutrient availability under conservation agriculture practices in a reclaimed sodic soil in cereal-based systems of North-West India. Arch. Agron. Soil Sci. doi:10.1080/03650340.2017.1359415
19. Jat, M.L., Bijay-Singh, Stirling, C.M., Jat, H.S., Tetarwal, J.P., Jat, R.K., Singh, R., Lopez-Ridaura, S., Shirsath, P.B., 2018. Soil Processes and Wheat Cropping Under Emerging Climate Change Scenarios in South Asia. Adv. Agron. doi:10.1016/bs.agron.2017.11.006
20. Jat, R.D., Jat, H.S., Nanwal, R.K., Yadav, A.K., Bana, A., Choudhary, K.M., Kakraliya, S.K., Sutaliya, J.M., Sapkota, T.B., Jat, M.L., 2018. Conservation agriculture and precision nutrient management practices in maize-wheat system: Effects on crop and water productivity and economic profitability. F. Crop. Res. 222, 111–120. doi:https://doi.org/10.1016/j.fcr.2018.03.025
21. Jiménez-Bueno, N.G., Valenzuela-Encinas, C., Marsch, R., Ortiz-Gutiérrez, D., Verhulst, N., Govaerts, B., Dendooven, L., Navarro-Noya, Y.E., 2016. Bacterial indicator taxa in soils under different long-term agricultural management. J. Appl. Microbiol. doi:10.1111/jam.13072
22. Kebede, Y., Bianchi, F., Baudron, F., Abraham, K., de Valença, A., Tittonell, P., 2018a. Implications of changes in land cover and landscape structure for the biocontrol potential of stemborers in Ethiopia. Biol. Control 122, 1–10. doi:10.1016/j.biocontrol.2018.03.012
23. Krupnik, T.J., Schulthess, U., Ahmed, Z.U., McDonald, A.J., 2017. Sustainable crop intensification through surface water irrigation in Bangladesh? A geospatial assessment of landscape-scale production potential. Land use policy 60, 206–222. doi:10.1016/j.landusepol.2016.10.001
24. Kumar, V., Jat, H.S., Sharma, P.C., Balwinder-Singh, Gathala, M.K., Malik, R.K., Kamboj, B.R., Yadav, A.K., Ladha, J.K., Raman, A., Sharma, D.K., McDonald, A., 2018. Can productivity and profitability be enhanced in intensively managed cereal systems while reducing the environmental footprint of production? Assessing sustainable intensification options in the breadbasket of India. Agric. Ecosyst. Environ. 252, 132–147. doi:10.1016/j.agee.2017.10.006
25. Liben, F.M., Tadesse, B., Tola, Y.T., Wortmann, C.S., Kim, H.K., Mupangwa, W., 2018. Conservation agriculture effects on crop productivity and soil properties in Ethiopia. Agron. J. 110, 758–767. doi:10.2134/agronj2017.07.0384
26. Lohan, S.K., Jat, H.S., Yadav, A.K., Sidhu, H.S., Jat, M.L., Choudhary, M., Peter, J.K., Sharma, P.C., 2018. Burning issues of paddy residue management in north-west states of India. Renew. Sustain. Energy Rev. 81, 693–706. doi:10.1016/j.rser.2017.08.057
27. Luedeling, E., Smethurst, P.J., Baudron, F., Bayala, J., Huth, N.I., van Noordwijk, M., Ong, C.K., Mulia, R., Lusiana, B., Muthuri, C., Sinclair, F.L., 2016. Field-scale modeling of tree–crop interactions: Challenges and development needs. Agric. Syst. 142, 51–69.
28. Mashingaidze, N., Twomlow, S., Madakadze, I.C., Mupangwa, W., Mavunganidze, Z., 2017. Weed growth and crop yield responses to tillage and mulching under different crop rotation sequences in semi-arid conditions. Soil Use Manag. 33, 311–327. doi:10.1111/sum.12338
29. Naresh, R.K., Gupta, R.K., Jat, M.L., Singh, S.P., Dwivedi, A., Dhaliwal, S.S., Kumar, V., Kumar, L., Singh, O., Singh, V., Kumar, A., Rathore, R.S., 2016. Tillage, irrigation levels and rice straw mulches effects on wheat productivity, soil aggregates and soil organic carbon dynamics after rice in sandy loam soils of subtropical climatic conditions. J. Pure Appl. Microbiol. 10, 1987–2002.

30. Ndoli, A., Baudron, F., Schut, A.G.T., Mukuralinda, A., Giller, K.E., 2017. Disentangling the positive and negative effects of trees on maize performance in smallholdings of Northern Rwanda. F. Crop. Res. 213, 1–11. doi:10.1016/j.fcr.2017.07.020
31. Ndoli, A., Baudron, F., Sida, T.S., Schut, A.G.T., van Heerwaarden, J., Giller, K.E., 2018a. Conservation agriculture with trees amplifies negative effects of reduced tillage on maize performance in East Africa. F. Crop. Res. 221, 238–244. doi:10.1016/j.fcr.2018.03.003
32. Parihar, C.M., Kumar, B., Jat, S.L., Singh, A.K., Jat, M.L., Chaudhary, V., Dass, S., 2016b. Specialty Corn for Nutritional Security and Dietary Diversification, in: Biofortification of Food Crops. Springer, pp. 387–398.
33. Parihar, C.M., Parihar, M.D., Sapkota, T.B., Nanwal, R.K., Singh, A.K., Jat, S.L., Nayak, H.S., Mahala, D.M., Singh, L.K., Kakraliya, S.K., Stirling, C.M., Jat, M.L., 2018b. Long-term impact of conservation agriculture and diversified maize rotations on carbon pools and stocks, mineral nitrogen fractions and nitrous oxide fluxes in inceptisol of India. Sci. Total Environ. 640–641, 1382–1392. doi:10.1016/j.scitotenv.2018.05.405
34. Powlson, D.S., Stirling, C.M., Thierfelder, C., White, R.P., Jat, M.L., 2016. Does conservation agriculture deliver climate change mitigation through soil carbon sequestration in tropical agro-ecosystems? Agric. Ecosyst. Environ. 220, 164–174.
35. Sapkota, T.B., Aryal, J.P., Khatri-Chhetri, A., Shirsath, P.B., Arumugam, P., Stirling, C.M., 2018. Identifying high-yield low-emission pathways for the cereal production in South Asia. Mitig. Adapt. Strateg. Glob. Chang. 23, 621–641. doi:10.1007/s11027-017-9752-1
36. Sapkota, T.B., Aryal, J.P., Khatri-Chhetri, A., Shirsath, P.B., Arumugam, P., Stirling, C.M., 2018. Identifying high-yield low-emission pathways for the cereal production in South Asia. Mitig. Adapt. Strateg. Glob. Chang. 23, 621–641. doi:10.1007/s11027-017-9752-1
37. Sapkota, T.B., Jat, M.L., Jat, R.K., Kapoor, P., Stirling, C., 2016. Yield estimation of food and non-food crops in smallholder production systems, in: Methods for Measuring Greenhouse Gas Balances and Evaluating Mitigation Options in Smallholder Agriculture. pp. 163–174. doi:10.1007/978-3-319-29794-1_8
38. Sapkota, T.B., Jat, R.K., Singh, R.G., Jat, M.L., Stirling, C.M., Jat, M.K., Bijarniya, D., Kumar, M., Yadvinder-Singh, Saharawat, Y.S., Gupta, R.K., 2017a. Soil organic carbon changes after seven years of conservation agriculture in a rice-wheat system of the eastern Indo-Gangetic Plains. Soil Use Manag. doi:10.1111/sum.12331
39. Sida, T.S., Baudron, F., Deme, D.A., Tolera, M., Giller, K.E., 2018. Excessive pruning and limited regeneration: Are Faidherbia albida parklands heading for extinction in the Central Rift Valley of Ethiopia? L. Degrad. Dev. 29, 1623–1633. doi:10.1002/ldr.2959
40. Sida, T.S., Baudron, F., Hadgu, K., Derero, A., Giller, K.E., 2018a. Crop vs. tree: Can agronomic management reduce trade-offs in tree-crop interactions? Agric. Ecosyst. Environ. 260, 36–46. doi:https://doi.org/10.1016/j.agee.2018.03.011
41. Sida, T.S., Baudron, F., Kim, H., Giller, K.E., 2018b. Climate-smart agroforestry: Faidherbia albida trees buffer wheat against climatic extremes in the Central Rift Valley of Ethiopia. Agric. For. Meteorol. 248, 339–347. doi:10.1016/j.agrformet.2017.10.013
42. Singh, V.K., Dwivedi, B.S., Singh, S.K., Majumdar, K., Jat, M.L., Mishra, R.P., Rani, M., 2016. Soil physical properties, yield trends and economics after five years of conservation agriculture based rice-maize system in north-western India. Soil Tillage Res. 155, 133–148.
43. Steward, P.R., Dougill, A.J., Thierfelder, C., Pittelkow, C.M., Stringer, L.C., Kudzala, M., Shackelford, G.E., 2018. The adaptive capacity of maize-based conservation agriculture systems to climate stress in tropical and subtropical environments: A meta-regression of yields. Agric. Ecosyst. Environ. 251, 194–202. doi:10.1016/j.agee.2017.09.019
44. Subbarao, G. V, Arango, J., Masahiro, K., Hooper, A.M., Yoshihashi, T., Ando, Y., Nakahara, K., Deshpande, S., Ortiz-Monasterio, I., Ishitani, M., Peters, M., Chirinda, N., Wollenberg, L., Lata, J.C., Gerard, B., Tobita, S., Rao, I.M., Braun, H.J., Kommerell, V., Tohme, J., Iwanaga, M., 2017. Genetic mitigation strategies to tackle agricultural GHG emissions: The case for biological nitrification inhibition technology. Plant Sci. 262, 165–168. doi:10.1016/j.plantsci.2017.05.004
45. Sunderland, T., Abdoulaye, R., Ahammad, R., Asaha, S., Baudron, F., Deakin, E., Duriaux, J.-Y., Eddy, I., Foli, S., Gumbo, D., Khatun, K., Kondwani, M., Kshatriya, M., Leonald, L., Rowland, D., Stacey, N., Tomscha, S., Yang, K., Gergel, S., Van Vianen, J., 2016. A methodological approach for assessing cross-site landscape change: Understanding socio-ecological systems. For. Policy Econ. doi:10.1016/j.forpol.2017.04.013
46. Vetter, S.H., Sapkota, T.B., Hillier, J., Stirling, C.M., Macdiarmid, J.I., Aleksandrowicz, L., Green, R., Joy, E.J.M., Dangour, A.D., Smith, P., 2017. Greenhouse gas emissions from

agricultural food production to supply Indian diets: Implications for climate change mitigation. Agric. Ecosyst. Environ. 237, 234–241. doi:10.1016/j.agee.2016.12.024
47. Wood, S.A., Baudron, F., 2018. Soil organic matter underlies crop nutritional quality and productivity in smallholder agriculture. Agric. Ecosyst. Environ. 266, 100–108. doi:10.1016/j.agee.2018.07.025
48. Yadav, M.R., Parihar, C.M., Jat, S.L., Singh, A.K., Kumar, R., Yadav, R.K., Kuri, B.R., Parihar, M.D., Yadav, B., Verma, A.P., Jat, M.L., 2017a. Long term effect of legume intensified crop rotations and tillage practices on productivity and profitability of maize vis-a-vis soil fertility in North-Western Indo-Gangetic Plains of India. Legum. Res. 40, 282–290. doi:10.18805/lr.v0i0.7583
49. Zhang, Z., Qiang, H., McHugh, A.D., He, J., Li, H., Wang, Q., Lu, Z., 2016. Effect of conservation farming practices on soil organic matter and stratification in a mono-cropping system of Northern China. Soil Tillage Res. 156, 173–181.

#37

Conceptual approach to restoration

Name of respondent and e-mail: Endri Martini (emartini@cgiar.org); James Roshetko (jroshetko@cgiar.org)
Center: ICRAF
CRP/Flagship (if relevant):

Title: Farmer-to-farmer approach
Year: 2011-present – also implemented previously in other locations as the approach was being developed

1a) Scale:
Plot
Farm – **primarily here, impact at plot and landscape scale**
Landscape

1b) Driver of degradation addressed/reversed

1c) Stage of the forest transition curve
Forested landscape - **impact here**
Agriculture – **also here**
Agroforestry – **primarily here**

1d) Entry point:
Biophysical (soil, vegetation) – **here also**
Economics, livelihoods- primarily here
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)

3) Used
Where? – Sulawesi, Sumatra, Yogyakarta, West Java, Nusa Tenggara
By whom? ICRAF
For what? Focus on improving land management to increase livelihoods

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

1. Martini E, Roshetko JM, Paramita E. 2017. Can farmer-to-farmer communication boost the dissemination of agroforestry innovations? A case study in Sulawesi, Indonesia. *Agroforestry Systems* 91: (5) 811-824. http://link.springer.com/article/10.1007/s10457-016-0011-3
2. Martini E, Riyandoko, Roshetko JM. 2017. Guidelines for establishing coffee agroforestry systems. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. ISBN: 978-979-3198-97-2.
3. Roshetko, JM, N Idris, P Purnomosidhi, T Zulfadhli, and J Tarigan. 2013. Farmer extension approach to rehabilitate smallholder fruit agroforestry systems: the “Nurseries of excellence (NOEL)” program in Aceh, Indonesia. *Acta Hort. (ISHS)* 975:649-656 (http://www.actahort.org/books/975/975_81.htm)
4. Gaol AL, Roshetko JM. 2017. Agroforestry and Forestry in Sulawesi series: Impact of agricultural-extension booklets on community livelihoods in South and Southeast Sulawesi. Working Paper 259. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. DOI: 10.5716/WP17125.PDF.

#38

Conceptual approach to restoration

Name of respondent and e-mail: Peter Minang a.minang@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant):

Title: Trends of governance in landscape restoration
Year: 2018

1a) Scale: Landscape
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed Any

1c) Stage of the forest transition curve: Across
Forested landscape: Yes
Agriculture: Yes
Agroforestry: Yes

1d) Entry point: Governance, Institutions, incentives for land restoration
Biophysical (soil, vegetation): No
Economics, livelihoods: No
Governance, institutions: Yes
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
This is a systematic review on governance in restoration as well as a rigorous literature review. We investigate best-practice principles of good governance in restoration projects, the institutional dynamics, development challenges and to what incentives are required for restoration, both in theory and in practice.

3) Used: This is an ongoing study to provide the context for understanding trends in governance of restoration projects and best practices. When complete, we will advance recommendations which we hope will be used by policy makers to guide decision-making on land management and restoration work.
Where?
By whom?
For what?

4) Results: On-going study
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

#39

Conceptual approach to restoration

Name of respondent and e-mail: Fiona Flintan f.flintan@cgiar.org
Center: ILRI
CRP/Flagship (if relevant): PIM and Livestock

Title: Participatory Rangeland Management
Starting year: 2010
Ending year: Ongoing
Place: Ethiopia, now being taken up in Kenya and Tanzania

1a) Scale:
Plot
Farm
Landscape – rangeland units

1b) Driver of degradation addressed/reversed
- Diminishing customary authority and management of rangelands
- Lack of land and resource tenure security
- Lack of investment in improvement of rangeland productivity and reversal of degradation such as management of invasive species and bush encroachment
- Lack of tools for large-scale restoration of rangelands

1c) Stage of the rangeland transition curve
Rangeland landscape x
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation) 2
Economics, livelihoods 3
Governance, institutions 1
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the approach (2-5 lines)
In 2010 the process of PRM (participatory rangeland management) was developed with an Introductory Manual see: . https://cgspace.cgiar.org/handle/10568/99430

Since that time the process has been piloted by a number of organisations in Ethiopia, and then scaled-up to large scale areas of the pastoral areas through a USAID-funded pastoralism-focused project. In 2017-18 ILRI conducted a review of the implementation of PRM in Ethiopia. ILRI is providing technical support to the piloting of PRM in Kenya and Tanzania through an EU-grant to the International Land Coalition.

3) Used
Currently used extensively in rangelands of Ethiopia, and being piloted in Kenya and Tanzania. Potential to be use in all rangelands.
Mainly supported by NGOs as has not been mainstreamed/institutionalized in government policy and legislation though government involved in its implementation on the ground.

