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Building local institutional capacity to implement agricultural carbon projects: participatory action research with Vi Agroforestry in Kenya and ECOTRUST in Uganda

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Abstract

Background: Smallholders have begun to take advantage of a growing pool of investment in climate change mitigation. Meanwhile, early movers in this area are working to develop innovative models that will allow projects to be financially sustainable and scalable while benefiting local actors. This study focuses on two of these projects in East Africa, managed by Vi Agroforestry in Kenya and ECOTRUST in Uganda. They engaged in a participatory action research process to identify ways that local actors could take on expanded roles within the projects.

Results: Results are presented as case studies which include project context, roles of local project actors, actions selected, and the outcomes of the actions on the key actors targeted. The actions focused on building the capacities of community-based intermediaries, facilitating partnerships with local government and local non-governmental organizations, and supporting a more active role played by women. Key findings from this process were that community-based intermediaries can play a leading role in land management trainings; local government involvement is critical to project success; local non-governmental organizations and businesses can play central roles in training and providing market incentives to farmers to implement sustainable practices; and women's roles in projects can grow if project benefits are aligned with their needs and trainings are made more accessible.

Conclusions: These cases demonstrate that there is substantial scope for the responsibilities within agricultural carbon projects, and by extension climate-smart agriculture initiatives more broadly, to be institutionalized at the local level. However, regardless of the institutional setup, due to carbon market factors beyond the control of these projects, the financial case for smallholder projects that rely solely on financing from carbon credits remains challenging to these projects and others like them. As programmatic and policy-led approaches grow from these project models, it may be easier to find ways to integrate carbon financing with support for climate change adaptation, rural development, and ecosystem services provision. With these new models, the ability to institutionalize management and implementation capacity at the local level will remain critically important.

Keywords: Agriculture carbon project, Scaling-up climate-smart agriculture, Sustainable land management, Smallholders, Agricultural extension, Participatory action research

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Background

Climate change models predict many dire impacts on agriculture throughout the world, with smallholders in developing countries standing to suffer some of the greatest impacts [1, 2]. Meanwhile, land use provides substantial opportunities for climate change mitigation [3]. While much of the global focus has been on the forestry sector under the banner of REDD+ [4, 5], initiatives focused on mitigating climate change by changing on-farm agricultural practices are gaining traction as viable and important opportunities (e.g., UN Food and Agriculture Organizations' Mitigation of Climate Change in Agriculture (MICCA) Programme, Coalition on Agriculture Greenhouse Gases (C-AGG)) [6, 7]. Climate-smart agriculture has emerged in recent years as a framework to design and implement agricultural systems that can simultaneously provide climate change resilience and mitigation [8–11].

In 2013 about USD 6 billion flowed globally to finance climate mitigation in agriculture, forestry, land use, and livestock management [12], and these funds could provide opportunities to scale up climate-smart agriculture practices. Within the context of the global voluntary carbon markets, agricultural carbon projects with smallholders in developing countries have begun to take advantage of carbon finance to support the broader benefits of climate-smart agriculture [13, 14].

The number and scale of these projects have been small; an inventory of African agricultural carbon projects identified 81 project initiation efforts in 24 countries in 2010 [15], but many of these have not matured into functioning projects. While these projects face numerous challenges, especially in their inherent complexity, high costs of project development, risk management, and securing benefits for smallholders [16], some have developed innovative ways of overcoming these obstacles. An assessment of six agricultural carbon projects in East Africa highlighted the importance of empowering local actors to manage projects, developing partnerships for scaling-up, and strengthening the role of women [17]. Moreover, by building on existing institutional capacity and working at a larger scale, agricultural carbon project managers are working to mitigate some of the costs and risks, while ensuring that farmers experience livelihood improvements [17]. However, more needs to be learned about how various local actors can expand their roles in the long-term management and implementation of these projects [18]. The objective of this study is to develop a deeper understanding of the ways in which the roles of local actors can be expanded within the context of agricultural carbon projects.

To accomplish this, we engaged two well-established smallholder agriculture carbon projects in East Africa,

one run by Vi Agroforestry in Kenya and the other by ECOTRUST in Uganda. The Vi Agroforestry and ECOTRUST projects, while not fully representative of all project models, do conform to the basic institutional structure of smallholder carbon projects [17]. The managers for these projects agreed that the development of local capacities is critical to efficiently manage the project over time and to maintaining the long-term development benefits of the project [19]. Participatory action research (PAR) methods were used to collaboratively develop research questions, to identify actions that could build the capacity of local actors, and to track the impact of these efforts in order to understand how the projects could build these capacities more effectively in the future. Actions were selected in the areas of (1) building the capacities of community-based intermediaries (CBIs)—individuals who mediate between community organizations and carbon projects—to train on sustainable agriculture land management (SALM) practices, recruit farmers, and mobilize resources; (2) building local partnerships to support carbon project management by engaging with local government and partnering with non-governmental actors; and (3) supporting a more active role played by women in the project and increasing their benefits.

Results are presented as project case studies which include findings from throughout the research process. This includes project context, roles of local project actors, actions selected, and the outcomes of the actions on the key actors targeted in the study. The results are followed by a discussion of the implications of these findings for the future of these specific projects as well as for the design and implementation of future projects, programs or policies which intend to connect smallholders with climate mitigation finance.

Methods

This study's methodology is based on the process of participatory action research (PAR). PAR has been recognized as an effective strategy for working with project stakeholders to identify institutional capacity needs and to catalyze change [20]. PAR is an approach in which project stakeholders are engaged in a process that allows them to play an active role in the development of research questions and research methodology as well as data collection and analysis. We selected a PAR methodology in this case because the carbon project managers, through their long-term experience within the project sites and understanding of current project constraints, were in the best position to identify the most relevant research questions and actions. They knew which project roles needed to be taken on by local actors, which actors were most likely to succeed in these roles, and which actions would

best illuminate their current and future ability to play these roles.

Our PAR process included five steps: (1) getting started/partnership development; (2) understanding the goals; (3) developing research questions and action plans; (4) implementing and monitoring actions; and (5) reflecting on the process and considering future actions [21]. The research team included representatives from EcoAgriculture Partners, an international NGO, the management and staff of the participating project implementation organizations, as well as local consultants for each of the projects to provide additional research expertise.

The PAR process began with the general goal of understanding how local capacities to manage and implement carbon projects could be transferred from current carbon project managers to other local actors in order to improve benefits for those actors and to strengthen the long-term viability of the projects. Toward this end, carbon project managers and researchers first identified four categories of institutional capacities that would be necessary for local actors to sustainably manage a carbon project. These included the capacities to: (1) implement and manage SALM activities; (2) monitor the carbon sequestering activities; (3) manage the carbon payment; and (4) contribute to farmer and community development [19]. Using this framework, the carbon project managers and researchers developed an assessment tool to identify key actions to build local institutional capacity to manage these elements of the carbon project and track the impacts of those actions. As a result of those findings, the research team jointly identified three areas of action that they hypothesized would help to develop the four capacities. The action areas included: (1) building the capacities of community-based intermediaries (CBIs) to train on SALM practices, recruit farmers, and mobilize resources; (2) building local partnerships to support carbon project management by engaging with local government and partnering with non-governmental (NGO) actors; and (3) supporting a more active role played by women in the project. Within the three areas of action—CBI capacity development, local partnership building, and women's engagement—the research team developed detailed work plans for the period of 2012–2014, which included specific actions to implement within each area, associated research questions, and indicators to track progress and assess impact of the actions.

The research team then developed a set of research tools. These included a combination of self-reporting guides that the project managers and farmers used continuously throughout the project to track the progress of activities along with comprehensive independent assessments for community members, CBIs, and project staff,

which were administered by the research team at the end of the project to assess the impact of the interventions. In the case of Vi Agroforestry, the CBIs self-reported on the number of farmers they trained and recruited to the project, and Vi Agroforestry staff self-reported on their engagements with local government officials, NGOs, and CBIs. For the project managed by ECOTRUST, the staff self-reported on the number of farmers trained and their engagements with CBIs and local government officials.

The end-of-project assessments for the community members, CBIs, and project staff included a questionnaire and group discussion guide. They were facilitated by at least one independent assessor (i.e., EcoAgriculture Partners staff member or the consultant), accompanied by members of the participating project implementation organization. These assessments were conducted in the form of small group sessions of 15–30 people over the course of a half-day; the assessment was split between the implementation of a scoring tool and a group discussion. The project staff, CBIs, and community members were each assessed independently, and the women community members were assessed separately, where possible, to reduce bias and improve participation. The sessions began with an overview of the project and the objectives of the assessment. Then, each member of the interview group was given a scorecard and a pen. As the interviewers read out each of the statements on the scorecard, interviewees circled a number from one to five indicating their level of agreement with the statement. Those not able to read or write were paired with someone who could help them circle their preferred score. The interviewer then facilitated a group discussion of key topics, using a discussion guide. All participants were informed of the purpose of the research, consented to participate in the study, and the confidentiality of their responses was maintained. Table 1 highlights the numbers of community members (women's groups and mixed groups), CBIs, local government officials, and project staff who engaged in these end-of-project assessments in each site.

Table 1 Number of community members, CBIs, local government officials, and project staff who participated in end-of-project assessments

Actor	Vi Agroforestry	ECOTRUST
Community members (women's groups)	103 participants	16 participants
Community members (mixed groups)	94 participants	78 participants
CBI (mixed group)	27 participants	17 participants
Local government (mixed group)	~20 participants	2 participants
Project staff (mixed group)	9 participants	3 participants

Following the end-of-project assessments, the research team summarized the results of both the self-reported and independently assessed data and analyzed the full dataset to identify insights on the capacity of local actors to play expanded roles within these particular agricultural carbon projects, as well as broader implications regarding future climate mitigation efforts involving smallholders.

Results

This section describes the results of the PAR process written as two case studies, highlighting the experiences of Vi Agroforestry in Kenya and ECOTRUST in Uganda. We describe the particular context of each project: the specific actions chosen to help build local institutional capacity, as well as the outcomes of those actions through reported impacts and reflections on the results from various project participants. Additionally, we describe the outcomes of the PAR process with respect to the capacities of Vi Agroforestry and ECOTRUST project staff.

Vi Agroforestry, Kenya

Vi Agroforestry is a Swedish non-governmental organization that works to promote agroforestry and support farmers' organizations in four countries in the Lake Victoria Basin in Eastern Africa [22]. Vi Agroforestry has been operating in the Kisumu and Kitale Regions in Kenya, since 2002, and as the main implementer of the Western Kenya Agriculture Carbon Project (KACP), since 2009 [23]. KACP was initiated by the World Bank in 2008 to promote the adoption of SALM among 60,000 smallholders, over 45,000 ha in western Kenya. SALM practices, which include minimum tillage, composting, agroforestry, improved livestock enclosures, and the use of crop residues on fields, among others, are promoted as a means of sequestering carbon and allowing smallholders to earn additional income through their participation in the carbon market, while increasing their agricultural productivity and enhancing their resilience to climate change. In November 2010, KACP became the first African project to sell carbon credits generated in part from soil sequestration, which were purchased by the World Bank's BioCarbon Fund [23]. The SALM methodology received approval from the Verified Carbon Standard (VCS) in December 2011, and in January 2014, the project issued its first carbon credits under the VCS certification system for a reduction of 24,788 metric tons of carbon dioxide [24].

Vi Agroforestry takes a holistic approach to project implementation, focusing not only on carbon, but also on improving farm productivity and livelihoods. It combines the implementation of SALM practices, the

promotion of village saving and loaning associations (VSLAs), and the development of farmer enterprises [19]. In total, during the 2010–2012 monitoring period, Vi Agroforestry paid about USD 50,000 in bonuses from carbon credits sold to the BioCarbon Fund to 1195 farmer groups in the Kisumu and Kitale regions; the average farmer received about USD 2.50 per year per hectare. Because of the low price of carbon, the recruitment of new farmers is not as contingent on the promise of carbon money as it was at the beginning. The primary motivations reported by farmers for participation in the project were increased yield for maize, beans and sorghum, increased technical skills in implementing SALM practices, and improved food security and nutrition, among others.

Roles of local project actors

Before undertaking the PAR process described in this paper, the Vi Agroforestry staff performed the majority of the monitoring and management tasks for the carbon project, including collecting, analyzing, and reporting carbon monitoring data, and liaising with carbon buyers, such as the World Bank BioCarbon Fund. To reach a large number of farmers, the Vi Agroforestry staff relied on CBIs, who are predominately skilled farmers and leaders of local community-based organizations (CBOs), to train and recruit other farmers into the project. (For clarity, in this paper we refer to the community-based intermediary broadly as a CBI even though they are known by the title of community facilitator in this project.) Vi Agroforestry provided informal training to the CBIs who were expected to train other farmers in SALM practices. The CBIs were not compensated monetarily for their service, and they reported that their motivation was the sense of empowerment as teachers and the responsibility they felt to help their communities.