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
Impacts have included the development of multi-stakeholder bodies for management of rangelands. In some places cooperatives rather than customary institutions have been developed, which have become more economic/business oriented rather than playing a management role. Some NGOs have implemented PRM at landscape level, which has worked from a higher-level planning and governance perspective, but has left-out its implementation and 'ownership' by communities on the ground. Other NGOs have focused on the local level, and compromised the higher-level landscape planning which has resulted in some secondary users of the rangeland being missed out of decision-making

processes. Overall women's involvement in PRM has been good and their increased role in natural resource management and related decision-making processes is highlighted as a key result. In all cases of implementation to date there has been little attention paid at national level to instill supporting policy and legislation – and therefore there is still a gap here.

5) References

1. Draft report of Review of Participatory Rangeland Management in Ethiopia (2018). Flintan *et al.* Forthcoming.
2. Participatory Rangeland Management Planning and Its Implementation in Ethiopia. Paper presented at the WB Conference on Land and Poverty March 2015. Sisay Awgachew, Fiona Flintan and Solomon Bekure. https://cgspace.cgiar.org/bitstream/handle/10568/67916/Participatory_Rangeland_Management_Ethiopia.pdf;sequence=1
3. An evaluation of participatory rangeland management and its impact on land security, land use planning, rangeland governance and productivity. Fiona Flintan, Abule Ebro, Bedasa Eba, Katie Reytar and Zelalem Gebreyohannes. Poster presented at the WB Conference on Land and Poverty, March 2018. https://www.cgiar.org/research/publication/evaluation-participatory-rangeland-management-ethiopia-impact-land-security-land-use-planning-rangeland-governance-productivity
4. Mapping Guidelines for Participatory Rangeland Management in Pastoral and Agro-Pastoral Areas. Ben Irwin, Adrian Cullis and Fiona Flintan 2015 https://www.prime-ethiopia.org/wp-content/uploads/2016/06/Mapping%20Guidelines_PRM.pdf
5. Introductory Guidelines to Participatory Rangeland Management (2010) Fiona Flintan and Adrian Cullis. https://www.slideshare.net/coppldsecretariat/introductory-guidelines-prm

#40

Conceptual approach to restoration

Name of respondent and e-mail: Fiona Flintan f.flintan@cgiar.org
Center: ILRI
CRP/Flagship (if relevant): PIM and Livestock

Title: Sustainable Rangeland Management Project including Joint Village Land Use Planning
Starting year: 2012 onwards
Ending year: Ongoing
Place: Tanzania

1a) Scale:
Plot
Farm
Landscape – rangeland units

1b) Driver of degradation addressed/reversed

- Diminishing customary authority and management of rangelands
- Poorly implemented policy and legislation
- Lack of land and resource tenure security
- Lack of investment in improvement of rangeland productivity and reversal of degradation such as management of invasive species and bush encroachment
- Lack of tools for large-scale restoration of rangelands

1c) Stage of the rangeland transition curve
Rangeland landscape x
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation) 2
Economics, livelihoods 3
Governance, institutions 1
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
Between 2010 and 2015, the Sustainable Rangeland Management Project (SRMP) assisted nine villages to carry out VLUP. Joint village planning was piloted successfully across three of these villages, leading to their protection through certification of a shared grazing area called Olengapa, found in Kiteto district, Manyara region. SRMP has now entered its third phase (2016–2020) with the financial support of International Fund for Agricultural Development of the United Nations, Irish Aid, the International Land Coalition (ILC), ILRI and the government of Tanzania. ILRI is managing this third phase. This phase is focusing on the scaling-up of the joint VLUP approach in several new clusters of villages, as well as expanding the original ones. This includes the securing of grazing areas through the provision of group CCROs (Certificates of Customary Rights of Occupancy) and improving the management of the areas by the established Livestock Keepers Association. ILRI is also undertaking action research on issues such as rangeland rehabilitation, and improvement and intensification of rangeland and livestock productivity; as well as research on pastoral women and access to resources and land. A new ILC-supported project started in 2018 is piloting participatory rangeland management (PRM) in the secured grazing areas – ILRI is providing technical support to this project.

3) Used
Joint village land use planning is used in clusters of villages that share resources such as grazing or water. Specific to Tanzania and supported by facilitating policy and legislation there is opportunity to transfer the concepts of the approach elsewhere. Being a governmental process, it is implemented by government with local communities, often supported by NGOs.

4) Results

Impacts: positive, failure, unexpected impacts (positive or negative)
The process is long requiring strong investment of time and resources, and the facilitation of negotiations between different land users. The community and local government (including village government institutions) are in the driving seat however, so there is strong local ownership. The process requires agreement over land uses which can stir up disagreement in the short-term but should lead to agreement and resolution of often long-standing confusions and sometimes conflicts over land use. The process leads to the establishment of management bodies ready for improving management of the rangeland (grazing and other resources), increases security of tenure, and incentives to invest in the land including rangeland rehabilitation.

A facilitating policy and legislation have been important.

4) References

1. Victor Mwita, Deus Kalenzi and Fiona Flintan (2017). *Joint village land use planning in Tanzania: A process to enhance the securing of rangelands and resolving land use conflicts.* A paper presented at the 2017 Conference on Land Policy in Africa, 14-17 November 2017, Addis Ababa Ethiopia, organised by the African Union Land Policy Initiative.
2. Kisambu, N., Flintan, F., Daley, E. and Pallas, S. 2017. Pastoral women's land rights and village land use planning in Tanzania: Experiences from the sustainable rangeland management project. Paper presented at the 2017 World Bank Conference on Land and Poverty, Washington DC, 20-24 March 2017.http://hdl.handle.net/10568/80082
3. No. 2 Participatory rangeland resource mapping as a valuable tool for village land use planning in Tanzania. https://cgspace.cgiar.org/handle/10568/90495
4. No. 7 Improving the implantation of land policy and legislation in pastoral areas of Tanzania: Experiences of joint village land use agreements and planning. https://cgspace.cgiar.org/handle/10568/79796
5. No. 1 Securing pastoral women's land rights in Tanzania https://cgspace.cgiar.org/handle/10568/89483

#41

Conceptual approach to restoration

Name of respondent and e-mail: Rachel Atkinson r.atkinson@cgiar.org ; Evert Thomas e.thomas@cgiar.org
Center: Bioversity International (Peru)
CRP/Flagship (if relevant):

Title: Seed supply systems for the implementation of landscape restoration under Initiative 20x20: An analysis of national seed systems in Mexico, Guatemala, Costa Rica, Colombia, Peru, Chile and Argentina
Year: 2017

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Addressing the need for seed supply systems for restoration projects

1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions x
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
This report presents a baseline of the national seed supply systems in 7 Latin American countries, drawing on knowledge from members of LAFORGEN, the Latin American Network of Forest Genetic Resources, as well as other experts. The resulting baselines were qualitatively assessed against a set of indicators for a fit-for purpose seed system in order to identify gaps in current systems and set priorities for action.
3) Used
Where? Analysis carried out in Mexico, Guatemala, Costa Rica, Colombia, Peru, Chile, Argentina but system of indicators for any country
By whom? To be provided to governments to identify weaknesses in their systems, options for horizontal knowledge transfer and as a system for monitoring advances
For what? Understand the status quo, identify weaknesses in their systems, options for horizontal knowledge transfer and as a system for monitoring advances

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact
The document has yet to be socialised with governments
4) References
Atkinson R., Thomas E., Cornelius J., Zamora R. & M. Franco Chuaire (2017) Seed supply systems for the implementation of landscape restoration under Initiative 20x20: An analysis of national seed systems in Mexico, Guatemala, Costa Rica, Colombia, Peru, Chile and Argentina. World Resources Institute, Bioversity International, ICRAF. XXXX

Not yet published but available on Research Gate and via Bioversity web pages

#42

Approaches and conceptual frameworks, including evaluations

Name of respondent and e-mail: Christopher Kettle c.kettle@cgiar.org
Center: Bioversity International
CRP/Flagship (if relevant): FTA
Title: Evaluation of genetic diversity of brazil nut seedlings used in restoration of degraded lands in Madre di Dios Peru
Starting year: 2016
Ending year: 2020
Place: Peru
1a) Scale:
Plot
Farm
Landscape x
1b) Driver of degradation addressed/reversed
Evaluating the quality and genetic diversity of seed collections and seedlings of Brazil nut for enrichment planting
1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry
1d) Entry point:
Biophysical (soil, vegetation) -- 1
Economics, livelihoods – 2
Governance, institutions -- 3
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
Evaluating the genetic diversity
3) results – still at data collection stage –
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? Strong collaboration with international university and local government agencies
Main constraints? None
Evidence of impact
4) References www.sustain.pe

#43

Approaches and conceptual frameworks , including evaluations

Name of respondent and e-mail: Christopher Kettle c.kettle@cgiar.org and, Riina Jalonen (Bioversity-Malaysia) <r.jalonen@cgiar.org>
Center: Bioversity International
CRP/Flagship (if relevant): FTA
Title: Developing indicators for Genetic conservation units of native trees to deliver resilient seed supply systems for priority tree species in S E Asia
Starting year: 2018
Ending year: 2022
Place: Malaysia, Indonesia, Vietnam (S E Asia)
1a) Scale:
Plot
Farm
Landscape x
1b) Driver of degradation addressed/reversed
Ensuring genetic diversity conservation and delivery of suitably adapted seed sources for restoration of degraded landscapes in SE Asia
1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry
1d) Entry point:
Biophysical (soil, vegetation) -- 1
Economics, livelihoods – 2
Governance, institutions -- 3
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
This is a PhD project which will develop indicators of genetic diversity of native tree species and build a theoretical framework for planning genetic conservation units for native tree species in SE Asia, as a foundation of resilient seed systems. It will also examine the social barriers to resilient community-based seed system establishment for restoration.
3) results – inception stage –
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? Strong collaboration with international university
Main constraints? None
Evidence of impact
4) References

#44

Conceptual approach to restoration

Name of respondent and e-mail: Riina Jalonen r.jalonen@cgiar.org
Center: Bioversity International (Malaysia)
CRP/Flagship (if relevant): FTA, FP1

Title: Global survey on seed sourcing practices for restoration
Year: 2015-2017

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Assessment of the success in restoring viable and adaptable (genetically diverse) forest ecosystems and forested landscapes
1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) x
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
Restoring millions of hectares of forested landscapes requires billions of seed and seedlings, yet seed supply systems are lagging behind. A global survey was conducted in 2015 to find out where and how restoration practitioners obtain seed/seedlings for their projects, what problems they have in the process and how these affect restoration outcomes. The results were analysed using multiple correspondence analysis to identify typologies of projects and their seed sourcing practices
3) Used
Where? Global survey, with responses from 136 projects across 57 countries.
By whom? High-level recommendations for policy-makers and restoration practitioners
For what? Ensuring that enough fit-for-purpose seed is available and accessible for restoration projects and programmes to improve restoration success and meet the national and global FLR commitments

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
Accepted to a high-impact journal with emphasis on policy relevance. Concrete impacts unknown.
What has helped?
Main constraints?
Evidence of impact

4) References
Jalonen R, Valette M, Boshier D, Duminil J, Thomas E. 2018. Forest and landscape restoration severely constrained by a lack of attention to the quantity and quality of tree seed: Insights from a global survey. Conservation Letters, Vol 11(4): e12424. https://doi.org/10.1111/conl.12424

#45

Conceptual approach to restoration

Name of respondent and e-mail: Riina Jalonen r.jalonen@cgiar.org
Center: Bioversity International (Malaysia)
CRP/Flagship (if relevant): FTA, FP1

Title: Genetic considerations in ecosystem restoration using native tree species. Thematic study for the State of the World's Forest Genetic Resources.
Year: 2014

1a) Scale:
Plot x
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Erosion of genetic diversity and approaches for restoring it as a foundation for viable and resilient forest ecosystems
1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation) x
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
The study consists of descriptions of key genetic considerations and why they are important for restoration, descriptions of restoration approaches, and analysis and recommendations for scientists and policy makers for improving restoration success by integrating genetic considerations
3) Used
Where? Global
By whom? Aimed at restoration practitioners, policy makers, scientists
For what? Understanding the importance of genetic diversity for restoring viable and resilient forest ecosystems, and ways to integrate these considerations in restoration practice, policies and strategies

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
Positive, unexpected. The study was picked up by CBD Secretariat, and resulted in CBD COP12 adopting a decision on the importance of genetic diversity in ecosystem restoration

What has helped? The study was presented at several regional capacity-strengthening workshops organized by CBD Secretariat, ahead of the COP
Main constraints?
Evidence of impact: CBD COP12 decision on the importance of genetic diversity in restoration

4) References
Bozzano M, Jalonen R, Evert T, Boshier D, Gallo L, Cavers S, Bordacs S, Smith P, Loo J. (eds). 2014. Genetic considerations in ecosystem restoration using native tree species. A thematic study for the State of the World's Forest Genetic Resources Report. Food and Agriculture Organization of the United Nations, Rome, Italy. 251 p.

#46

Approaches and conceptual frameworks , including evaluations

Name of respondent and e-mail: Christopher Kettle c.kettle@cgiar.org and, Gotor, Elisabetta (Bioversity) <e.gotor@cgiar.org>
Center: Bioversity International
CRP/Flagship (if relevant): FTA
Title: Developing a theoretical framework for the economic evaluation of diversity in forest landscape restoration
Starting year: 2018
Ending year: 2019
Place: Global (tropics)
1a) Scale:
Plot
Farm
Landscape x
1b) Driver of degradation addressed/reversed
Genetic and species diversity as a driver of resilient restoration
1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry
1d) Entry point:
Biophysical (soil, vegetation) -- 3
Economics, livelihoods – 1
Governance, institutions --2
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
Development of a theoretical framework including an ex-ante economic assessment for the economical evaluation of genetic diversity in forest landscape restoration using economic simulation models.
3) results – **inception stage** –
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints? **None**
Evidence of impact
4) References

#47

Conceptual approach to restoration

Name of respondent and e-mail: Marius Ekue m.ekue@cgiar.org
Center: Bioversity International (Cameroon)
CRP/Flagship (if relevant):

Title: Seed supply systems for the implementation of landscape restoration under AFR100: An analysis of national seed systems in 10 SAFORGEN countries

Year: 2018-2019

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Addressing the need for seed supply systems for restoration projects
1c) Stage of the forest transition curve
Forested landscape x
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions x
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
This report will present a baseline of the national seed supply systems in 10 countries members of the sub-Saharan African Forest Genetic Resources Programme (SAFORGEN). The resulting baselines will be assessed against a set of indicators for a fit-for purpose seed system in order to identify gaps in current systems and set priorities for action.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact
In development
4) References

#48

Conceptual approach to restoration

Name of respondent and e-mail: Diana Suhardiman
Center: IWMI
CRP/Flagship (if relevant): PIM Flagship 5

Title: Land governance reform and state transformation processes in Myanmar
Year: 2017-now (ongoing under PIM)

1a) Scale: It links farm level (farmers' strategy to strengthen their land rights) with landscape (ongoing land governance reform processes at national level)
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed
Large-scale land acquisition for commercial use by the previous military government and its business connections results not only in farmers' losing their farmlands and access to communal forest, it also accelerates the chain on land degradation, in particular the speed of deforestation in Myanmar. In line with the new government's attempt to return farmers' farmland, earlier confiscated by the military and its business cronies, our research looks at local communities' strategies to reclaim their land back (individual land and communal forest).

1c) Stage of the forest transition curve: Across all three stages
Forested landscape
Agriculture
Agroforestry

1d) Entry point: Governance and institutions
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
The research looks at land restoration as an integral part of land governance reform processes. Putting local community central in land governance practices, it argues that land restoration efforts (e.g. reforestation, forest protection) will have actual significance only if the latter is supported by local community living in the surrounding areas. It highlights the need to incorporate customary land rights in the current discussion on land governance reforms in Myanmar towards rights-based approaches in land governance.

3) Used
Deriving from legal pluralism research, the concept of rights-based approaches in land governance has been applied by various civil society organizations in Myanmar to highlight the importance of customary land rights and the need to incorporate this into National Land Use Policy implementation.

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The research has helped shed light on the National Land Use Policy implementation framework for the country-wide implementation in general and within the context of ethnic state in particular
Main constraints? Unclear messages from the government on the direction of reform processes and ongoing armed conflict in ethnic states make it difficult to link national level policy formulation processes with local community's development needs and aspirations
Evidence of impact: Key findings from the research has been used by international donors to help guide the ongoing process of land governance reform in general, and in informing institutional framework for National Land Use Policy implementation in particular.

4) References

1. -Suhardiman, D., Bright, J., Palmano, C. The Politics of Legal Pluralism in the Shaping of Spatial Power in Myanmar's Land Governance. Under review in Political Geography.
2. -Suhardiman, D., Kenney-Lazar, M., Meinzen-Dick, R. The contested land governance landscape in Myanmar. Under review in Critical Asian Studies.

#49

Essential CIFOR past (and some recent) work on reforestation and rehabilitation. Compiled by Manuel R. Guariguata

Criteria & indicators of sustainable (plantation) forest management (led by Ravi Prabhu; late 1990s);

1. http://www.cifor.org/publications/pdf_files/C&I_India.pdf
2. http://www.cifor.org/publications/pdf_files/C&I-Plantation.pdf

Site Management and Productivity in Tropical Plantation Forests (1995-2008) assessed impacts of soil and site management practices on the productivity of successive rotations across 16 experimental sites in Australia, Brazil,Congo, China, India, Indonesia, South Africa and Vietnam (led by Christian Cossalter, Sadanandan Nambiar);

3. http://www.cifor.org/online-library/browse/view-publication/publication/2517.html

Plantation policy issues, including the prospective role of and issues associated with tropical 'fastwood' plantations (led by Christian Cossalter up to 2005)

4. http://www.cifor.cgiar.org/publications/pdf_files/Books/ForestPerspective.pdf

The role of plantation-based development in emerging economies; political ecology and political economy (eg China, led by Christian Cossalter; Indonesia, led by Chris Barr and Krystof Obidzinski)

5. http://intra.cifor.cgiar.org/InfoServices/Library/Publications/PublicationDetail?PubID=4015
6. http://www.sciencedirect.com/science/article/pii/S0006320712001632

Stakeholder perceptions of industrial plantations

7. https://www.cifor.org/library/6099/perceptions-of-local-people-toward-pulpwood-plantations-insights-from-q-method-in-indonesia/
8. https://www.cifor.org/library/6265/local-impacts-of-industrial-tree-plantations-an-empirical-analysis-in-indonesia-across-plantation-types/

Do plantations alleviate natural forest conversion?

9. https://www.cifor.org/library/5929/do-timber-plantations-contribute-to-forest-conservation/

Do industrial plantations alleviate poverty at the local level?

10. https://www.cifor.org/library/5702/more-trees-more-poverty-the-socioeconomic-effects-of-tree-plantations-in-chile-2001-2011/

Ecosystem services of planted forests and mosaic landscapes

11. See book "Ecosystem goods and services from plantation forests" (Earthscan, 2011). See also:
12. https://www.cifor.org/library/6258/a-proposed-framework-for-assessing-ecosystem-goods-and-services-from-planted-forests/
13. https://www.cifor.org/library/5120/spatial-assessment-of-ecosystem-goods-and-services-in-complex-production-landscapes-a-case-study-from-south-eastern-australia/

- Small holder plantations and value chains:

(i) 'Strengthening rural institutions to support livelihood security for smallholders involved in industrial tree-planting programs in Vietnam and Indonesia' (BMZ funded; 2008-2010). A few papers on smallholder silviculture by Maarit Kallio and Markku Kanninen

14. http://intra.cifor.cgiar.org/InfoServices/Library/Publications/PublicationDetail?PubID=3349
15. http://www.tandfonline.com/doi/abs/10.1080/14728028.2012.734127

(ii) "Improving economic outcomes for smallholders growing teak in agroforestry systems in Indonesia" led by Herry Purnomo (funded by ACIAR)

16. http://intra.cifor.cgiar.org/InfoServices/Library/Publications/PublicationDetail?PubID=3526

Review of rehabilitation initiatives - Lessons from the past' funded by the Government of Japan (2002-2006), focused on Peru, Brasil, Indonesia, China, Philippines and Vietnam.

17. http://www.cifor.org/online-library/browse/view-publication/publication/2020.html
18. http://www.cifor.org/online-library/browse/view-publication/publication/2106.html
19. http://www.cifor.org/online-library/browse/view-publication/publication/2025.html

20. http://www.cifor.org/online-library/browse/view-publication/publication/2455.html

Gender

21. https://www.cifor.org/library/6685/gender-matters-in-forest-landscape-restoration-a-framework-for-design-and-evaluation/

Tenure and rights

22. https://www.cifor.org/wp-content/uploads/2017/11/Implementing%20FLR.pdf

#50

WORK BOTH RECENTLY PRODUCED AND ONGOING. Manuel R. Guariguata

- FLR Training and capacity building

1. Meli, P., Schweizer, D., Brancalion, P.H.S., Murcia, C., Guariguata, M. R. Are professionals in Latin America trained in the multiple dimensions of ecosystem restoration? Restoration Ecology (in review).

- FLR Legal frameworks, governance

2. Schweizer, D., Meli, P., Brancalion, P. H. S., Guariguata, M. R. Enabling forest landscape restoration in Latin America: The role of legal frameworks. Forest Policy and Economics (in review)
3. Guariguata, M. R., Brancalion, P.H.S. 2014. Current challenges and perspectives on governing forest restoration. Forests 5: 3022-3030.

- FLR Monitoring

4. Evans, K., Guariguata, M. R., Brancalion, P.H.S. 2018. Participatory monitoring to connect local and global forest restoration priorities. Conservation Biology 32: 525-534.
5. Evans, K.A., Guariguata, M. R. 2016. Success from the ground up: participatory monitoring and forest restoration. Ocasional Paper no. 159. CIFOR, Bogor, Indonesia (peer reviewed).

- Upscaling

6. Murcia, C., Guariguata, M. R., Aronson, J., Andrade, A., Andrade, G., Escobar, E., Ramirez, W., Montes, E. 2016. Challenges and prospects for scaling-up ecological restoration to meet international commitments: Colombia as a case study. Conservation Letters 9: 213-220.

- Planning

7. Chazdon, R. L., Guariguata, M. R. 2018. Decision support tools for forest and landscape restoration: current status and future outlook. Ocassional Paper 183, CIFOR, Bogor, Indonesia (peer reviewed).

- Natural forest regeneration: options, constraints, opportunities

8. Chazdon, R. L., Bodin, B., Guariguata, M. R., Lamb, D., Walder, B., Chokkalingam, U., Shono, K. 2017. Partnering with nature: The case for natural regeneration in forest and landscape restoration. FERI Policy Brief. SCBD, Montreal, Canada.
9. Chazdon, R. L., Guariguata, M. R. 2016. Natural regeneration as a tool for large-scale forest restoration in the tropics: prospects and challenges. Biotropica 48: 716-730.

- Restoration in the context of biodiversity offsetts: a policy analysis

10. Murcia, C., Guariguata, M. R., Quintero-Vallejo, E., Ramírez, W. 2017. La restauración ecológica en el marco de las compensaciones por pérdida de biodiversidad en Colombia: un análisis crítico. Ocasional Paper 176. CIFOR, Bogor, Indonesia

- Nation-wide and/or regional systematic assessments on gaps and needs for FLR

11. Murcia C., Guariguata M. R., Montes, E. 2015. Estado del monitoreo de la restauración en Colombia. In: *Monitoreo a procesos de restauración ecológica aplicado a ecosistemas terrestres* (eds.) Aguilar-Garavito, M., W. Ramírez. Instituto Alexander von Humboldt. Bogotá, Colombia
12. Méndez-Toribio M., Martínez-Garza C., Ceccon E., Guariguata M. R. 2018. La restauración de ecosistemas terrestres en México: Estado actual, necesidades y oportunidades. Occasional Paper 185. CIFOR, Bogor, Indonesia.
13. Murcia, C., Guariguata, M. R., Peralvo, M., Gálmez, V. 2017. La restauración de bosques andinos tropicales: avances, desafíos y perspectivas del futuro. Occasional Paper 170. CIFOR, Bogor, Indonesia (peer reviewed).
14. Murcia, C., Guariguata, M. R. 2014. La restauración ecológica en Colombia: tendencias, necesidades y oportunidades. Occasional Paper 107. CIFOR, Bogor, Indonesia (peer reviewed).

- In progress (2018-2019)

15. Assessing and predicting the socioeconomic uncertainty of restoration success: a global analysis—in collaboration with the International Institute for Sustainability (IIS, Brazil)
16. Designing a local to national participatory monitoring protocol—in collaboration with US Forest Service Silva Carbon Program.
17. A systematic review and analysis of ecosystem service benefits and flows as a function of restorative activities—in collaboration with PARTNERS network[1].
18. Towards developing quality standards for FLR—in collaboration with WeForest, WRI Brazil, ImaFlora, TNC Brazil, U. Sao Paulo, PARTNERS.
19. Reforestation impacts on water in Andean watersheds: a meta-analysis.

[1] Restoring trees and forest cover can contribute to human wellbeing in many ways, but these contributions are utilized, valued, accessed, appropriated, and commercialized differently by various stakeholders, with consequences for who benefits and who is burdened by different reforestation approaches.

#51

FORLAND PROJECT SYNTHETIC SHEET

Title of the Project: FORLAND-RESTORATION
Acronym : FORLAND
Leader: ONF-I
Partners: Cirad, ETH
Cooridnators for Cirad: P. Sist and H. Dessard
Countries, regions: Brazil, Scotland
Duration : 20 months
Beginning: September 2018

ABSTRACT (150 words, general objective) :

The Agriculture, Forestry, and Other Land Use (AFOLU) sector represents a significant opportunity for carbon sequestration, particularly through landscape restoration. In this context, the Bonn Challenge launched in 2011 aims to restore 150 million ha of degraded landscapes by 2020 and 350 million ha by 2030. Globally, current land restoration pledges total over 160 million hectares. Land-use planning for restoration draws on large amounts of biophysical and socio-economic data, but also involves negotiations among stakeholders with competing land-use and resource agendas. The main objective of this project is to develop a new participative and easy-to-use Decision Support Systems (SDSS) to provide land-use decision makers with new spatial decision making-tool, henceforth called FORLAND. This Demonstrator project starts with the development and testing of a first module focusing on landscape restoration: FORLAND Restoration. Further future products can include: FORLAND Sustainable Forest Management (SFM), FORLAND Environmental, Social, and Governance (ESG), FORLAND REDD+ (cf. Figure 1 "FORLAND Vision").

SPECIFIC OBJECTIVES:

- Design of project-specific, tailored platforms that take into account the specific needs and requirement of each end-user. FORLAND Restoration will be developed as an easy to use and smart tool based on the day-to-day experiences of end users.
- Inclusion of reliable prospective simulation features based on decision makers' choices. This objective implies the identification of needs and exploration of scenarios with the end-users, to identify and develop appropriate modeling technologies, and to design features allowing end-users to explore various assumptions and simulations themselves to foster transformative change.
- FORLAND will be marketed as a "Service as a Software" (SaaS). As such, FORLAND Restoration aims to facilitate collaborative work and stakeholders' consultation, and promote transparency during the feasibility and implementation stages of AFOLU projects through the use of a multi-stakeholder participative approach.
- Develop FORLAND Restoration as a web access/web server platform to facilitate the handling of large amount of data to process and stock, particularly due to the utilization of remote sensing data.

This Demonstrator is an opportunity to implement different pilots in promising markets both in Europe and emerging countries, with high potential for replication, and to contribute to the growing pool of climate-smart solutions and innovations in restoration initiatives.

OUTPUTS:

- tailored FORLAND web-platforms delivered to the end-user;
- the FORLAND service package to accompany the web-platforms and allowing an ongoing stakeholder engagement throughout the restoration process;

CALL :

Funding agency : KIC EU/EIT
Call : KIC Climate
State: Approved

FUNDINGS:

Total Project Costs: 2,100,000 €
EIT (KIC) contribution: 1,423,000 €
Co-Fundings (consortium) : 677,000 €

Total budget for Cirad: 570,680 €

EIT funding: 361,240 €
Co-funfing Cirad: 209,440 €

#52

The delivery of planting material for productive forest landscape restoration to bridge production gaps and promote resilience.
Information Note by ICRAF, Tree Productivity and Diversity Team

A global programme, with a specific focus in Ethiopia 2017-2020, supporting their forest landscape restoration target of 22 million ha by 2030, with four major ongoing projects:

- Tree Field Genebanks with support from the CGIAR Consortium Research Programme (CRP) on Genebanks 2010-2016 and the CGIAR Genebank Platform 2017-2022 (#55)
- Agrobiodiversity and Landscape Restoration for Food Security and Nutrition in East Africa, 2016-2019, supported by European Commission and the International Fund for Agricultural Development (EC/IFAD) (#53)
- Provision of adequate tree seed portfolios 2017-2020 to enhance productivity and resilience of forest landscape restoration in Ethiopia, supported by the Norwegian International Climate and Forest Initiative (NICFI) (#10)
- Tree Genetic Resources to bridge production gaps and promote resilience, Flagship of Forests, Trees and Agroforestry (FTA) CGIAR CRP 2017-2022 (#55)

Key bio-physical and socio-economic features that provide context for the FLR work:
The development of REDD+, the Global Partnership on Forest and Landscape Restoration (GPFLR), the Bonn Challenge to restore 350 million ha of degraded land by 2030, the Global Alliance for Climate-Smart Agriculture, the African effort to create and Evergreen Agriculture, the emergence of farmer managed natural regeneration, to mention some of the more prominent initiatives, are all targeting large scale restoration.
A major challenge of tree based restoration work is that it requires the use of many tree species at the same time. Where restoration is based on natural regeneration, it would require the presence of healthy and diverse seed sources. When planting is necessary, whether for replenishment or enrichment, the supply of a broad spectrum of genetically diverse, healthy and productive tree species is not easily available. Traditional supply programmes focus on few species, most of them of unknown genetic quality and often with insufficient knowledge on adaptation to site conditions and adaptability to climate change.

Key drivers for FLR interventions:
Pledges to the Bonn Challenge have passed the 150 million ha mark with a potential impact of sequestering more than 15 Gt of CO_2 and generation economic activity of some 47 billion USD (Bonn Challenge web-site, August 2017). This assumes successful restoration. Adequate management of tree genetic resources is both a prerequisite for these impact measures and an opportunity to enhance those further.
In general, matching of planting material to planting site is inadequate, leading to huge loss of higher productivity opportunities. Most seed and other forms of germplasm procured by traders are collected from trees in farmlands, urban areas and other compounds, implying that the genetic quality and origin of the seed is not known and performance is suboptimal compared to seed deliberately chosen to match a planting site. Immediate availability of seed rather than site and purpose matching is the overriding factor in the distribution chains. Information about quality is not provided with seed/seedlings distribution and tree planters are not aware of the (lack of) quality of the planting material that they receive. Seed sources for improvement of productivity and product quality is practically non-existent in the sector.

Partnership involved in delivery and support:

The work is led by ICRAF, embedded in FTA 2017-2022 and with Bioversity International as a primary partner. The partnership extends to agricultural, forestry and horticultural development and research institutions of global and national excellence; including regional forest genetic resource networks; international organisations like FAO, CBD, IUCN; private sector companies as Mars Inc.; and renowned universities and NGOs, to mention but a few; with national tree seed centres and nursery entrepreneurs being the ultimate suppliers of the reproductive material.

Costs and financing:

The portfolio of projects mentioned comprise an investment of approximately 30 million USD over the timespan 2010-2022, of which the investment ahead (2017-2022) of about 15-20 million is approximately 50% secured. Main sources of funding are contributors to the CGIAR FTA and Genebank programmes and specifically NICFI and EC/IFAD.