Also, instead of directly contracting with individual farmers, Vi Agroforestry worked through local CBOs, primarily producers groups, women's groups, and self-help groups. The role of the CBOs was to collect the monitoring data from individual farmers, receive and manage the carbon bonus payments, and liaise with external organizations. The design of the project required farmers to form partnerships with external organizations to access extension and inputs, as these were not directly provided by Vi Agroforestry.

While the local government agencies were aware of the carbon project activities and the promotion of SALM practices is generally within their mandate, they had limited involvement with the carbon project prior to this research project. Similarly, while women were involved in the project as implementers of SALM practices, they

did not play a significant leadership role in the training, monitoring, or management activities.

Despite initial successes, Vi Agroforestry staff experienced several challenges with the sustainability of this system. First, Vi Agroforestry faced significant budgetary challenges, because very little money has been made available for carbon, and it was costly for Vi Agroforestry staff to train, recruit, and monitor farmers. The size of the area and the opportunity costs of travel limited the degree to which Vi Agroforestry staff and the local government's extension services were able to access farmers. Prior to the PAR project, there were not enough CBIs to meet the demand for training, and CBIs often lacked the technical capacity and resources required to train and recruit more farmers. Secondly, to help ensure the sustainability of these practices in the long term even in the absence of Vi Agroforestry support, the staff sought to increase the buy-in and capacities of local actors, especially women. Thus, in an effort to reduce its costs and improve the sustainability of the project, Vi Agroforestry was interested in building the capacity and engagement of local actors to see if it was possible to expand their roles in the carbon project.

Actions selected

It was not possible to transform the roles of all of these actors in this project, so the research team (including Vi Agroforestry) selected several interventions, which it thought would be most crucial to expand local institutional capacity. These were based on the three categories of action laid out in the methodology section—capacities of CBIs, partnerships with local government and non-governmental actors, and roles of women. Table 2 highlights the specific activities Vi Agroforestry identified and implemented over the period of 2012–2014 within each of these action areas, as well as several key outcomes of those activities.

To help enhance the role of CBIs in training and recruitment of farmers, Vi Agroforestry staff first worked with the research team to develop training materials, including a training manual and a set of posters that focused on the implementation of SALM practices. These were used by the Vi Agroforestry staff when they were training CBIs and then subsequently by the CBIs when they were training farmers. Vi Agroforestry staff then selected 30 CBIs and trained them through both classroom and field-based training sessions using the newly created training materials. Finally, they established six field-based learning sites throughout the project area where the CBIs could hold training and demonstration activities, and distributed the training materials to each of the learning sites for the CBIs to use.

To enhance the role of the local government and other partners in the project, Vi Agroforestry organized a two-day training workshop for local government actors on SALM practices, held a two-day policy forum to discuss increasing policy support for SALM practices, and organized two countywide field days that attracted representatives from 60 public, private and community-based organizations to help link farmers to other partners in the county. The Vi Agroforestry staff also interacted with county government officials informally through phone calls and at community meetings. Finally, they organized a high-level meeting with county policymakers and drafted a policy memo outlining how policymakers could support the scaling-up of SALM practices.

To increase the participation and role of women, Vi Agroforestry staff instructed and supported the CBI's each to identify, recruit, and train 1–2 women's groups. Additionally, the Vi Agroforestry staff involved women in the planning of training sessions, including determining the time and location of the trainings, and emphasized the benefits of implementing SALM practices for women in the training materials. Finally, Vi Agroforestry targeted women specifically to become CBIs.

Outcomes from the actions

Capacities of CBIs to train, recruit, and mobilize resources Following the training from Vi Agroforestry, the 30 CBIs went on to train 1492 male and 2686 female farmers and recruited 775 men and 1058 women to the project. The CBIs reported that the supplemental training and training materials provided by Vi Agroforestry enhanced their ability to train farmers: 85 % of CBIs agreed that the technical trainings and instructional materials were useful and 81 % of CBIs agreed they would have the capacity to train farmers in SALM practices if Vi Agroforestry staff left. Additionally, 78 % of community members in mixed groups and 80 % of community members in women's groups agreed that the CBIs had the capacity to support them to implement SALM practices. CBIs reported that the training and support from Vi Agroforestry allowed them to actively look for farmers to train, hold on-farm demonstrations, and follow-up with farmers after the training sessions, which was not possible prior to the research project's activities.

The farmers also reported that their capacities had increased as a result of the CBIs' training, particularly with technical skills in mulching/composting, agroforestry, soil and water conservation, residue management, use of improved crop varieties, and improved livestock management. Overall, 69 % of community members (both mixed groups and women's groups) agreed they had the capacity to implement SALM practices as a result of the training by the CBIs.

Table 2 Vi Agroforestry's activities and highlights of outcomes listed according to action area

Action areas	Vi Agroforestry activities	Key outcomes
Building the capacities of CBIs to train on SALM practices, recruit farmers, and mobilize resources	<ul style="list-style-type: none"> • Developed training materials, including a manual [25] and a set of posters [26] • Selected 30 CBIs • Organized classroom and field-based training sessions for the CBIs • Developed six field-based learning sites • Distributed training materials to CBIs and learning sites 	<ul style="list-style-type: none"> • 30 CBIs trained 1492 male and 2686 female farmers on SALM practices and recruited 775 men and 1058 women to the project • 85 % of CBIs agreed the technical trainings and instructional materials were useful • 81 % of CBIs agreed they would have the capacity to train farmers in SALM practices if Vi Agroforestry staff left • 78 % of community members in mixed groups and 80 % in women's groups agreed CBIs had the capacity to support them to implement SALM practices • 69 % of community members (both mixed groups and women's groups) agreed they have the capacity to implement SALM practices
Building local partnerships to support carbon project management by engaging with local government and partnering with non-governmental actors	<ul style="list-style-type: none"> • Organized a two-day training workshop, a two-day policy forum, and two countywide field days • Interacted with officials informally through phone calls and at community meetings • Organized high-level meeting with Bungoma County policy-makers • Drafted policy memo to support scaling-up of SALM in Bungoma County 	<ul style="list-style-type: none"> • Increased awareness of government officials of SALM and project activities • Some government officials incorporated SALM practices and training curriculum into existing extension work • No policy adopted at local government level that addresses SALM practices • Farmers developed informal partnerships with various partners to access resources • Strengthened partnerships with local organizations doing complementary work
Supporting a more active role played by women in the project	<ul style="list-style-type: none"> • Supported CBIs to identify, recruit, and train 1–2 women's groups each • Involved women in planning of training sessions • Emphasized the benefits of SALM practices for women • Selected women as CBIs 	<ul style="list-style-type: none"> • 2686 women trained on SALM practices and 1058 women recruited to the project • Women accounted for about one-third of the leadership of participating groups • 74 % of community members in mixed groups and 80 % in women's groups agreed that women play a leading role in the group • Eight women recruited to become CBIs

The project activities also empowered the CBIs to mobilize resources for the farmers by helping the CBOs to develop VSLAs, identifying fundraising opportunities, and encouraging farmers to apply for grants and loans. The CBIs trained the CBOs on resource mobilization techniques such as establishing VSLAs and proposal writing. They also linked community groups to funding organizations, like the government-sponsored Women Enterprise Fund and Youth Fund. Finally, the CBIs encouraged farmers to engage in income-generating activities through the formation of common interest groups and helped them to select viable enterprises that are consistent with SALM practices.