Specific anticipated or already achieved outcomes / results:
Conservation and build-up of mass propagation units of tree genetic resources to bridge production gaps and provide environmental and economic resilience in forest landscape restoration are underway; with

- the field genebanks on 40 sites in 16 Countries in different regions of Africa, Latin America, and Asia (12,000 accessions of 59 species),
- the tree seed bank in Nairobi (5490 accessions representing 189 species),
- 2280 accessions of 120 species at Kunming Institute of Botany Genebank, China and 1510 accessions of 3 species at the Millennium Seed Bank (MSB), UK as safety duplicates,
- 777 accessions representing 120 agroforestry tree species deposited at Svalbard Global Seed Vault, Norway,
- fruit tree portfolios developed for East Africa as a case of functional agro-biodiversity restoration
- the large- scale mobilisation of tree genetic resources underway in Ethiopia in close collaboration with the national government,
- decision-support tools such as the www.vegetationmap4africa.org, Tree Seeds for Farmers toolkit and BiodiversityR package

Eventually, **s**takeholders will have better information on the best tree species and seed sources to plant/restore. The role tree nursery operators within efficient tree seed and seedling systems will be understood and demonstrated. Suggestions will be provided to policy makers on appropriate policies, and collaboration is fostered between the national tree seed centres of countries involved, including increased exchange of seed. Breeding seed orchards *cum* conservation stands for important tree species will be established and in production. The value of breeding seed orchards will have been demonstrated and brought to scale. Tools will be available to account for the potential effects of climate change when planning for regional tree seed production and distribution – and when planning for tree planting on farms, in restoration and other planting projects. A much better general understanding is obtained regarding the usefulness, effectiveness and possible integration of different botanic, genetic and genomic types of surveys for supporting a sustainable use and conservation of socio-economic and ecological important tree species in the region.

Key challenges and strategies for addressing them:
The cost of the planting material to restore 100 million ha of land over the next 20 years will at current prizes of supply be in the order of 15 billion US$. To ascertain that this investment results in survival and adequate productivity will raise the cost of the planting material in the order of 5%, but also assure survival and physical productivity increases, possibly in a magnitude of 60%. A catalytic investment of less than 0.1% can be enough to ascertain such outcome. Despite the strategic importance of securing and using the right propagation material to achieve successful and productive restoration, the area is severely under-invested. The primary strategy to change this will be to demonstrate realized returns on the investment.

Three highlights from 2017

- **Use of map-based decision-support tools for global conservation and restoration planning**

The World Agroforestry Centre, in collaboration with the University of Copenhagen and national partners, developed interactive decision-support tools for agroforestry, restoration, afforestation and biodiversity conservation planning. In addition to web-based maps, smart phone Apps are available from the Google Play Store (Kindt et al. 2017, Africa Tree Finder, https://play.google.com/store/apps/details?id=com.icraf.gsl.africatreefinder). The high resolution baseline potential natural vegetation map that was developed by the project for eastern Africa (http://vegetationmap4africa.org) has now been integrated in the **Ecoregions 2017** (http://ecoregions2017.appspot.com/) map that updated the WWF Terrestrial Ecoregions map from 2001. In a *Bioscience* article published in 2017 (Dinerstein et al. 2017) with various FTA Flagship 1 scientists as co-authors, this new map was utilized to investigate the potential of allocating at least half of the Earth to conservation. As documented also in Nature (Watson & Venter, 2017, A global plan for nature conservation, https://doi.org/10.1038/nature24144) this BioScience study revealed that, in many ecoregions, enough habitat exists to reach this goal (funded by W1+2, co-funded with original donor: Rockefeller Foundation and Danida, co-funded by DFID (IUCN-ICRAF collaboration under Knowfor project).

- **Developing decision support tools for safeguarding and sustainable use of priority tree genetic resources and its application to forest and landscape restoration.**

Three papers published by Bioversity in the last year have focused on the important challenge of safeguarding tree genetic resources, and developing the tools to ensure this diversity can be effectively used in restoration. Critical to safeguarding is understanding the potential threats of climate change. Hotspots of diversity can be identified using a combination of molecular markers, species distribution modeling and expert surveys. Gaisberger et al developed detailed threat maps for 16 important food tree species in Burkino Faso. These methods can be cost effectively applied to support safeguarding of diversity of priority species in many other countries. Marchelli et al identify critical hot spots of diversity in two species of Northofagus in Patagonian Argentia with practical and spatially-explicit conservation prioritisation. In the 89th Technical series of the Convention on Biological Diversity as part of the Lima declaration on Biodiversity and Climate Change Thomas et al showcase an online platform that integrates climate modeling with functional trait analysis and consideration of genetic suitability of seed sources to support resilient forest restoration in Colombian tropical dry forest. These methods will go on to be applied within other FTA projects to ensure that seed supply systems in restoration are suitably adapted to local conditions and resilient to future climate change.

- **Documenting the lack of adoption of appropriate tree germplasm portfolios in productive systems for large scale climate mitigation and landscape restoration; and suggesting approaches for change**

Two papers published by the flagship in 2017(/2018), one in *Conservation Letters* (Jalonen et al. 2017, http://onlinelibrary.wiley.com/doi/10.1111/conl.12424/full), and one in *Climate and Development* (Roshetko et al. 2018, http://www.tandfonline.com/doi/full/10.1080/17565529.2017.1334620) were the first studies to verify and document a common and often quoted suspicion that many plantings and regenerations for restoration and/or conservation do not pay adequate attention to the genetic quality of the reproductive material. This is likely to be one of the most important factors of success for the huge global agenda of forest landscape restoration and with very significant implications for conservation of biodiversity. A third paper published in *Development Policy Review* (Lillesø et al 2018, http://onlinelibrary.wiley.com/doi/10.1111/dpr.12233/full) goes on to analyse reasons for and suggest measures to mitigate the lack of adoption in productive systems and for landscape restoration (all work in 2017 funded by w1w2).

#53

Restoration project

Name of respondent and e-mail: Stepha McMullin, s.mcmullin@cgiar.org and Ramni Jamnadass r.jamnadass@cgiar.org
Center: World Agroforestry Centre (ICRAF)
CRP/Flagship (if relevant): FTA 1 and FTA 4.3 (Linking landscapes and diets: Investigating relative contributions of agrobiodiversity, wild foods, and markets to diets)

Title: Agro-biodiversity and landscape restoration for food security and nutrition in East Africa (Ethiopia and Uganda)
Starting year: 2017
Ending year: 2019
Place: Ethiopia and Uganda

1a) Scale:
Farm

1b) Driver of degradation addressed/reversed
Addressing a lack of species diversity in farming landscapes through the promotion of ecologically suitable tree species (exotic and indigenous) and crops to target food and nutrient gaps in local food systems.

1c) Stage of the forest transition curve
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation) - 2 [Ecological suitable species diversity]
Economics, livelihoods – 1 [Nutrition and Food security as components of Livelihoods]
Governance, institutions – 3 [Working through national partners]
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
The Project aims to mobilize diverse agricultural biological resources to support targeted restoration interventions through diversifying farming systems and landscapes. The innovative approach is to use food trees and leguminous annual crops for landscape restoration, which will not only bring ecological benefits to rural communities, but also directly improve food and nutrition security of poor smallholder households through the food products harvested and increase resilience through diversification of livelihood options.

3) results: Project is on-going, baselines completed, portfolios and planting material being distributed (interventions) for M&E and future Impact Assessment – key indicators, no. of trees and crops, no. of species, food secure months, dietary diversity, food consumption.
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References
http://www.worldagroforestry.org/project/agro-biodiversity-and-landscape-restoration-food-security-and-nutrition-eastern-africa

#54

Restoration tool

Name of respondent and e-mail: Roeland Kindt, R.Kindt@cgiar.org / Lars Graudal, L.Graudal@cgiar.org.
Center: ICRAF
CRP/Flagship (if relevant):FTA, FP1

Title: Vegetation map for Africa including species selection tools
Year: Ongoing (began in 2007)

1a) Scale: All three
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed
Lack of know-how; disappearing resources

1c) Stage of the forest transition curve: All three
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation): 1
Economics, livelihoods: 2
Governance, institutions: 3
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
The map is available in different formats and is accompanied by an extensive documentation of the floristic, physiognomic and other characteristics of the different vegetation types and useful woody species. It is complemented by a species selection tool, which can be used to 'find the right tree for the right place' and potential distribution maps of the useful woody species that occur in eastern Africa.

3) Effective use
Where? Currently covering eight countries in Eastern and Southern Africa
By whom? All restoration practitioners/users with access to internet and/or smartphones
For what? Setting and implementing conservation and restoration priorities

4) results: See highlight "Use of map-based decision-support tools for global conservation and restoration planning" in reference below (and the website http://vegetationmap4africa.org/).
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

5) References

Information Note by ICRAF, Tree Productivity and Diversity Team: The delivery of planting material for productive forest landscape restoration to bridge production gaps and promote resilience, August 2018 (#52).

#55

Conceptual approach to restoration

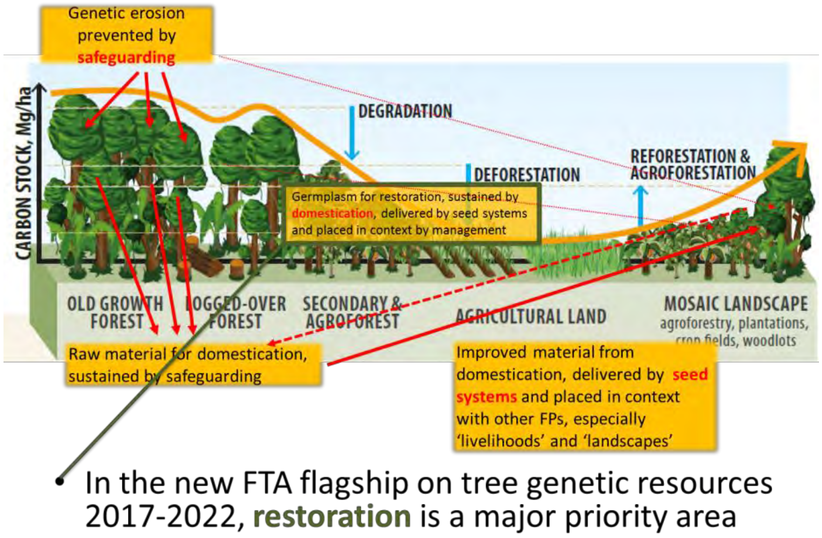
Name of respondent and e-mail: Ramni Jamnadass, R. Jamnadass@cgiar.org /Alice Muchugi, A.Muchugi@cgiar.org / Lars Graudal, L.Graudal@cgiar.org.
Center: ICRAF
CRP/Flagship (if relevant): FTA/FP1, Genebank Platform

Title: The delivery of planting material for productive forest landscape restoration to bridge production gaps and promote resilience within the framework of FTA FP1 and the Genebank Platform
Year: 2017-2022

1a) Scale: All
Plot
Farm
Landscape

1b) Driver of degradation addressed/reversed

1c) Stage of the forest transition curve: All



Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation): 1
Economics, livelihoods: 1
Governance, institutions: 1
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
Integrated management of tree genetic resources in support of FLR, comprising safeguarding (conservation), domestication (intensification and diversification), and delivery (mobilization of the genetic resources and institutional development).

3) Used: See the reference given below
Where?
By whom?
For what?

4) Results: See description and highlights 2017 in reference below

Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

4) References

Information Note by ICRAF, Tree Productivity and Diversity Team: The delivery of planting material for productive forest landscape restoration to bridge production gaps and promote resilience, August 2018 (#52).

#56

Restoration project: Case study/Project

Name of respondent and e-mail: Wolde Mekuria – w.bori@cgiar.org
Center: IWMI - Ethiopia
CRP/Flagship (if relevant): WLE
Title: Restoration of degraded landscapes following exclosure establishment in communal grazing lands
Starting year: 2013; Ending year: 2018; Place: Ethiopia

1a) Scale:
Landscape – or Watershed levels √

1b) Driver of degradation addressed/reversed
The drivers of land degradation addressed/reversed include overgrazing on communal grazing lands, deforestation and soil erosion. The project also worked to address the underlying drivers, such as weak regulatory context and institutions and poverty.

1c) Stage of the forest transition curve
Forested landscape √

1d) Entry point:
The project used all the below lists as an entry point. Please see the rank in the bracket.
√ Biophysical (soil, vegetation) – (1st); √ Economics, livelihoods – (3rd); √ Governance, institutions (2nd)

2) short description of the project (2-5 lines)
This project focused on investigating the changes in ecosystem services, hydrological variables and livelihood following the establishment of exclosures on communal grazing lands; and identifying the incentives and requirements that support local communities to adopt exclosures.

3) results
The outputs/outcomes/impacts achieved through this project include:

(1) **Increase in income and diversification of livelihood** - The capacity of 127 women and 200 men for integrating income generating activities into exclosures has been enhanced through training. The women headed households engaged in the production of sheep indicated increased income and ability to send their children to school. Landless youth demonstrated increased income and expansion of livestock fattening program.
(2) **Achieving equity in benefit sharing and increasing participation in grazing land management** - The provision of incentives and short-term trainings ensure equity in sharing of benefits obtained from the establishment and management of exclosures. Also, incentives increased the participation of all members of the community in exclosure management.
(3) **Reducing dependence on NRM** - Short-term incentives and capacity building has led to reductions in the degradation of natural resources in two ways. On the one hand, engaging local communities in income generating activities is reducing dependence on natural resources and consequently protect natural resources from degradation and enhance/maintain ecosystem services. On the other hand, integrating income generating activities with exclosures enhance the short-term benefits of the interventions, which consequently support the local communities to adopt and protect long-term conservation approaches such as exclosures.

Engaging local communities from the beginning of the project through assignment of focal person (s), participating in action research and organizing feedback workshops is key for the success. We learned that addressing local communities' concerns and integrating NRM interventions with income generating activities are required to expand and sustain NRM interventions. Ensuring equity is key to increase the participation of local communities and sustaining the interventions.

Lack of finance to integrate income generating activities with exclosures at a larger scale is one of the main constraints faced during the implementation of the project.

4) References – selected related publications

1. **Mekuria, W**.; Aynekulu, E. 2013. Exclosure land management for restoration of the soils in degraded communal grazing lands in northern Ethiopia. Land Degradation and Development 24: 528-538.
2. **Mekuria, W**.; Langan, S.; Johnston, R.; Belay, B.; Amare, D.; Gashaw, T.; Desta, G.; Noble, A.; Workeleul, A. 2015. Restoring aboveground carbon and biodiversity: The case study from the Nile basin, Ethiopia. Forest Science and Technology 11: 86-96.
3. **Mekuria, W**.; Langan, S; Noble, A.; Johnston, R. 2017. Soil restoration after seven years of exclosure management in north-western Ethiopia. Land Degradation and Development 28: 1287–1297.
4. **Mekuria, W**.; Barron, J.; Dessalegn, M.; Adimassu, Z.; Amare, T.; Wondie, M. 2017. Exclosures for ecosystem restoration and economic benefits in Ethiopia: A catalogue of management options. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). 28p. (WLE Research for Development (R4D) Learning Series 4). DOI: 10.5337/2017.204.

#57

Restoration project

Name of respondent, center, CRP (if relevant): CIAT
Title: **Creating climate-smart multifunctional landscapes through integrated soil, land and water management at different scales**
Starting year: 2014
Ending year: 2021
Place: Ethiopia

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Soil erosion and nutrient mining due to natural and anthropogenic processes

1c) Stage of the forest transition curve
Forested landscape
Agriculture x
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)
In our case all if the three have more or less equal weight because both of them need to be considered at the same time if restoration is to succeed in a sustainable manner.

2) short description of the project (2-5 lines)
The project aims to create multifunctional climate-smart landscape through the implementation of complementary land and water management practices following the landscape continuum. Based on this, develop scaling framework/recommendation domain to scale technologies across space.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
Successful implementation in the areas we operated.
What has helped?
The government policy that encourages communities to participate in community work tremendously facilitated our work.
Main constraints?
Shortage of financial resources to implement options at scale. The community have huge land and water related problems (erosion, shortage of water for irrigation etc.). Implementing practices to effect these costs a lot – thus there is bug mismatch between what the community expects and what we can do – and some donors also don't allow us spend resources for 'development' oriented activities. We tried to address this by collaborating with NGOs and development actors.