The CBIs also reported that the training materials (training guides and posters) provided by Vi Agroforestry enhanced their ability to train farmers. The manuals' illustrations were its most effective elements, and Vi Agroforestry was successful in translating these illustrations and associated text to field posters as a companion to the manual. Also, the establishment of learning sites managed by CBIs allowed for practical demonstration of the practices. Both the farmers and CBIs found these sites to be very effective, because farmers more readily adopt practices they can see are working. However, many of the CBIs reported that the training materials were difficult to understand and use to train farmers, because they were too technical, were not translated into the local language, and did not have enough illustrations. Additionally, the CBIs reported that it was difficult to finance their transportation to visit participating farmers.

Engagement with local government and other partners

The local government reported an increased awareness of SALM and the carbon project as a result of their interactions with Vi Agroforestry during the research project, and several government officials reported they used the training tools developed in their own work with farmers. Vi Agroforestry staff reported that the most effective modes of collaborating with the local government officials were to organize a training workshop for them on SALM practices and to co-organize countywide field days with them. However, despite the efforts of Vi Agroforestry, engagement by government workers was limited due to the lack of a specific policy mandate and budget to support these activities. As of the end of the project period, no specific policy had been adopted at the county level that addresses the promotion of SALM practices or participation in carbon projects.

However, engagement with private sector and NGO partners increased as a result of the research project activities. Farmers developed informal partnerships with a variety of organizations who were also working to

promote SALM in the project area. For example, farmers were able to access dairy goats and financial resources from The Western Kenya Community Driven Development project, potato vines from the Community Research in Environment and Development Initiatives (CREADIS), and other farm inputs from the government's Uwezo Fund for economic growth. One of the most successful methods for developing these types of partnerships was through organizing field days at the learning sites. NGOs and companies participated in these events to take advantage of the large gatherings of people to advertise their products, some of which they offered to farmers at a subsidized price. Additionally, Vi Agroforestry strengthened partnerships with several organizations in western Kenya, such as the Anglican Development Services, the Toloso River Water Resource Users Association, and One Acre Fund. The areas of potential partnership include collaboratively establishing learning sites, organizing joint field days, marketing farm produce, and supporting access to farm inputs and training.

Women's participation

In total, 2686 women were trained on SALM practices and 1058 women were recruited to the project, which was more than the 1492 men trained and 775 men recruited. Project participants considered this to be a successful outcome, and the Vi Agroforestry staff highlighted that women are generally more competent in implementing SALM practices than men. Women reported that holding the training sessions at the learning sites and in the afternoon or on weekends made them more accessible. Women also accounted for about one-third of the leadership of participating CBOs, and 74 % of community members in mixed groups and 80 % of community members in women's groups agreed that women play a leading role in the group. However, there were some challenges with ensuring gender equality within the ranks of the CBIs, where only 8 out of 30 CBIs were women.

Increased capacity for project staff

While the selected interventions were not targeted directly at the capacities of Vi Agroforestry staff, they reported that the activities did increase their skills in giving trainings and demonstrations, developing training materials, and understanding how to influence policy. They also reported that the project made them think more about the sustainability of their actions. However, they faced challenges with the short time period of the PAR activities, because they felt they needed more time and resources to effectively build sustainable local institutional capacity.

ECOTRUST, Uganda

Environmental Conservation Trust of Uganda (ECOTRUST) [26] is a nonprofit environmental organization that was established in 1999. ECOTRUST manages the carbon project through its trees for global benefits (TFGB) program, which is a cooperative community carbon offset initiative that seeks to link small-scale landowners to the voluntary carbon market [26]. Under the TFGB program, ECOTRUST assists small-scale farmers to develop carbon credits from on-farm tree planting using the Plan Vivo system, and the carbon credits are certified under the Plan Vivo Standard [17].

In 2011, ECOTRUST expanded its TGBF program to the Mbale region of eastern Uganda, with support from the Territorial Approach to Climate Change (TACC), a project lead by the United Nations Development Programme (UNDP) to support the integration of climate change adaptation and mitigation into regional planning and programming. In the 3 years since the TFGB project has expanded to the Mbale Region, about 400 farmers have been involved in the project, and they have planted about 35,000 trees, with a total of 25,000 tons of CO₂ expected to be sequestered over the 20-year agreement period. ECOTRUST pays individual households for the carbon credits generated in installments over 10 years; on average, USD 200–300 is paid per half hectare over the 10-year period. Farmers have also reported increases in farm productivity from agroforestry-related improvements in soil fertility, the shading of crops, and the provision of fruit and other household goods.

Roles of local project actors

Prior to the PAR project, ECOTRUST staff served as the primary trainer and recruiter of farmers; they conducted two trainings per year to raise awareness about the program and then inducted and registered new farmers. The ECOTRUST staff also had the primary responsibility for monitoring and measuring carbon, organizing the payments, and liaising with carbon buyers, but the farmers assisted with the monitoring by tracking of tree health. ECOTRUST did not directly provide farmers with materials, like the seedlings required for tree planting, and farmers needed to form partnerships with external organizations to access the required extension and inputs. The district governments had a general mandate to support ECOTRUST's work through a memorandum of understanding. However, prior to the project, the local government extension officers had limited technical experience in training farmers on tree planting and had a very minimal budget for training.

To start scaling up the project, they also began building the capacities of the project's CBIs [which they referred to as farmer coordinators and trainer of trainers (ToT)].

The CBIs in this case refer to the group of both farmer leaders and government extension officials because they played essentially interchangeable roles in the project. The primary role of the CBIs was to organize and recruit interested farmers, but they also supported the monitoring and reporting of carbon by collecting data from farmers, and training farmers how to monitor the health of the trees. Similar to the Vi Agroforestry case, the CBIs were not compensated monetarily for their service to the project.

Despite initial success, ECOTRUST faced challenges in implementing and scaling-up the TFGB program in Mbale. The TFGB presence in the area is relatively small, and it faces high staff costs for training, recruiting, and monitoring individual farmers. Therefore, ECOTRUST was unable to recruit the number of farmers originally targeted. Additionally, because ECOTRUST emphasized payments to individual farmers in its recruitment and trainings, farmers had high expectations for the carbon payment. At times ECOTRUST struggled to find buyers for carbon credits and was unable to make timely payments to farmers. This, in addition to farmers' difficulties in accessing the seedlings needed to participate in the project, limited recruitment. Finally, women were restricted in their ability to register for the carbon project, because land ownership is required to participate, and the land tenure system in this region of Uganda includes barriers for women to own land. Therefore, to reduce its costs and more effectively scale up the project, ECOTRUST was interested in further transforming its role from a direct technical service provider to that of a trainer of trainers [19]. In the process, they wanted to expand the roles of the CBIs, district government and other partners, and women in the project.

Actions selected

The research team (including the ECOTRUST staff) selected several priority interventions. As in the Vi Agroforestry case, these were based on the three categories of action laid out in the methodology section—capacities of CBIs, partnerships with local government and non-governmental actors, and roles of women. Table 3 highlights the specific activities ECOTRUST identified and implemented over the period of 2012–2014 in each of these action areas, as well as several key outcomes of those activities.

To enhance the capacities of CBIs to train and recruit farmers for the project, ECOTRUST, in collaboration with the research team, developed and pilot tested a training manual focused not only the implementation of SALM practices, but also on other elements of carbon project planning and management, such as carbon payment agreements, resource mobilization and financial

Table 3 ECOTRUST's activities and highlights of outcomes listed according to action area

Actions	ECOTRUST activities	Key outcomes
Building the capacities of CBIs to train on SALM practices, recruit farmers, and mobilize resources	<ul style="list-style-type: none"> • Developed and pilot tested a training manual [27] • Identified 26 total CBIs (nine government extension officers and 17 community members) • Provided CBIs with supplemental one-on-one trainings • Distributed training manual to CBIs and supported CBIs to follow up with and train interested farmers 	<ul style="list-style-type: none"> • 26 CBIs followed up with 228 male and 71 female farmers and helped 59 farmers register in the program (target was 150 farmers) • 94 % of CBIs agreed the technical trainings and instructional manual were useful • 94 % of CBIs agreed they could implement the required carbon project activities if ECOTRUST staff left • 87 % of community members in mixed groups agreed they have the capacity to implement carbon project activities • 72 % of community members in mixed groups agreed CBIs have the capacity to train and support them during the carbon project
Building local partnerships to support carbon project management by engaging with local government and partnering with non-governmental actors	<ul style="list-style-type: none"> • Sensitized 25 district government officials through meetings and a demonstration trip to visit a carbon project in western Uganda • Trained 49 District Government extension officers using new curriculum • Drafted policy memo to support scaling-up of the carbon project in Mbale region 	<ul style="list-style-type: none"> • 49 government extension officers aware of carbon project activities • No specific policy related to carbon project implementation adopted by local or national government • Farmers developed informal partnerships with local government to access seedlings • Linkages with private sector identified and strengthened
Supporting a more active role played by women in the project and increasing their benefits	<ul style="list-style-type: none"> • Focused communications on benefits women could receive from tree planting • Ensured application forms were cosigned by men and women 	<ul style="list-style-type: none"> • 71 women participated in the training sessions • 50 % of community members in women's group agreed they have the capacity to implement carbon project activities • 30 % of community members in women's group agreed CBIs had capacity to train and support them during the carbon project • 13 % of community members in women's group agreed that women play a leading role in among farmers in the project • Three women recruited to become CBIs

management, and participatory carbon monitoring. Then, ECOTRUST staff identified 26 CBIs, composed of 17 community members and 9 government extension officers, and provided these CBIs with one-on-one trainings using the training manual. Finally, they distributed the training manual to the CBIs and supported them to follow up with and train interested farmers.

To enhance the engagement of the local government and other partners, ECOTRUST sensitized 25 District Government officials through meetings and a demonstration trip to visit a similarly structured carbon project in western Uganda. 49 District government extension officers were trained in addition to nine CBIs using the newly created training manual and drafted a policy memo outlining how the local government could support the scaling-up of the carbon project in the Mbale region.

Finally, to increase the participation of women in the carbon project, ECOTRUST focused its communications on the benefits women could receive from tree planting, such as access to firewood, construction materials, fruit, and medicine, and included this in its training of both men and women. Additionally, ECOTRUST ensured the project application forms were cosigned by men and women.

Outcomes from the actions

Capacities of CBIs to train, recruit, and mobilize resources The one-on-one trainings provided by ECOTRUST staff were effective in increasing the capacities of the CBIs: 94 % of CBIs agreed the technical trainings and instructional manual were useful and 94 % of CBIs agreed they could implement the required carbon project activities if ECOTRUST staff left. The 26 CBIs at ECOTRUST then followed up with and further trained 228 male and 71 female farmers (after they had been trained by ECOTRUST). The CBIs reported that the supplemental training and training materials provided by ECOTRUST enhanced their ability to train farmers.

The reviews of the farmers in mixed groups who received the training and support from CBIs were also positive. Many farmers reported increased technical knowledge of the spacing of trees, the benefits of indigenous trees, and the importance of carbon sequestration. 87 % of farmers in mixed groups agreed they have the capacity to implement carbon project activities and 73 % of them thought the CBIs had the capacity to train and support them in the carbon project activities.

However, the CBIs fell significantly short of their goal of registering 150 new farmers into the program and were only able to recruit 59 farmers to the program. These recruitment difficulties could be a result of factors outside of the CBIs control, as previous farmers often faced

a delay in receiving their payments and had difficulties accessing the seedlings they needed to participate, which might have disincentivized new farmers from joining the project. Furthermore, in the case of the ECOTRUST, land size was a significant constraint to participation, as many households did not meet the minimum land size requirement of 0.3 ha.

The project activities also empowered the CBIs to support farmers in opening accounts in savings and credit cooperative organizations (SACCOs), answer farmers' questions about the payment schedule, manage expectations about carbon bonus payment levels, provide guidance to farmers on the use of the carbon money, and connect farmers to external partners. Many CBIs expressed an interest in playing a larger role in maintaining and facilitating these partnerships. For example, CBIs would like to develop formal contracts with local coffee sector actors, including the Kyagalanyi Coffee Traders and Coffee A Cup, to provide farmers with premiums for shade-grown coffee grown on their farms.

While the project activities did not attempt to fundamentally change the role of the CBI in carbon monitoring, the use of the training materials, which included a module on carbon monitoring, did improve the capacities of farmers and CBIs, which allowed them to perform their designated roles more effectively. For example, the training manual helped the CBIs to better train farmers in how to monitor the trees' health, which saved ECOTRUST's staff time when they were performing their monitoring duties.