Evidence of impact
Visit watersheds as 'seeing is believing'

4) References

1. Tamene, L., Z. Adimassu; J. Ellison; T. Yaekob; K. Woldearegay; K. Mekonnen; P. Thorne; Q.B. Le. 2017. Mapping soil erosion hotspots and assessing the potential impacts of land management practices in the highlands of Ethiopia. Geomorphology 292: 153–163. http://ciat.cgiar.org/publications/publication-details/?handle1=10568&handle2=80914

2. Tamene, L.; Z. Adimassu; E. Aynekulu; T. Yaekob. 2017. Estimating landscape susceptibility to soil erosion using a GIS-based approach in Northern Ethiopia. *International Soil and Water Conservation Research* 5(3): 221-230. https://cgspace.cgiar.org/handle/10568/81310
3. Woldearegay, K.; L. Tamene; K. Mekonnen; F. Kizito; D. Bossio. 2018. Fostering food security and climate resilience through integrated landscape restoration practices and rainwater harvesting/management in arid and semi-arid areas of Ethiopia. In: Leal Filho W., de Trincheria Gomez J. (eds) *Rainwater-Smart Agriculture in Arid and Semi-Arid Areas*. Springer, Cham https://link.springer.com/chapter/10.1007/978-3-319-66239-8_3
4. Tamene, L.; K Mekonnen; S. Mengistu; F. Tessema; H. Terefe. 2016. *Africa RISING Ethiopian Highlands Integrated Landscape Management Exchange Visit, 4-7 May 2016*. https://cgspace.cgiar.org/bitstream/handle/10568/78173/AR_Ethiopia_exchange_may2016.pdf?sequence=1
5. Woldearegay, K.; L. Tamene; K. Mekonnen; Z. Admassu; T. Yaekob. 2016. Poster: *Promoting landscape restoration and water harvesting at scale; the case of Africa Rising project, Ethiopia*. https://cgspace.cgiar.org/bitstream/handle/10568/79168/ARethiopia_poster_kifle_nov16.pdf?sequence=1
6. Tamene, L.; T. Yaekob; J. Ellison; K. Mekonnen. 2017. *Integrated landscape management: Africa RISING R4D experiences in the Ethiopian highlands.* https://www.slideshare.net/africa-rising/ar-n2africa-liveslulseged2016
7. Tamene, L; K. Mekonnen; P. Schmitter; Z. Adimassu; A. Gebrekirstos; A. Haileslassie. No date. Poster: *Soil and water management at farm and landscape scale*. http://www.worldagroforestry.org/downloads/Publications/PDFS/PO16126.pdf
8. Ndengu, G.B.; L. Tamene; K. Mekonnen; S. Mengistu. 2015. *Report from a cross learning visit to Africa RISING project sites in the Ethiopian highlands*. https://cgspace.cgiar.org/bitstream/handle/10568/66320/AR_Ethiopia_crosslearning_2015.pdf?sequence=1&isAllowed=y
9. Tamene, L. *Africa RISING: Finding solutions to tackle drought*. http://blog.ciat.cgiar.org/africa-rising-finding-solutions-to-tackle-drought/
10. Smith, G. *Not so dirt-cheap*. http://blog.ciat.cgiar.org/not-so-dirt-cheap/

#58

Restoration project

Name of respondent, center, CRP (if relevant): Fred Kizito. CIAT, WLE (RDL)

Title: Biophysical and socio-economic synthesis of the effectiveness of land restoration towards enhancing food security and livelihoods in smallholder communities
Starting year: 2016 - Ending year: 2018/19
Place: Tana Basin, Kenya

1a) Scale: From farm to landscape

1b) Driver of degradation addressed/reversed
Land use changes/habitat transition. Since the 1970s, forests on steep hillsides and areas of wetlands in the Tana Basin have been converted to agriculture. As a result, sedimentation is becoming a serious problem, reducing the capacity of reservoirs and increasing the costs for water treatment. Today, 60% of Nairobi's residents are water insecure.

1c) Stage of the forest transition curve
It is a mix of Agriculture for the most part and Agroforestry for the other parts.

1d) Entry point:
1. Governance, institutions
2. Biophysical (soil, vegetation)
3. Economics, livelihoods

2) short description of the project (2-5 lines)
The project is located in the Upper Tana Basin of Kenya. It is a public-private partnership that includes the Nature Conservancy and CIAT. Forests and wetlands in the Upper Tana play an important role in maintaining water quality and quantity, providing areas where runoff water and sediment can be stored and filtered naturally. The challenges to water security will likely grow as climate change brings increasingly unpredictable rainfall. The impact of landscape restoration on incomes and livelihoods of farmers was previously not well understood. This project endeavors to translate biophysical data into socio-economic metrics with specific indicators under consideration.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
Results from our monitoring data in relation to soil erosion and the associated intervention measures indicated that there was an order of magnitude of increase in runoff for areas without sustainable land management with about 40% increases in sediment losses. This underpins the importance of landscape stewardship at the farm level which translates to wider influences at the landscape scale.

What has helped? The existence of a functional partnership with the water resources users association and the private sector have been very critical to the success of ongoing efforts to control upstream soil erosion from the Tana Basin to downstream areas.

Main constraints? There are several challenges associated with the management of partnerships that involve the public and private sector entities. Currently, there are challenges associated with funding upstream activities and interventions that reduce erosion that involve the smallholder communities.

Evidence of impact: Results from our monitoring data in relation to soil erosion and the associated intervention measures indicated that there was an order of magnitude of increase in runoff for areas without sustainable land management with about 40% increases in sediment losses. This underpins the importance of landscape stewardship at the farm level which translates to wider influences at the landscape scale. The areas that had interventions specifically grass strips & terraces indicated better sedimentation retention and water yields of 30% and 45% respectively.

4) References

1. http://www.ciatnews.cgiar.org/wp-content/uploads/2014/11/WLE-Innovation-Fund_Final-Report.pdf

#59

Restoration project

Name of respondent and e-mail: e.betemariam@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant): WLE
Title: Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) Programme
Starting year: 2015
Ending year: 2017
Place: Chad

1a) Scale:
Plot
Farm
Landscape x
1b) Driver of degradation addressed/reversed
Soil erosion, vegetation clearance
1c) Stage of the forest transition curve
Forested landscape
Agriculture x
Agroforestry
1d) Entry point:
Biophysical (soil, vegetation) x
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
The Programme Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED), aims to improve the integration of disaster risk reduction and climate adaptation methods into development approaches in Chad.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?

- Capacity development in land health surveillance
- Understanding of land health constraints for spatially targeting sustainable land management interventions

Main constraints?
Evidence of impact

4) References

1. http://www.worldagroforestry.org/project/building-resilience-and-adaptation-climate-extremes-and-disasters-braced-programme
2. http://www.braced.org/news/i/?id=a3a3320f-0007-4e0c-ade7-73ec86d6e3ea
3. http://www.braced.org/news/i/?id=a3a3320f-0007-4e0c-ade7-73ec86d6e3ea

#60

Restoration project

Name of respondent and e-mail: e.betemariam@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant): WLE

Title: Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) Programme
Starting year: 2011
Ending year: on-going
Place: Côte d'Ivoire

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed

- Cocoa Swollen Shoot Virus (CSSV)
- Soil erosion and nutrient depletion

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation, disease) x
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
The project aims at the building sustainable cocoa production system in Côte d'Ivoire

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?

- Identify land health constraints and drivers of land degradation
- Human capacity development in land health surveillance and soil spectral lab and data management
- Soil spectral labs established to enhance the physical capacity of the project/country to assess soil and plant health

Main constraints?
Evidence of impact

4) References

1. http://humidtropics.cgiar.org/wp-content/uploads/downloads/2015/04/Situational-Analysis-Report-Banna.pdf
2. Diby L, Kouassi G, N'Guessan MP, Yao E, Oro F, Aynekulu E, Kassin E, Kouame C, Coe R, Shepherd K. 2014. Cocoa Land Health Surveillance: An evidence-based approach to sustainable management of cocoa landscapes in the Nawa region, South-West Côte d'Ivoire, Working Paper 193. Abidjan, World Agroforestry Centre.

#61

Restoration project

Name of respondent and e-mail: Keith Shepherd (k.shepherd@cgiar.org)
Center: ICRAF
CRP/Flagship (if relevant): WLE

1 Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) Programme - Apr 2015 to Dec 2017
2 Land health surveillance system for smallholder cocoa in Ivory Coast (V4C) - Jul 2011 to Dec 2017
3 Land health surveillance for high value biocarbon development in East and West Africa (BIODEV) - Jul 2012 to Dec 2016
4 Carbon sequestration options in pastoral & agro-pastoral systems in Africa - Apr 2011 to Dec 2014
5 Africa Soil Information Service (AfSIS) Phase I – July 2012-July 2015
6 Carbon Benefit Project (CBP), A Protocol for Measurement and Monitoring Soil Carbon Stocks in Agricultural Landscapes
7 Trees for food security project
8 Improved Agricultural Measurement for Evidence-based Investments in Improved Crop Production in Kenya - Jan 2017 to Dec 2017
9 Probabilistic Causal Models for Nutrition Outcomes of Agricultural Actions, Uganda- Sep 2015-Aug 2018

Title: Africa Soil Information Service (AfSIS)
Starting year: 2012
Ending year: 2016
Place: sub Saharan Africa

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed

1c) Stage of the forest transition curve: All
Forested landscape
Agriculture
Agroforestry
Grazing land

1d) Entry point:
Biophysical (soil, vegetation) x
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
AfSIS aims at narrowing Sub-Saharan Africa's soil information gap by providing a consistent baseline for monitoring soil ecosystem services. The AfSIS project area includes 17.5 million square km of continental sub-saharan Africa (SSA) and almost 0.6 million square km of Madagascar

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?

- Narrowing sub-Saharan Africa's soil information gap by providing a consistent baseline data including maps for monitoring soil ecosystem services.

Main constraints?
Evidence of impact

4) References

1. http://www.worldagroforestry.org/project/africa-soil-information-service-afsis-i

2. https://onlinelibrary.wiley.com/doi/abs/10.1111/gcb.12632
3. https://www.sciencedirect.com/science/article/pii/S0308521X14001206
4. https://www.dropbox.com/s/tljc15b59yf8nxp/8.%20Mapping%20Soil%20Properties%20of%20Africa%20at%20250M%20Resolution%20Random%20Forests%20Significantly%20Improve%20Current%20Predictions.pdf?dl=0
5. https://www.dropbox.com/s/6a4y2xqvwpghrn2/11.%20Towett%20et%20al%202015_MIRS%20%26TXRF%20complementarity%20for%20prediction%20of%20soil%20properties.pdf?dl=0

#62

Restoration project – Tool

Name of respondent, center, CRP (if relevant): John Mutua, CIAT, WLE
Title: Methodology on bush encroachment mapping
Starting year: 2016
Ending year: 2017
Place: Namibia

1a) Scale: Landscape
1b) Driver of degradation addressed/reversed: Bush encroachment
1c) Stage of the forest transition curve: Agroforestry
1d) Entry point: Biophysical (soil, vegetation), Economics, livelihoods

2) short description of the project (2-5 lines)
Application of free and open source GIS tools and open datasets for mapping bush encroachment in the Otjozondjupa region, Namibia.

3) results
Impacts:
We built capacity to conduct bush encroachment mapping on the ground. In 2016, we collaborated with a team from Namibia's Ministry of Environment and Tourism (MET) to establish a baseline to measure Bush Encroachment (BE) among other LDN indicators. The methods was adapted locally and local scientists can now map and monitor bush encroachment.
What has helped?
Working with scientists from International Soil Reference and Information Centre – ISRIC made access to some of the datasets easier.
Main constraints?
The only constraint was during the training session. For most participants it was their first time to work with R programming software and open datasets.
Evidence of impact
Twenty land resources management professionals were trained in remote sensing, geographic information systems (GIS) and digital soil mapping (DSM) technologies using open source software; this enabled them to later produce LDN baselines for Omusati region, Namibia in the year 2018.

4) References

1. Mutua, J., & Nijbroek, R. (2018). Measuring land degradation needs to be done from the ground up. Rural 21.
2. Nijbroek, Ravic; Mutua, John; Soderstrom, Mats; Piikki, Kristin; Kempen, Bas; Hengari, S. (2017). Pilot Project Land Degradation Neutrality (LDN), Namibia: Establishment of a baseline for land degradation in the region of Otjozondjupa. Harvard Dataverse. https://doi.org/10.7910/DVN/FA3ZJS

#63

Restoration tool

Name of respondent, center, CRP (if relevant): CIAT, WLE-RDL
Kristin Piikki & Mats Söderström, Kristin.piikki@slu.se
Title: Digital soil maps for Mukuyu and Shikomoli -web applications and map books.
Year: 2018

1a) Scale: (covers two villages with 5 m * 5 m resolution)
Plot yes
Farm yes
Landscape yes

1b) Driver of degradation addressed/reversed
Crop production with insufficient inputs (lime, fertilizer, manure, …)

1c) Stage of the forest transition curve: Any
Forested landscape no
Agriculture yes
Agroforestry no

1d) Entry point:
Biophysical (soil, vegetation) yes
Economics, livelihoods no
Governance, institutions no
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
Risk maps of nutrient deficiencies were produced for two villages in Western Kenya (Mukuyu and Shikomoli). The maps were provided to local farmers and extension officers through a mobile phone app and in the form of map books (English and Kiswahili).

3) Effective use
Where? Mukuyu and Shikomoli in W. Kenya.
By whom? Farmers and extension officers
For what? For communicating assessments of nutrient deficiencies and inadequate soil pH. The maps are a form of decision support that can be used for farmers to decide on whether to take a soil sample and send for analysis or for directly guiding management decisions (application of fertilizer, manure, fertilizers).

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
The map books and the web applications were well received when presented to the end-users at participatory workshops.
Main constraints?
The maps constitute decision support but the farmers may not be able to afford the inputs required for soil correction.
Evidence of impact: Not yet.

5) References

Web applications :

1. http://bit.ly/Mukuyu_Soil2016
2. http://bit.ly/Shikomoli_Soil2016

Map books :

3. https://www.dropbox.com/sh/hycxhqw23ahn128/AADOpzsByjiYmFvN-uCZA5dna?dl=0

#64

Restoration tool

Name of respondent, center, CRP (if relevant): CIAT
Title: Landscape Doctor
Year: 2018

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed
Deforestation, overgrazing, cultivation, erosion, nutrient mining

1c) Stage of the forest transition curve **All**
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)
All equally relevant

2) Short description of the tool (2-5 lines)
Understanding the complex interactions, feedback and spatial dynamics is essential to successfully restoring degraded landscapes and developing management plans for keeping other landscapes healthy. A Landscape Doctor with a set of decision tools can be used by planners, investors and other decision-makers to diagnose problems, identify the best course of treatment and implement those considering site-and context-specificities.

3) Effective use
Where? In Ethiopia: Framework completed-tested and automation underway.
By whom? Being tested under the Africa RISING project. Once completed will be scaled across the SLMP watersheds in Ethiopia and beyond. Discussing with the SLMP team to integrated tool with EthioCAT – WOCAT version of Ethiopia.
For what? To facilitate planning and targeting options fitting with context as well as generate evidences and assess tradeoffs.

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
Positively tested in various watersheds.

What has helped? Challenge of implementing the SLM manual on the ground necessitated the need to try developing an automated option.
Main constraints? Shortage of data at the required scale, resolution and quality.

Evidence of impact: Being tested and automation needs to be completed and option used across various scales to assess impact.

5) References
(Tool under-development thus no specific publications yet. But associated publications that can be linked to it are below)

1. Woldearegay, K.; L. Tamene; K. Mekonnen; F. Kizito; D. Bossio. 2018. Fostering food security and climate resilience through integrated landscape restoration practices and rainwater harvesting/management in arid and semi-arid areas of Ethiopia. In: Leal Filho W., de Trincheria Gomez J. (eds) *Rainwater-Smart Agriculture in Arid and Semi-Arid Areas*. Springer, Cham https://link.springer.com/chapter/10.1007/978-3-319-66239-8_3

2. Woldearegay, K.; L. Tamene; K. Mekonnen; Z. Admassu; T. Yaekob. 2016. Poster: *Promoting landscape restoration and water harvesting at scale; the case of Africa Rising project, Ethiopia*. https://cgspace.cgiar.org/bitstream/handle/10568/79168/ARethiopia_poster_kifle_nov16.pdf?sequence=1
3. Tamene, L.; T. Yaekob; J. Ellison; K. Mekonnen. 2017. *Integrated landscape management: Africa RISING R4D experiences in the Ethiopian highlands.* https://www.slideshare.net/africa-rising/ar-n2africa-liveslulseged2016
4. Tamene, L; K. Mekonnen; P. Schmitter; Z. Adimassu; A. Gebrekirstos; A. Haileslassie. No date. Poster: *Soil and water management at farm and landscape scale*. http://www.worldagroforestry.org/downloads/Publications/PDFS/PO16126.pdf

#65

Restoration tool

Name of respondent, center, CRP (if relevant):
Kristin Piikki & Mats Söderström, CIAT, WLE-RDL
Contact: Kristin.piikki@slu.se
Title: Package 'mapsRinteractive'
Year: 2018

1a) Scale: Multiple
Plot yes
Farm yes
Landscap yes

1b) Driver of degradation addressed/reversed
Not applicable.

1c) Stage of the forest transition curve : Any
Forested landscape yes
Agriculture yes
Agroforestry yes

1d) Entry point:
Biophysical (soil, vegetation) yes
Economics, livelihoods no
Governance, institutions no
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
The tool is used to locally adapt and evaluate large-scale digital soil maps by use of local soil sample data.

3) Effective use
Where? anywhere
By whom? anyone
For what? Large-extent maps are not always accurate enough for use in project areas of smaller extent. By use of a local soil sample dataset, large-extent maps can be locally adapted and evaluated. This may be a useful (cost and time effective) alternative to creating a soil maps from scratch.

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The method (before it was implemented in the tool) has been used for LDN baseline mapping by Nijbroek et al., 2018 (https://doi.org/10.3390/su10051610) and Söderström et al., 2017 (https://doi.org/10.1080/02571862.2016.1166400)
Main constraints? Knowledge of R is required.
Evidence of impact Not yet.

5) References

1. Piikki & Söderström, 2018. Package 'mapsRinteractive'. Available online: https://cran.r-project.org/web/packages/mapsRinteractive/mapsRinteractive.pdf Verified August 10, 2018.
2. Nijbroek et al., 2018 (https://doi.org/10.3390/su10051610)
3. Söderström et al., 2017 (https://doi.org/10.1080/02571862.2016.1166400)

#66

Restoration project – Tool

Name of respondent, center, CRP (if relevant): Rolf Sommer, CIAT, WLE
Title: The CIAT SOC App (http://ciatsocapp.github.io/index.html)
Starting year: 2015 - Ending year: n.a.
Place: global

1a) Scale: Point to Landscape
1b) Driver of degradation addressed/reversed: loss of soil organic carbon
1c) Stage of the forest transition curve: n.a.
1d) Entry point: Biophysical (soil)

2) short description of the project (2-5 lines)
The CIAT SOC APP is a soil organic content computation tool that computes SOC concentration and sequestration of a given soil, and outputs the results in graphic and table formats. The tool is open-access to be use by individuals, governments, NGOs, researchers, communities, and others. We are happy to share the source code upon enquiry.

3) results
Impacts:
There has been quite some debate about the scope for mitigating climate change by soil organic carbon (SOC) sequestration. However, it seems there is a general lack of understanding of quantities and the time-dimension, as well as the possible contribution that SOC sequestration can play. Our tool allows any user to calculate SOC sequestration potentials in space and time. The underlying idea has been used in various publications and has been presented widely.
We have not true impact yet to report.

What has helped? -
Main constraints?
The major constraint for using this tool is that it isn't a crystal ball for gazing into the future and predicting actual SOC sequestration. The user still has to have some evidence and data on SOC that are needed as input data. This sometimes is a surprise to the users, who tend to think that this tool "will tell it all".

Evidence of impact: None so far.

4) References

1. Sommer, Rolf; Koech, Nicolas; and Godiah, David. 2015. CIAT SOC APP. International Center for Tropical Agriculture (CIAT). Web tool (Available from http://ciatsocapp.github.io/index.html).
2. Zomer, R.J., Bossio, D.A., Sommer, R., Verchot, L. 2017 Global Sequestration Potential of Increased Organic Carbon in Cropland Soils. Scientific Reports 7: 15554 DOI:10.1038/s41598-017-15794-8

#67

Restoration tool

Name of respondent, center, CRP (if relevant):
Kristin Piikki & Mats Söderström, CIAT, WLE-RDL. Contact: Kristin.piikki@slu.se
Title: R package: 'SurfaceTortoise'
Year: 2018

1a) Scale: **Multiple**
Plot yes
Farm yes
Landscape yes
1b) Driver of degradation addressed/reversed. Not applicable.
1c) Stage of the forest transition curve: **Any**
Forested landscape yes
Agriculture yes
Agroforestry yes
1d) Entry point:
Biophysical (soil, vegetation) yes
Economics, livelihoods no
Governance, institutions no
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
The tool is used to find optimal soil sampling locations based on spatial covariate(s), e.g. in land restoration projects.

3) Effective use
Where? anywhere
By whom? anyone
For what? For targeting soil sampling locations, in order to efficiently cover spatial variation patterns in a study area.

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The method (before it was implemented in the tool) has been used for LDN baseline mapping by Nijbroek et al., 2018 (https://doi.org/10.3390/su10051610)
Main constraints? Knowledge of R is required.
Evidence of impact Not yet.

5) References

1. Piikki & Söderström, 2018. Package 'SurfaceTortoise'. Available online: https://cran.r-project.org/web/packages/SurfaceTortoise/SurfaceTortoise.pdf. Verified August 10, 2018.
2. Nijbroek et al., 2018 (https://doi.org/10.3390/su10051610)

#68

Restoration tool

Name of respondent and e-mail: Keith Shepherd (k.shepherd@cgiar.org)
Center: ICRAF
CRP/Flagship (if relevant): WLE

Title: Decision Analysis
Year: 2018 (publication of the article)

1a) Scale:
Plot
Farm
Landscape x

1b) Driver of degradation addressed/reversed

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry x

1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods x
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)

3) Effective use
Where?
By whom? Development-oriented researchers
For what? Projection of development interventions outcomes even in the absence of precise information

4) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact

5) References

1. https://www.dropbox.com/s/cortjmwwu0qbcpm/18.%20Keith%20et%20al%20Nature%20Article.pdf?dl=0
2. https://www.dropbox.com/s/a8md110mtyatac9/2.%20Luedeling%20et%20al%202015_Fresh%20groundwater%20for%20Wajir%E2%80%B9ex-ante%20assessment%20of%20uncertain%20benefits%20for%20multiple%20stakeholders%20in%20a%20water%20supply%20project%20in%20Northern%20Kenya.pdf?dl=0
3. http://www.worldagroforestry.org/publication/decision-analysis-methods-guide-agricultural-policy-nutrition

#69

Conceptual approach to restoration

Name of respondent and e-mail: Zenebe Adimassu (z.adimassu@cgiar.org)
Center: IWMI
CRP/Flagship (if relevant): WLE Flagship 2: Land and Water Solutions
Title: Highlights of watershed soil and water conservation investments of Ethiopia: impacts, benefits and needs for environment and development
Year: 2015-2018

1a) Scale:
A series of studies were conducted in four regions of Ethiopia, exploring the scale, effectiveness and opportunity of SLM – SWC (Sustainable land management – soil and water conservation) practices promoted through national policy, research and policy actors during the last 40+ years. Aspects of agronomy/crop productivity, local environmental impact, and farmer response and impact data were collected in individual land restoration initiative's implemented at plot, farm and landscape levels.

1b) Driver of degradation addressed/reversed
Soil erosion by water, and nutrient depletion are the main land degradation addressed. Policy at national level recognises issues and have –is continuing investments to address this (Adimassu et al., 2018a). Yet , farmer benefits in terms of increased yields on SWC –SLM are difficult to realise at the landscape scale (Adimassu et al., 2016; Adimassu et al., 2018b), despite several technologies available to effective curb soil erosion and nutrient loss. Physical structures alone are less effective in realising yields, whereas physical combined with biological (vegetative) measures are more promising (Adimassu et al., 2017; Tamene et al., 2017). New drivers and approaches of positive change are emerging in Ethiopia farming landscapes. For example, afforestation and exclosure are emerging as most important approaches used to restore degraded forests and grazing lands in Ethiopia (Mekuria et al., 2017). There are emerging information that tree planting (driven by emerging value chains and market opportunities) also benefits the SLM agenda in Ethiopia (Mekuria et al., 2017). Social interventions can be critical to build resilience at the landscape scale (Tessema et al., 2018). Landscape impacts on water and sediment loss, as well as habitat improvement needs more analyses of these evolving and intensified agro-ecological landscapes. Incentives for farmers need further development, for more effective and rapid uptake of best practices.

1c) Stage of the forest transition curve
Most of the land restoration projected are implemented in the agricultural and degraded forest Forested landscape
1d) Entry point:
Land restoration projected assessed in this case study were focused on restoring soil and vegetation (biophysical) while improving the livelihood of communities.

2) Short description of the approach (2-5 lines)
The studies analyzed land restoration efforts in various regions of Ethiopia, which fall into the following categories: farmland management, hillside management and gully rehabilitation practices, including check dams and cut-off drains.

3) Used
This paper provides details of land restoration investments in Ethiopia over the past 20 years. It presents land restoration practices and estimates the level of SWC investments in Amhara, Oromia, SNNPR and Tigray regions of Ethiopia. The results of the studies are important for policy makers, development organizations and donors, and encourage further investments in land restoration.

4) Results
Adding up the past three years of land restoration interventions across the four regions of Ethiopia where most SWC practices are implemented, the total area covered by new farm and hillside terraces alone would total 6.4 Mha (nearly 20% of Ethiopia's agricultural land). The study also shows that these practices involved both paid and unpaid labor, together representing an estimated investment of more than ETB 25 billion (or approximately USD 1.2 billion) per year over the past 10 years.
The use of physical SWC structures alone are not effective to contribute to yield increase and farmer gains. SWC –SLM technologies at the plot level need to be combined with biological management,

such as rotation , grass strips and-or planting permanent woody species at strategic points (trees, bushes).
Impacts of these plot changes are still poorly understood at the landscape level for a range of ecosystem services including surface-groundwater storage and flows, habitat and species diversity , and sediment flows . Climate change of rainfall and temperatures may undermine current and past SLM efforts and may require more pro-active land use change to transform farmer and rural livelihoods

4) References

1. Adimassu, Z., Barron, J., Langan, S. 2018a. Influence of soil and water conservation practices on selected soil physico-chemical properties and crop performance: case studies in four watershed of Ethiopia, Land degradation and Development (under review).
2. Adimassu, Z.; Langan, S.; Barron, J. 2018b. Highlights of soil and water conservation investments in four regions of Ethiopia. Colombo, Sri Lanka: International Water Management Institute (IWMI). 35p. (IWMI Working Paper 182). doi: 10.5337/2018.214 http://www.iwmi.cgiar.org/Publications/Working_Papers/working/wor182.pdf
3. Adimassu, Z., Tamene, L., Schmitter, P., Yaekob, T., Barron, J. 2017. The effect of soil bunds on run-off, soil loss, soil moisture dynamics and crop yield in the Jawe-gumbura watershed, Ethiopia. Nairobi, Kenya: ILRI. https://cgspace.cgiar.org/handle/10568/83020
4. Mekuria, W.; Barron, J.; Dessalegn, M.; Adimassu, Z.; Amare, T.;Wondie, M.2017.Exclosures for Ecosystem Restoration and Economic Benefits in Ethiopia: A Catalogue of Management Options.Colombo,Sri Lanka:International Water Management Institute (IWMI).32p. (WLE Research for Development (R4D) Learning Series 12) doi:10.5337/2017.204
5. Tamene, L., Z. Adimassu, J. Ellison, T.Yaekob, K.Woldearegay, K. Mekonnen, P.Thorne ,Q.BaoLe. 2017. Mapping soil erosion hotspots and assessing the potential impacts of land management practices in the highlands of Ethiopia Geomorphology Vol 292 : 153-163 https://doi.org/10.1016/j.geomorph.2017.04.038
6. Adimassu, Z.; Langan, S.; Johnston, R..; Mekuria, W.; Amede, T. 2016. Impacts of soil and water conservation practices on crop yield, run-off, soil loss and nutrient loss in Ethiopia: review and synthesis. Environmental Management, doi: 10.1007/s00267-016-0776-1
7. Tamene, L., Adimassu, Z. Aynekulu, E.; Yaekob, T. 2017. Estimating landscape susceptibility to soil erosion using a GIS-based approach in Northern Ethiopia . International Soil and Water Conservation Research 5(3): 221-230: http://dx.doi.org/10.1016/j.iswcr.2017.05.002
8. Tessema, G., Kassahun, B., Adimassu, Z., Mojo, D. 2018. Empowering Farmers and Local Institutions through Devolution for Sustainable Land Management: A Case in Central Highlands of Ethiopia Building Resilient Communities Land Use Change, Rural Development and Adaptation to Climate Consequences. Lulu Publishing Services.

#70

Conceptual approach to restoration

Name of respondent, center, CRP (if relevant): CCAFS CIAT
Title: Climate smart villages (CSV)
Year:

1a) Scale:
Plot x
Farm x
Landscape x
1b) Driver of degradation addressed/reversed
Climate change, deforestation, soil erosion, soil nutrient depletion
1c) Stage of the forest transition curve
Forested landscape
Agriculture x
Agroforestry x
1d) Entry point:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
The project to test evaluate climate smart agricultural (CSA) practices at farm and landscape levels using two sites from Africa RISING integrated land and water management sites. The overall goal is to build livelihoods and improve resilience of smallholder farmers to climate change through large scale adoption of CSA technologies and practices.

3) Used
Where? Two sites in Ethiopia (Hoseana and Debre Birehan)
By whom? CCAFS and CIAT
For what? Identifying best CSA practices in the highland of Ethiopia

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped? The two sites were already the part of Africa RISING project sites thus easier for implementing.
Main constraints?
Evidence of impact : To be evaluated…..

4) References

1. Meron Tadese, The effects of climate smart agriculture on soil fertility and productivity, the case of Tula-Jana watershed, SNNPR, Ethiopia, MSc thesis, 2018, Addis Ababa university.

#71

Conceptual approach to restoration

Name of respondent, center, CRP (if relevant): WLE CIAT Ravic Nijbroek
Title: Scientist
Year:

1a) Scale:
~~Plot~~
~~Farm~~
Landscape / micro-catchment

1b) Driver of degradation addressed/reversed:
1. On-farm soil fertility
2. Off-farm soil / water conservation
3. Overall focus on improving Carbon, Water and Nutrient cycles in the landscape

1c) Stage of the forest transition curve
~~Forested landscape~~
Agriculture
~~Agroforestry~~

1d) Entry point:
1. Economics, livelihoods
2. Biophysical (soil, vegetation)
3. Governance, institutions

(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the approach (2-5 lines)
Starting with community needs assessment, develop sustainable intensification community farm, then address drivers of degradation that adversely affect community farm

3) Used Where? Smallholder farmers
By whom?
For what?

N/A in testing phase

4) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact: **N/A in testing phase**

4) References

#72

CSP30 Restoration project

Name of respondent and e-mail: Ephraim Nkonya, e.nkonya@cgiar.org
Center: IFPRI
CRP/Flagship (if relevant): CRP2

Title: Global Economic Assessment of Land Degradation and Improvement.
Starting year:2015
Ending year: On-going
Place: Global

1a) Scale: Global

1b) Driver of degradation addressed/reversed: ELD method identifies drivers of land degradation and shows how to compute land degradation and strategies and cost of restoration.

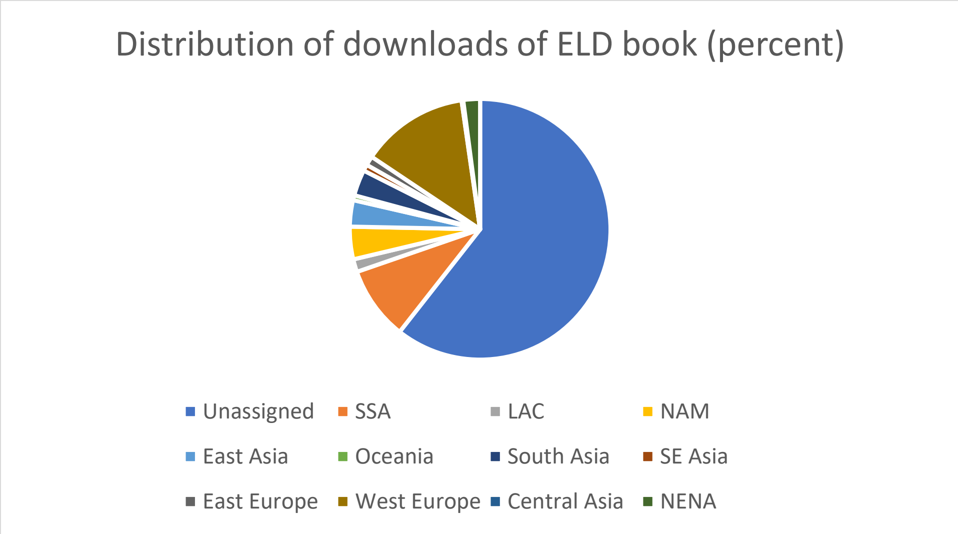
1c) Stage of the forest transition curve: All stages are discussed since this is a global study

1d) Entry point:
Biophysical (soil, vegetation) 3
Economics, livelihoods 1
Governance, institutions 2
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines):
Designs the analytical methods for assessment of economics of land degradation. Then the model shows sources of data and demonstrates computations of ELD using 12 case study countries.