Engagement with local government and other partners

The trainings and support offered by ECOTRUST were successful in building the capacity of the nine government extension officers who acted as CBIs for the project. They gained technical knowledge on agroforestry systems and tree crop species, in addition to learning how to sensitize and mobilize farmers and the importance of including women in carbon project activities. However, the resources from the PAR activities alone were not sufficient to support these government extension officials to act as primary CBIs for the project in the long term. Currently, environmental issues, and climate change in particular, are relatively low priorities for the relevant district governments in Uganda and receive limited government resources. The project actors agreed that in order for the district government to take on additional roles in the carbon project, particularly if it is to scale up, a clear policy decision to guide the extension workers coming from their supervisors at the district and national levels would be required. Despite the efforts of ECOTRUST, as of the end of the project, no new policy had been adopted at the district government level that would encourage this shift.

However, farmers were able to develop informal partnerships with the local government to access inputs. For example, the District Forest Department was an important source of seedlings, and farmers have been able to negotiate with the Mt. Elgon National Park authorities to access wild seedlings in the nearby park. Additionally, the project activities helped to identify linkages to the private sector and relevant agricultural markets. Standard Chartered Bank contributed seedlings, and ECOTRUST is working to link its carbon farmers with coffee eco-certification systems.

Women's participation

Efforts to more strongly engage women in project activities proved to be challenging. In total, 71 women participated in the training sessions, compared to 228 men. Only 50 % of women agreed that they have the capacity to implement carbon project activities, and only 30 % agreed that CBIs had the capacity to train and support them on the carbon project activities (as opposed to 87 and 73 %, respectively, for respondents in the mixed groups). Furthermore, only 13 % agreed that women play a leading role among farmers in the project. While CBIs emphasized the importance of including women in the project in all of their trainings, women reported that some men still did not want them to work with male CBIs. Unfortunately, ECOTRUST was able to recruit only three women to become CBIs (out of 26 total CBIs).

Increased capacity for project staff

The ECOTRUST staff reported that developing the training guide helped them to establish a standard curriculum and reference material for the training sessions, and their training capacities increased over the course of the project. This standardized material is particularly important because of the constant turnover in local government staff. The project activities also allowed them to begin relying more on CBIs for extension work and farmer support. Furthermore, the interactions with the local government were a new form of engagement for ECOTRUST, which they hope to expand in the future.

Discussion

This section discusses the lessons that can be gleaned from these two cases for the future of these specific projects as well as for the design and implementation of future projects, programs, or policies which intend to connect smallholders with climate mitigation finance. First, it covers the opportunities and limits of key actor roles within project management, including CBIs, local government, local NGOs, and the private sector. This is followed by a discussion of the implications for the role of women in these projects, training and engagement of

farmers, structuring carbon payments, and the scaling of these projects through policy engagement.

The opportunities and limits of stakeholder group roles within project management

This study sought to identify how various local actors can take on additional roles in the context of smallholder carbon projects. This sub-section addresses the implications of the PAR results by key actor group.

CBIs and community groups

In both cases, CBIs recruited new farmers to the project, trained them on technical and management matters, and supported them with logistical details of participating in the project. As the Vi Agroforestry case clearly demonstrated, when provided with proper training, materials, and support, these community recruiters and trainers can be highly effective. By focusing on the land management elements of training, both projects indicated that they saw this as an area where CBIs could continue to increase their role. It also appears that some CBIs are in a position to take on larger roles in group financial management, agricultural marketing, and partnership development.

CBIs act in a support role for project managers for managing the carbon-specific elements of the project, including managing funds and participating in the monitoring system, but do not take on the central leadership role. Project leadership chose not to focus strongly on these areas when developing the PAR activities, likely because they did not see CBIs as well positioned to take on substantially new responsibilities beyond what they were already doing. Managing carbon marketing and sales and leading the carbon monitoring process are highly technical roles in which farmers have little-to-no experience at this point. Even if the control of these project elements were further ceded to the communities, they would still need to hire outside technical expertise to help manage them. Furthermore, if this model were to become sustainable over the long term, there would need to be a source of funds to compensate the CBIs for their training services and their transportation costs to visit participating farmers.

Local government

In both cases, project managers recognized that increased government involvement will be necessary for the long-term success and expansion of the SALM practices and therefore government engagement was a major pillar of their PAR activities. Carbon projects are designed to last up to 30 years, and in these sites, project designers recognize the stability that government institutions can maintain over that period relative to NGOs. The roles that government can play in a carbon project

are limited only by the capacities of its agencies and their access to resources in a particular context. In the case of Vi Agroforestry and ECOTRUST, so far the role of the local government has been in support of training efforts and providing access to inputs such as seedlings. Given that these types of activities already fall within the mandate of extension officers, this has been an obvious starting point. As is the case with CBIs, the sustainability of these efforts will depend on the development of sustainable financing mechanisms and policy mandates to support them.

Local NGOs and the private sector

In addition to strengthened engagement with the local government, a variety of other NGO and private sector partners in both cases could play a stronger role in supporting project activities. Local NGOs and businesses have shown their ability to link farmers to training on land management practices, markets for their products, as well as to agricultural inputs and tree seedlings. Long-term sustainability of land management activities promoted within these projects will be strongly correlated with the livelihood benefits they provide, and these partnerships are critical to translate the SALM training into improved livelihoods. Many of these organizations and businesses are already operating in the project areas and are implementing similar or complementary land management or market activities. However, for these partnerships to have a significant impact on the sustainability of the carbon projects, they need to be expanded and formalized. CBIs are well positioned to play a central role in building these partnerships, but this will require proper training and incentives.

Women's roles

Vi Agroforestry's experience demonstrates that in a supportive environment, women's participation and role in the carbon project can grow. Vi Agroforestry accomplished this by ensuring women were represented in project design, setting specific targets for women's participation, advocating for leadership positions for women among all partner CBOs, ensuring women are represented among the ranks of the CBIs, and scheduling training activities during the times of day in which women can participate.

However, the case of ECOTRUST highlights that larger cultural barriers to women's participation may prove more challenging to overcome. In the ECOTRUST case, women's participation was in many ways limited by the attitudes of men toward their involvement, which persisted despite ECOTRUST's efforts to sensitize all community members of the need to involve women. Additionally, the project's requirement that

participants must be landowners limited women's ability to participate in and benefit from the project considerably. ECOTRUST's efforts to bypass this limitation by requiring wives to cosign on carbon agreements did not prove effective in stimulating their participation in trainings and group leadership, and additional effort will be needed to ensure progress in these areas. Including women in project design and leadership may help to identify both short-term and long-term strategies for changing these more deeply entrenched community beliefs and structural barriers.

Methods for training and engagement

The experience of implementing the activities described in this paper demonstrated that the training methods and models for carbon projects can be very similar to more conventional agricultural and forestry extension activities. The CBI model is working well in both cases, and a deep reservoir of training capacity has been found within the communities. CBIs have enormous potential to drive the scaling-up of SALM practices in the Vi Agroforestry and ECOTRUST projects. However, for them to maintain these primary training roles they will likely need to be compensated more substantially for their time and expertise. Training manuals proved to be valuable tools to reduce transaction costs of training and increase the effectiveness of all trainers, including project staff, CBIs, and government workers. However, based on the findings of this study, new versions could be produced that are even more effective.

Structuring carbon payments to support project success

In the two cases described, the incentive of the carbon payment to farmers does not function as it was originally designed. For Vi Agroforestry, the role of the carbon payment shifted over time to the point where it was not even mentioned in the training manual developed by the project. ECOTRUST continued to use the promise of cash compensation for carbon sequestration as a strong message in recruitment, and this was reflected in the content of its manual. However, ECOTRUST appears to be confronting some of the same challenges that Vi Agroforestry faced in its early years—that the payments are not arriving at the level and frequency that had been anticipated—and as a result recruitment is depressed. An important lesson from these experiences is that efforts to recruit farmers to implement SALM practices and plant trees at a large scale cannot be based primarily on the promise of the carbon payment. Ultimately, the expansion of these activities will require farmers to see the short-term and long-term benefits in terms of production, access to markets, and resilience to climate change. This means that the role of CBIs as trainers on SALM

practices is even more critical to long-term project success and local livelihood improvements than a primary role in carbon monitoring.

If the payments are not used to directly incentivize farmers to participate, new models can be considered for how the carbon funds will be spent by the project. One option would be to set up a training fund for CBIs. Given that materials and models have already been developed to support these trainers, expanding these groups of trainers could be more cost-effective than continuing to pay a project management staff to perform these functions. Compensating these trainers for their work and paying for their transportation would also help to retain them for longer periods of time and to further institutionalize their role within the project.

Carbon project managers as policy advocate

For the project cases described to have significant climate mitigation, adaptation, livelihood and ecosystem benefits they will need to operate at a larger scale. Based on the experience of these projects, even with enhanced roles of CBIs, community groups and local government agents, a substantial scaling-up of project scope may require that these program models are integrated into, or substantially supported by, a government program which operates at a jurisdictional scale. While these projects, and others like them, can be successful on their own terms, they may best be seen as pilot projects that lay the groundwork for larger programs and policies on climate and land management.

To emphasize this point, in addition to the work the projects undertook to expand the capacity of local actors to take on additional roles, during the study period both projects chose to take on advocacy roles in order to communicate to local and national governments that their project experiences can be used as a foundation to build larger programs and policies. In both cases, the project staff interacted closely with local governments throughout the implementation of activities in order to involve them as much as possible. Additionally, they used their experiences to draft policy briefs directed to local and national government officials to suggest specific policy steps that they could take to scale up SALM practices, even if they are not directly related to carbon finance. Project managers plan to continue to use these briefs and the relationships they developed with government officials in order to advocate for improved programs and policies.

While some progress was made on this front as the project engagements improved relationships between both carbon projects and their respective local government officers, these relationships need to be strengthened, and much more local and national advocacy would be required to solidify a policy shift. There could be space

for this to happen now as Kenya and Uganda design their strategies to implement their nationally determined contributions to climate change as part of the United Nations Framework Convention on Climate Change. The staffs of these carbon projects will not accomplish this alone, but they can share their experience with relevant policy networks to help them advocate for policy that will support the scaling-up SALM practices and of climate-smart agriculture more broadly.

Conclusions

As climate finance becomes increasingly available to smallholders for mitigation and adaptation, projects and programs will need to develop institutional models that are sustainable and scalable. This study aimed to deepen understanding of how the roles of local actors can be expanded within the context of agricultural carbon projects to achieve these goals. In the PAR processes in the two cases presented here, actions to expand the roles of local actors were identified, implemented, and monitored. With these actions, the projects were successful in the development of training materials; deepening the roles of CBIs; building relationships with government, NGO and private sector partners; and engaging women. These cases offer lessons in the capacity of these actors to take on new responsibilities within these specific projects, and they also provide insights that could be useful for future efforts to design smallholder carbon projects, programs, and policies.

The project managers from Vi Agroforestry and ECOTRUST have shared this knowledge widely among their own stakeholders as well as between the projects. Both projects organized internal knowledge-sharing seminars in which project representatives, in a series of community meetings throughout the project sites, reported back on the results of the work and facilitated discussions on how this knowledge can be integrated into future activities. The projects also arranged learning exchange visits with each other in which stakeholders from the projects travelled to one another's sites. Both Vi Agroforestry and ECOTRUST are highly motivated to build on this work and continue along these trajectories of local institutional strengthening.

Meanwhile, the context around these projects will continue to change. When they were initially designed, project developers, carbon buyers, and donors were more interested in investing in projects which relied largely on carbon finance to establish and scale up project activities. Over time, as carbon markets struggled and the complexity of managing smallholder carbon projects became more apparent, enthusiasm diminished. However, the broader proposition of supporting climate-smart agriculture in smallholder systems continues to grow. In the face of climate change, agricultural systems

will need to serve as the basis of communities' resilience, by providing improved livelihood opportunities, support to agroecosystem functions as well as opportunities for mitigation. Perhaps the central challenge for the development of these carbon projects is that they were designed to provide all of these benefits while relying on financing for only one of them. This challenge will remain even if CBIs are optimally effective trainers and projects are able to cultivate ideal partnerships with local governments, NGOs, and businesses.

These kinds of climate-smart agriculture activities will continue to require financing, and even if these particular projects are able to achieve their ideal forms of efficiency and local control, carbon project finance in its current form may not be enough to support them. As programmatic and policy approaches grow from these project models, it may be easier to find ways to integrate carbon financing with support for climate change adaptation, rural development, and ecosystem services provision. With these new models, the ability to institutionalize management and implementation capacity at the local level will likely be just as important as it is in the Vi Agroforestry and ECOTRUST carbon projects.

Abbreviations

CBI: community-based intermediary; CBO: community-based organization; CREADIS: Community Research in Environment and Development Initiatives; KACP: Kenya Agriculture Carbon Project; NGO: Non-governmental organization; PAR: participatory action research; SACCO: Savings and credit cooperative organization; SALM: sustainable agricultural land management; TACC: Territorial Approach to Climate Change; TFGB: Trees for Global Benefits; ToT: Training of Trainers; UNDP: United Nations Development Programme; VCS: Verified Carbon Standard; VSLA: village saving and loaning association.