3) results
Impacts: positive, failure, unexpected impacts (positive or negative)
What has helped?
Main constraints?
Evidence of impact
Impacts: ELD book used to formulate SDG 15 about zero net land degradation.
ELD approach goes beyond the conventional market values of only crop and livestock products lost due to land degradation but seeks to capture all major terrestrial losses of ecosystem services. Twelve carefully selected national case studies provide rich information about various local contexts of cost of land degradation as evaluated by local communities, drivers of land degradation, and amenable strategies for sustainable land management. The 12 case studies countries used include: Argentina, Bhutan, China, Ethiopia, India, Kenya, Malawi, Niger, Russia, Senegal, Tanzania and Uzbekistan. The 12 countries account for 45% of the global population and are representative of all low- and middle-income countries.

About 526,000 copies downloaded from the website so far. The book is among the most downloaded Springer books.



Key: SSA=Sub-Saharan Arica, LAC=Latin America, NAM=North America, NENA=Near East and North Africa.

What has helped? Rigorous analysis and media coverage of the results.
Main constraints? No funding to continue improving on the ELD approach using new satellite data with higher resolution.
Evidence of impact Downloads at http://link.springer.com/book/10.1007%2F978-3-319-19168-3

4) References

1. http://link.springer.com/book/10.1007%2F978-3-319-19168-3
2. https://www.ifpri.org/land-management

#73

Restoration project

Name of respondent and e-mail: Susan Chomba, s.chomba@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant): N/A

Title: Reversing Land Degradation in Africa by Scaling-up Evergreen Agriculture
Starting year: Sept 2017
Ending year: Sept 2022

Place: East & West Africa: *Ethiopia, Kenya, Rwanda, Somalia, Niger, Mali, Ghana and Senegal.*

1a) Scale:
Farms
Landscapes
National
Regional

1b) Driver of degradation addressed/reversed
The project addresses context-specific drivers in each country. Both biophysical drivers such as those related to topography, landcover change, climate, soil erodibility; as well as socio-economic drivers such as land clearing, overgrazing, bush-burning, etc. are assessed and interventions for restoration designed to suit the context

1c) Stage of the forest transition curve
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation) (1)
Economics, livelihoods (1)
Governance, institutions (1)
(ranked from 1 to 3 if there are multiple objectives)

2) short description of the project (2-5 lines)
Overall objective: to improve livelihoods, food security and resilience to climate change by smallholder farmers in Africa and restore ecosystem services, particularly through evergreen agriculture.

Specific objective(s):
1. Equip 8 countries with surveillance and analytic tools on land degradation dynamics, including the social and economic dimensions, to support strategic decision-making and monitoring for the scaling-up of evergreen agriculture.
2. Support 8 countries in the accelerated scaling-up of evergreen agriculture by smallholder farmers, along with the development of agroforestry value chains. The overall target is adoption of sustainable land management practices by at least 500,000 farm households, over an area of at least 1 million hectares across 8 countries.

3) Results
Impacts: positive, failure, unexpected impacts (positive or negative)
It's too early to measure the impact of the project, however, data from the first two years shows:
- In total, **162,697 hectares are currently under restoration and a total of 145,274 households have been reached**
- Value chain development/strengthening activities were conducted for over 20 prioritised chains in six countries
- Scaling up of context-specific land restoration practices across the eight countries such as FMNR, Plantation/direct seeding, Agroforestry with high value fruit trees, tree planting (grove, orchard-Moringa, soil and water conservation techniques such as zai pits, stone barriers, ACN, fast composting, half-moons, trenches, dune stabilisation with grass strips, management of rangelands and protected areas, tree nurseries, among others

- Impressive gains on policy influencing at national and local levels with three East Africa countries (Kenya, Ethiopia and Rwanda) already enacting AF strategies and three West African country governments (Mali, Niger and Senegal) engaging with the project actively to understand the practical limitations of their tree and land tenure policies on land restoration.
- A robust evidence sharing, joint learning and adaptive management through the SHARED framework.
- Development and application of innovative tools for land restoration monitoring including a mobile-based application called Regreening Africa app for real-time tracking of project indicators and the application of the Land Degradation Surveillance Framework (LDSF framework)

Main constraints?

- Delays in onset of project activities due to the bureaucracy of setting up a large consortium of partners across eight countries
- Scaling up to non-project sites as the assumed uptake by farmers in other areas is not clearly understood
- Inadequate funding: the project has very ambitious targets across 8 countries with a relatively small budget and this puts a big constraint on the few scientists supporting the project as well as field level staff to support implementation.
- **March 2020 update:** COVID 19 has led to indefinite postponement of field level activities until the virus is no longer a threat to the local communities and project staff.

Evidence of impact

Robust impact evaluation studies are ongoing through baseline surveys, annual uptake surveys and end line survey which will provide data on set impact indicators including increased productivity, soil organic carbon, incomes and livelihoods as well as vegetation cover by the end of the project period.

4) References/publications

No	Title	Link	Type	Date
1	Project brochure (English and French)	https://regreeningafrica.org/wp-content/uploads/2019/02/Final-RA-Brochure-EN.pdf https://regreeningafrica.org/wp-content/uploads/2019/02/Final-RA-Brochure.pdf	Project brochures	January 2018
2	Overall Annual Technical Report	https://regreeningafrica.org/wp-content/uploads/2019/04/2019_AnnualReport_Public_Emailable.pdf	Annual report	2017 – 2018
3	Reverdir le Mali avec des arbres	https://regreeningafrica.org/wp-content/uploads/2019/06/MaliWorkshop_Print_A3_5mmbleed.pdf	Stakeholders Workshop report	February 2019
4	Regreening Rwanda with Trees	https://regreeningafrica.org/wp-content/uploads/2019/03/Rwanda-Regreening-SHARED-Workshop-Summary.pdf	Stakeholders Workshop report	February 2019
5	Regreening Kenya with Trees	https://regreeningafrica.org/wp-content/uploads/2019/03/Kenya-Regreening-SHARED-Workshop-Summary.pdf	Stakeholders Workshop report	February 2019
6	Regreening Ghana with Trees	https://regreeningafrica.org/wp-content/uploads/2019/03/Ghana-Regreening-SHARED-workshop-summary.pdf	Stakeholders Workshop report	February 2019
7	Regreening Ethiopia with Trees	https://regreeningafrica.org/wp-content/uploads/2019/03/Ethiopia-Regreening-SHARED-Workshop-Summary.pdf	Stakeholders Workshop report	February 2019
8	Regreening Africa Communications and Visibility Plan	https://regreeningafrica.org/wp-content/uploads/2019/10/Regreening-Africa-Communications-Plan-2019_WEBSITE.pdf	Workshop report	March 2019
9	Regreening Africa in Niger (Issues 1 – 3)	https://regreeningafrica.org/wp-content/uploads/2019/10/RN1.jpg https://regreeningafrica.org/wp-content/uploads/2019/05/REGREENING-AFRICA-NIGER-NEWS.pdf	Newsletter	April – September 2019

		https://regreeningafrica.org/wp-content/uploads/2019/10/RNIII.jpg		
10	Reverdir le Niger Assistée des abres	https://regreeningafrica.org/wp-content/uploads/2019/06/Niger-SHARED-Workshop-Summary-Report.pdf	Workshop report	May 2019
11	Reverdir le Sénégal avec des arbres	https://regreeningafrica.org/wp-content/uploads/2019/06/Regreening-Senegal-SHARED-Workshop-Report.pdf	Workshop report	May 2019
12	Regreening Africa in Ethiopia	https://regreeningafrica.org/wp-content/uploads/2019/12/Regreening-Ethiopia-News.pdf	Newsletter	June 2019
13	The improved fireplace, a solution for optimising the use of firewood in Zarmaganda	https://regreeningafrica.org/wp-content/uploads/2020/03/Le-foyer-am%C3%A9lior%C3%A9-une-solution-pour-l%E2%80%99optimisation-de-l%E2%80%99utilisation-du-bois-de-chauffe-dans-le-Zarmaganda1-.pdf	Fact sheet	July 2019
14	Regreening Africa Quarterly Newsletter	https://regreeningafrica.org/reports-and-publications/	Newsletter	August 2019
15	Joint Reflective and Learning Missions (JRLM) Synthesis Report	https://regreeningafrica.org/wp-content/uploads/2019/10/JRLM-Synthesis-Report.pdf	Workshop report	September 2019
16	Regreening Africa App User Guidelines (English and French)	https://regreeningafrica.org/wp-content/uploads/2020/01/Regreening_Africa_App_User_Guide_English-1.pdf	User guide	September 2019
17	Regreening Africa Project Fiche	https://regreeningafrica.org/wp-content/uploads/2019/11/Regreening-Africa-Fiche.pdf	Project fiché	October 2019
18	Report on Field Training and Field Survey: Biophysical Soil and Land Health Assessment using the Land Degradation Surveillance Framework (LDSF) within the Regreening Africa Project	https://regreeningafrica.org/wp-content/uploads/2020/01/Rwanda_LDSF_Analytics.pdf	Training report	October 2019
19	Policy Gaps and Opportunities for Scaling Agroforestry in sub-Saharan Africa: Recommendations from a policy review and recent practice	https://regreeningafrica.org/wp-content/uploads/2019/11/Regreening-Africa-Policy-Brief.pdf	Policy brief	November 2019
20	Land Degradation Dynamics Brief	https://regreeningafrica.org/wp-content/uploads/2019/12/LDD-Brief.pdf	Project brief	November 2019
21	Regreening Africa Quarterly Newsletter	https://regreeningafrica.org/wp-content/uploads/2020/01/Regreening-Africa-Quarterly-Newsletter_Issue-2-web.pdf	Newsletter	January 2020
22	Regreening Africa in Mali	https://regreeningafrica.org/wp-content/uploads/2020/03/Regreening-Africa-Mali-Newsletter-compressed-1.pdf	Newsletter	February 2020
23	Do men and women Speak with One Voice? Gender Preferences and Challenges of Tree-based Value Chains for Land Restoration in Africa		Journal article in progress	

24	Trade-offs and synergies in using market drivers to incentivise restoration		Journal article in progress	
25	Policy gaps and opportunities for scaling agroforestry to meet climate change, biodiversity and restoration challenges in Sub-Saharan Africa	Submitted to journal	Journal article in progress	
26	Opportunities and Constraints of Farmer managed Natural Regeneration for Land Restoration in Africa, a Review		Journal article in progress	

#74

Restoration related project

Name of respondent and e-mail: La Nguyen. l.nguyen@cgiar.org
Center: ICRAF
CRP/Flagship (if relevant): FTA

Title: Developing and Promoting Market-based Agroforestry and Forest rehabilitation Options for Northwest Viet Nam - AFLi2 project
Starting year: 2017
Ending year: 2021
Place: Dien Bien, Son La and Yen Bai provinces, Vietnam

1a) Scale:
Plot –with partner organizations and farmers at plot scale
Farm - with partner organization and farmers at farm scale
Landscape - with partners, local governments, and farmers at landscape scale

1b) Driver of degradation addressed/reversed
- develop and promote market-based agroforestry options to improve livelihoods
- enhance forest and landscape management.

1c) Stage of the forest transition curve
Forested landscape: Established in two sites the forest rehabilitation research in Dien Bien and Son La provinces (enrichment planting, planting non-timber forest products; assisted natural regeneration; and scattered tree planting)
Agriculture -
Agroforestry: Established and monitoring 10 agroforestry trials, six exemplar landscape in Dien Bien, Son la and Yen Bai provinces

1d) Entry point:
Biophysical (soil, vegetation) **#3**
Economics, livelihoods **#1**
Governance, institutions **#1**
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the project (2-5 lines)

AFLi2 aims to achieve improve livelihoods and enhance forest and landscape management through quantifying and evaluating performance of generic agroforestry options and tree species and suitability of different agroforestry options, understanding the ecological and economic values of degraded forests, drivers of land-use change and develop cross-sector planning approaches for landscapes, integrating forests and agroforestry lands uses; and capacity building.

3) Results

- Seven agroforestry trials established in the first phase of the project, which were considered promising systems, have been evaluated.
- Three new scientific trials of Longan+mango+maize+forage grass (Son La), Son_tra+ coffee+ forage grass (Dien Bien) and Plum+maize+forage grass (Yen Bai) have been established and put under monitoring and management.
- 10 Exemplar Landscapes (EL) have been established and put under management, monitoring and evaluation. The Farmer Demonstration Trials (FDT) have involved 174 households participating in eight group nurseries.
- In the two sites selected for forest rehabilitation research in Dien Bien and Son La, enrichment planting has been conducted in 16 ha; planting non-timber forest products done in eight ha; assisted natural regeneration in 60 ha; and scattered tree planting with 20,000 seedlings, involving 104 households.
- The study of Son_tra (*Docynia indica*) from the first phase of the project has been further developed with the establishment of new clone evaluation trials (36 clones) in three provinces.

The project has cooperated with TAFOOD's farmers to conduct top-working in 15 ha in Bac Yen (Son La).

- The market-linkage has been created with private enterprises. At the present, in addition to the collaboration with TAFOOD in the marketing of Son_tra in Bac Yen, contacts have been established with Hoan Duong trading & manufacturing joint-stock company and Viet Nam BigGreen clean food company limited for project's farmers. Key issue remained is the quality of farmers' products, which will need time for farmers to meet.
- The agroforestry suitable mapping has been studied and implemented in three provinces. The integrated landscape management study has been conducted at a research site in Dien Bien.
- In the aim of developing community capacity, the project conducted field visits and training on basic techniques of agroforestry development, benefiting more than 350 individuals, including farmers and extension workers working in provinces, districts and communes, researchers of other ongoing projects in the Northwest and neighboring Laos. The cooperation of SCU-TBU on training lecturers is carried out with professional skills training, research experiment setup, monitoring and evaluation.
- A main constraint of project implementation in market-linkage private sectors to farmers. The enterprises make certain requirements and request to support for implementation, which the project does not anticipate when designing.

4) References

1. Ha Van Tiep, Pham Huu Thuong, La Nguyen, Hoang Thi Lua, Vu Van Thuan, Lo Thi Kieu, Sammy Carsan, Ann Degrande, Delia Catacutan & Chris Harwood, 2018. Domestication of Docynia indica in Vietnam. Forests, Trees and Livelihoods. Volume 27, 2018 - Issue 4, Pages 230-242.
2. Heidi C. Zimmer, Hanh Le Thi, Duc Lo, Jack Baynes, J. Doland Nichols, 2017. Why do farmers still grow corn on steep slopes in northwest Vietnam? *Agroforestry Systems* 92(6). https://doi.org/10.1007/s10457-017-0121-6

#75

Restoration tool:

Name of respondent and e-mail: Nguyen Mai Phuong
Center: ICRAF. CRP/Flagship (if relevant): FTA

Title: The Land Degradation Surveillance Framework (LDSF) in Son La province, Vietnam
Year: 2019

1a) Scale:
Plot - Soil sampling and biophysical data collection on the ground
Farm -Soil sampling and biophysical data collection on the ground
Landscape: Field survey: 160 sample plots in a site of 10 x 10 km. Soil erosion prevalence mapping: for project area in 3 provinces of Northwest Vietnam

1b) Driver of degradation addressed/reversed:
Cultivating monoculture crops such as maize and sugarcane on steep slopes has been leading to high soil erosion and degraded landscape in Northwest Vietnam. In 2015, FTA program has invested the establishment of agroforestry exemplar landscape linked with AFLi project in Mai Son district, Son La province. This tool has been used to estimate the impact from tree-based intervention on land restoring at landscape level.

1c) Stage of the forest transition curve
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation) #1
Economics, livelihoods #2
Governance, institutions
(ranked from 1 to 3 if there are multiple objectives)

2) Short description of the tool (2-5 lines)
The study identified and measured key indicators of land and soil health in order to understand drivers of degradation and monitor changes over time using the Land Degradation Surveillance Framework (LDSF) methodology. The LDSF provides a field protocol for measuring indicators of the "health" of an ecosystem, including vegetation cover and structure, land use, land degradation, soil health, including soil organic carbon content, tree and shrub biodiversity, and infiltration capacity.

3) Effective use
Where? Mai Son district, Son La province, Vietnam
By whom? ICRAF Vietnam
For what? Measuring land health and estimating soil erosion prevalence for Northwest Vietnam

4) Results
- Providing in-the-field training for participants including ICRAF researchers, research partners, farmers on the LDSF methodology
- Assessment of landscape biophysical variables including topography, cultivation, land ownership, vegetation structure and land use, tree and shrub diversity and densities, erosion prevalence, soil water conservation measures.
- Map of estimation of soil erosion prevalence using field data and LANDSAT satellite imagery
- Continued analysis on these data to identify drivers of degradation and linkages between variables is ongoing. Predictive maps of key indicators of soil and land health will also be generated and shared.

5) References

1. Vagen, T. 2015. The Land Degradation Surveillance Framework (LDSF). Retrieved from http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/.
2. Winowiecki, L., Nguyen, M.P., Vagen, T. 2019. Technical report on "Assessing Land Health in Son La Vietnam".

#76

Restoration project

Name of respondent and e-mail: Leigh Winowiecki (L.A.Winowiecki@cgiar.org) and Fergus Sinclair (F.Sinclair@cgiar.org)
Center: World Agroforestry (ICRAF)

CRP/Flagship (if relevant): FTA 2

Title: Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale

Starting year: 2015
Ending year: 2020
Place: Kenya, Ethiopia, Niger and Mali

1a) Scale:
Farm, Landscape

1b) Driver of degradation addressed/reversed
Addressing a lack of species diversity in farming landscapes through the promotion of ecologically suitable tree species (exotic and indigenous) and crops to target food and nutrient gaps in local food systems.

1c) Stage of the forest transition curve
Agriculture
Agroforestry

1d) Entry points:
Biophysical (soil, vegetation)
Economics, livelihoods
Governance, institutions

2) Short description of the project (2-5 lines)
The overarching goal of the project was to reduce food insecurity and improve the livelihoods of poor people living in African drylands by restoring degraded land, and returning it to effective and sustainable tree, crop and livestock production, thereby increasing land profitability and landscape and livelihood resilience.

Restoration of degraded land can be a key pathway to achieving food security and reducing poverty for some of the most vulnerable people living in Africa's drylands. Landscape restoration is a process that aims to restore ecosystem functions and enhance human well-being. Restoration options need to be tailored according to biophysical and socio-economic conditions.

The research in development approach was applied to scale farmer-centered land restoration options by working with NGOs and development initiatives to implement planned comparisons on farmers' fields to test which options work best for each context.

The Integrating Gender and Nutrition within Agricultural Extension Services (INGENAES) toolkit2 was employed to understand the potential gender-related impacts of tree planting and planting basins.

3) Results:
Over 15,000 farming households implemented on-farm restoration options in the four countries. All households were monitored and the performance of the restoration options were tracked, all data are curated and available on Harvard Dataverse.

In Kenya, households increased yields of maize and legumes 2 to 5 times in planting basins, increased on-farm tree cover and diversity, reduced on-farm erosion prevalence, increase soil fertility, and increased livelihood options.

In Kenya, Increased tree cover with > 30,000 seedlings of seven tree species planted in home gardens, croplands and terraces.

In Kenya, over 75% of farmers already engaged in the Planting Basin Planned Comparison in Kenya expressed excitement to continue to expand the number of basins on their farm. Farmers are reporting increased food security and income from increased yields.

Planting basins may shift labour between men and women, increasing women's involvement in land preparation activities and their already heavy workloads, but potentially also increasing women's autonomy over these activities and allowing for earlier planting.

A key innovation within the project was to **bridge the knowledge gaps between stakeholder groups** to ensure the sharing of experience, data and evidence to more effectively scale lessons learned around restoration, using nested communities of practice.

Impacts:
Increased food security, increased livelihood options, increased farm resilience, increased autonomy of women, increased engagement of women and formation of women farming groups, increased awareness about on-farm options to restore degraded land.

What has helped? Nested Communities of Practice for knowledge sharing and co-learning within and between stakeholders. Planned comparisons.

Main constraints? Labour and shifting climate.

Evidence of impact: curated datasets monitoring the performance and uptake of the restoration interventions (household surveys and biophysical monitoring)

4) References

1. Project Website: www.worldagroforestry.org/project/restoration-degraded-land-food-security-and-poverty-reduction-east-africa-and-sahel-taking

Brochures:

2. Implementing a farmer-centered approach to land restoration in the drylands: http://www.worldagroforestry.org/output/full-brochure-2020-using-planned-comparisons-east-africa-and-sahel
3. Gender and Land Restoration: Considerations for Scaling: http://www.worldagroforestry.org/output/impact-farm-land-restoration-practices-time-and-agency-women-drylands-eastern-kenya

References:

4. Coe, R., Sinclair, F., Barrios, E., 2014. Scaling up agroforestry requires research "in" rather than "for" development. Curr. Opin. Environ. Sustain. 6, 73–77. https://doi.org/10.1016/j.cosust.2013.10.013
5. Crossland, M., Winowiecki, L., Pagella, T., Hadgu, K., Sinclair, F., 2018. Implications of Variation in Local Perception of Degradation and Restoration Processes for Implementing Land Degradation Neutrality. Environ. Dev. https://doi.org/10.1016/j.envdev.2018.09.005

Curated Datasets generated in the project:

1- Ethiopia- TP

Hagazi, Niguse; Sitotaw, Alemayehu; Tofu, Assefa; Hadgu, Kiros; Lavoll, Vilde; Winowiecki, Leigh Ann; Magaju, Christine; Nyaga, John; Sinclair, Fergus; Vagen, Tor-Gunnar, 2019, "Tree Planting Data 2017 - Ethiopia", https://hdl.handle.net/20.500.11766.1/FK2/O9LOGI, MELDATA, V1

2-Ethiopia- FP

Hagazi, Niguse; Sitotaw, Alemayehu; Tofu, Assefa; Hadgu, Kiros; Lavoll, Vilde; Winowiecki, Leigh Ann; Magaju, Christine; Nyaga, John; Sinclair, Fergus; Vagen, Tor-Gunnar, 2019, "Farmer Profiling Data - Ethiopia", https://hdl.handle.net/20.500.11766.1/FK2/LU99IW, MELDATA, V1

3-Kenya- TP 2018

Magaju, Christine; Winowiecki, Leigh Ann; Nyaga, John; Mumani, Ibrahim; Carsan, Sammy; Muriuki, Jonathan; Muthuri, Silas; Mutua, Francisca; Mbuvi, Caroline; Maithya, Stephen; Mwende, Mercy;

Muendo, Sylvester; Sinclair, Fergus; Vagen, Tor-Gunnar, 2019, "Tree Planting Data 2018 - Kenya", https://hdl.handle.net/20.500.11766.1/FK2/BLHHPR, MELDATA, V1
4-Kenya- TP 2017
Magaju, Christine; Winowiecki, Leigh Ann; Nyaga, John; Ochenje, Ibrahim; Carsan, Sammy; Muriuki, Jonathan; Muthuri, Silas; Mutua, Francisca; Mbuvi, Caroline; Maithya, Stephen; Mwende, Mercy; Muendo, Sylvester; Sinclair, Fergus; Vagen, Tor-Gunnar, 2019, "Tree Planting Data 2017 - Kenya", https://hdl.handle.net/20.500.11766.1/FK2/UUSV0P, MELDATA, V1
5-FP- Kenya
Winowiecki, Leigh; Magaju, Christine; Nyaga, John; Ochenje, Ibrahim; Wafula, Lydia; Crossland, Mary; Muthuri, Silas; Mutua, Francisca; Mbuvi, Caroline; Maithya, Stephen; Mwende, Mercy; Muendo, Sylvester; Sinclair, Fergus, 2019, "Farmer Profiling Data - Kenya", https://hdl.handle.net/20.500.11766.1/FK2/E4MRCZ, MELDATA, V1
6-Mali- FP
Savadogo, Patrice; Diakite, Adama, 2019, "Farmer Profiling Data - Mali", https://hdl.handle.net/20.500.11766.1/FK2/NREDEC, MELDATA, V1

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Land/Forest Restoration tool

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FTA Partner (CGIAR/Non-CGIAR Centre): ICRAF

Title/name of the tools and abbreviation (if used): Land Degradation Surveillance Framework (LDSF)
http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/
Year of creation/first deployment: 2005

1a) Scale: hierarchical sampling design from subplot (100m2) to plot (1000m2) to cluster 1km2 to site (100 km2) to national and global
ALL
Plot
Farm
Landscape
Sub-national
National
Global

1b) Driver(s) of degradation addressed/reversed
An assessment to understand and map drivers of degradation, prioritize restoration investments, and track/monitor impact of the restoration interventions overtime.

1c) Stage of the forest transition curve - ALL
Forested landscape
Agriculture
Agroforestry

1d) Entry point:
Biophysical (soil, vegetation)

2) Short description of the tool (2-5 lines)
The Land Degradation Surveillance Framework (**LDSF**) was developed as a response to a lack of methods for systematic landscape-level assessment of soil and ecosystem health. The methodology is designed to provide a biophysical baseline at landscape level, and a monitoring and evaluation framework for assessing processes of land degradation and the effectiveness of rehabilitation measures (recovery) over time. The framework provides field protocols for measuring indicators of the "health" of an ecosystem, including vegetation cover, structure and floristic composition, historic land use, visible signs of soil degradation, and soil physical and chemical characteristics. Due to the complex nature of ecosystems, multiple perspectives are needed to understand ecosystem processes, and variability of ecological variables at different spatial scales. The nested hierarchical sampling design used in the LDSF is useful for developing predictive models with global coverage, while maintaining local relevance.

3) context where tested/applied (a paragraph)
The LDSF has been applied in over 30 countries, in over 250-100 km2 sites.

4) Effective use
Where? In over 250 landscapes across the global tropics
When? Since 2005 and ongoing
By whom? Governments (Tanzania, Kenya, Lesotho, eSwatini, etc), NGOs (CI, The Nature Conservancy, etc), CG Centres (ICRAF, CIAT), donors (IFAD, BMGF), CRPs (WLE, FTA, etc)
For what? Assess land and soil health, prioritize, monitor and track interventions.

5) results – see list of publications
Impacts: positive, failure, unexpected impacts (positive or negative) - Positive
What has helped? Interventions, governments
Main constraints?

Evidence of impact – see below

6) References, weblinks, etc

1. Field guide: http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/
2. Atlas: https://www.unenvironment.org/resources/report/sahel-atlas-changing-landscapes-tracing-trends-and-variations-vegetation-cover-and
3. Conversation Piece: https://theconversation.com/lessons-from-kenya-on-how-to-restore-degraded-land-98178
4. Sentinel Landscapes (SL) Explorer: Explore the LDSF data from 27 LDSF sites: http://landscapeportal.org/slExplorer/
5. Land health maps produced using the LDSF are incorporated into the Decision Dashboards, available online here: http://landscapeportal.org/tools/

Selected Publications on SOC and the LDSF:

1. Abegaz, A., Winowiecki, L. A., Vågen, T.-G., Langan, S., & Smith, J. U. (2016). Spatial and temporal dynamics of soil organic carbon in landscapes of the upper Blue Nile Basin of the Ethiopian Highlands. Agriculture, Ecosystems & Environment, 218, 190–208. https://doi.org/10.1016/j.agee.2015.11.019
2. Lohbeck, M., Winowiecki, L., Aynekulu, E., Okia, C., & Vågen, T.-G. (2018). Trait-based approaches for guiding the restoration of degraded agricultural landscapes in East Africa. Journal of Applied Ecology, 55(1). https://doi.org/10.1111/1365-2664.13017; http://landscapesportal.org/blog/2018/01/15/finding-evidence-for-land-restoration-strategies/
3. Satdichanh, Manichanh; Ma, Huaixia; Yan, Kai; Dossa, Gbadamassi; Winowiecki, Leigh Ann; Vågen, Tor-Gunnar; Gassner, Anja; Xu, Jianchu; Harrison, Rhett. 2018. Phylogenetic diversity correlated with aboveground biomass production during forest succession: Evidence from tropical forests in Southeast Asia. JEcol-2018-0229.R1 https://besjournals.onlinelibrary.wiley.com/doi/abs/10.1111/1365-2745.13112
4. Vågen, T-G and Winowiecki, L. 2013. Mapping of soil organic carbon stocks for spatially explicit assessments of climate change mitigation potential. Environmental Research Letters. 8. http://dx.doi.org/10.1088/1748-9326/8/1/015011
5. Vågen, T-G and Winowiecki, L., Abegaz, A., Hadgu, K. 2013. Landsat-based approaches for mapping of land degradation prevalence and soil functional properties in Ethiopia. Remote Sensing of Environment. 134:266-275. http://dx.doi.org/10.1016/j.rse.2013.03.006.
6. Vågen, Tor-G., Winowiecki, L., Tondoh, J.E., Desta, L.T. and Gumbricht, T. 2016. Mapping of soil properties and land degradation risk in Africa using MODIS reflectance. Geoderma. http://dx.doi.org/10.1016/j.geoderma.2015.06.023
7. Vågen, T.-G., Winowiecki, L. A., Neely, C., Chesterman, S., & Bourne, M. 2018. Spatial assessments of soil organic carbon for stakeholder decision-making. A case study from Kenya. *SOIL Discussions*, (January), 1–14. https://www.soil-journal.net/4/259/2018/soil-4-259-2018.html
8. Vågen, T., L. A. Winowiecki, W. Twine, and K. Vaughan. 2018. Spatial Gradients of Ecosystem Health Indicators across a Human-Impacted Semiarid Savanna. *J. Environ. Qual.* 0. https://doi.org/10.2134/jeq2017.07.0300
9. Winowiecki, L., Vågen, T-G., Massawe, B., Jelinski, N.A. , Lyamchai, C., Sayula, G. and Msoka, E. 2016. Landscape-scale variability of soil health indicators: Effects of cultivation on soil organic carbon in the Usambara Mountains of Tanzania. Nutrient Cycling in Agroecosystems. https://link.springer.com/article/10.1007/s10705-015-9750-1
10. Winowiecki, L., Vågen, T-G. and Huising, J. 2016. Effects of land cover on ecosystem services in Tanzania: A spatial assessment of soil organic carbon. Geoderma. (http://www.sciencedirect.com/science/article/pii/S0016706115000816)
11. Winowiecki, L. A., Vågen, T.-G., Boeckx, P., & Dungait, J. A. J. (2017). Landscape-scale assessments of stable carbon isotopes in soil under diverse vegetation classes in East Africa: application of near-infrared spectroscopy. *Plant and Soil*. https://doi.org/10.1007/s11104-017-3418-3
12. Winowiecki, LA., Vågen, T-G., Kinnaird, MF, TG. O'Brien. 2018. Application of systematic monitoring and mapping techniques: Assessing land restoration potential in semi-arid lands of Kenya. Geoderma. https://www.sciencedirect.com/science/article/pii/S001670611830510X

FTA WORKING PAPER

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Despite the high level of political engagement and the wide range of organizations involved in restoration projects from local to global levels, beyond some success stories, restoration is not happening at scale. To address this issue, three CGIAR Research Programs (CRPs) – Forests, Trees and Agroforestry (FTA); Policies, Institutions and Markets (PIM) and Water, Land and Ecosystems (WLE) – decided to bring together their expertise in a joint stocktaking of CGIAR work on restoration. This publication illustrates with concrete examples the powerful contribution of forest and landscape restoration to the achievement of most, if not all the 17 sustainable development goals. It can be used to support the design of future restoration activities, programs and projects. We hope that this document will help upscale restoration efforts and deliver enhanced impact from our CGIAR research.

The CGIAR Research Program on Forests, Trees and Agroforestry (FTA) is the world's largest research for development program to enhance the role of forests, trees and agroforestry in sustainable development and food security and to address climate change. CIFOR leads FTA in partnership with Bioversity International, CATIE, CIRAD, ICRAF, INBAR and TBI.

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