Authors' contributions

SS, KH, MM, and JR participated in the design of the study, data collection, data analysis, and drafting of the manuscript. MK, LK, PNK, AS, and AW participated in the design of the study as and supervised its implementation in the field. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

Availability of supporting data

The data sets supporting the results of this article are included within the article (and its additional files).

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References

- Niang I, Ruppel OC, Abdrado MA, Essel A, Lennard C, Padgham J, Urquhart P. Africa. In: Barros VR, Field CB, Dokken DJ, Mastrandrea MD, Mach K, Bilir TE, White LL, editors. Climate change 2014: impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of working group II to the fifth assessment report on the intergovernmental panel on climate change. Cambridge: Cambridge University Press; 2014. p. 1199–265.
- Porter JR, Xie L, Challinor AJ, Cochrane K, Howden SM, Iqbal MM, Travasso MI. Food security and food production systems. In: Field CB, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD, Bilir TE, White LL, editors. Climate change 2014: Impacts, adaptation, and vulnerability. Part B: Regional aspects. Contribution of Working Group II to the fifth assessment report on the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2014. p. 485–533.
- Smith P, Bustamante M, Ahammad H, Clark H, Dong H, Elsidid EA, Tubiello F. Agriculture, forestry and other land use (AFOLU). In: Edenhofer O, Pichs-Madruga R, Sokona Y, Farahani E, Kadner S, Seyboth K, Minx JC, editors. Climate change 2014: Mitigation of climate change. Contribution of Working Group III to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press; 2014. p. 811–922.
- Agrawal A, Nepstad D, Chhatre A. Reducing emissions from deforestation and forest degradation. *Annu Rev Environ Resour*. 2011;36:373–96. doi:10.1146/annurev-environ-042009-094508.
- Matthews RB, van Noordwijk M. From euphoria to reality on efforts to reduce emissions from deforestation and forest degradation (REDD+). *Mitig Adapt Strat Glob Change*. 2014;19(5):615–20. doi:10.1007/s11027-014-9577-0.
- Beddington JR, Asaduzzaman M, Clark ME, Fernandezbrennautz A, Guillou MD, Howlett DJB, Wakhungu J. What next for agriculture after Durban? *Science*. 2012;335:289–90. doi:10.1126/science.1217941.
- Scholes RJ, Palm CA, Hickman JE. Agriculture and climate change mitigation in the developing world. CCAFFS working paper no. 61. In: CGIAR research program on climate change, agriculture and food security (CCAFFS). 2014. <http://hdl.handle.net/10568/34434>. Accessed 31 March 2016.
- Branca G, McCarthy N, Lipper L, Jolejole MC. Climate smart agriculture: a synthesis of empirical evidence of food security and mitigation benefits from improved cropland management. Mitigation of climate change in agriculture (MICCA) programme, FAO. Rome; 2011. <http://www.fao.org/3/a-i2574e.pdf>. Accessed 31 March 2016.
- Bryan E, Ringler C, Okoba B, Koo J, Herrero M, Silvestri S. Can agriculture support climate change adaptation, greenhouse gas mitigation and rural livelihoods? Insights from Kenya. *Clim Change*. 2012;118(2):151–65. doi:10.1007/s10584-012-0640-0.
- Harvey CA, Chacón M, Donatti CI, Garen E, Hannah L, Andrade A, Wollenberg E. Climate-smart landscapes: opportunities and challenges for integrating adaptation and mitigation in tropical agriculture. *Conserv Lett*. 2014;7(2):77–90. doi:10.1111/conl.12066.
- Lipper L, Thornton P, Campbell BM, Baedeker T, Braimoh A, Bwalya M, Torquebiau EF. Climate-smart agriculture for food security. *Nat Clim Change*. 2014;4(12):1068–72. doi:10.1038/nclimate2437.

12. Buchner B, Stadelmann M, Wilkinson J, Mazza F, Rosenberg A, Abramskieh D. The global landscape of climate finance 2014. Climate Policy Initiative. 2014. <http://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2014/>. Accessed 31 March 2016.
13. Deshmukh I, Sosis K, Pinjuv G. Eastern Africa forest carbon projects study. Washington DC: USAID Forest Carbon, Markets and Communities (FCMC) program; 2014.
14. Goldstein A, Gonzalez G. Turning over a new leaf: state of the forest carbon markets 2014. Washington, DC: Forest Trends' ecosystem marketplace; 2014.
15. Shames S, Scherr SJ. Institutional models for carbon finance to mobilize sustainable agriculture. Washington DC: United States Agency for International Development (USAID); 2010.
16. Shames S, Buck LE, Scherr SJ. Reducing costs and improving benefits in smallholder agriculture carbon projects: Implications for going to scale. In: Wollenberg E, Nihart A, Tapio-Bistrom M, Grieg-Gran M, editors. Agriculture and climate change mitigation. London: Earthscan; 2011.
17. Shames S, Wollenberg E, Buck LE, Kristjanson P, Masiga M, Biryahwaho B. Institutional innovations in African smallholder carbon projects. In: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen; 2012. http://ecoagriculture.org/documents/files/doc_422.pdf. Accessed 31 March 2016.
18. Siedenburg J, Martin A, McGuire S. The power of "farmer friendly" financial incentives to deliver climate smart agriculture: a critical data gap. *J Integr Environ Sci*. 2012;9(4):201–17. doi:10.1080/1943815X.2012.748304.
19. Shames S, Partners E, Bernier Q, Masiga M. Development of a participatory action research approach for four agricultural carbon projects in East Africa. Washington, DC: International Food Policy Research Institute; 2013.
20. Mapfumo P, Adjei-Nsiah S, Mtambanengwe F, Chikowo R, Giller KE. Participatory action research (PAR) as an entry point for supporting climate change adaptation by smallholder farmers in Africa. *Environ Dev*. 2013;5:6–22.
21. German, LA, Tiani A, Mutimukurumaravanyika T, Chuma E, Daoudi A, Beaulieu N, Lo H, Jum C, Nemarundwe N, Ontita E, Yitamben G, Orindi V. The application of participatory action research to climate change adaptation: a reference guide (vs. 2). Bogor: IDRC/CIFOR; 2009.
22. Vi Agroforestry. www.viagroforestry.org (n.d.). Accessed 31 March 2016.
23. The World Bank. First African emission reductions purchase agreement for soil carbon signed in the Hague. In: The World Bank. 2010. <http://go.worldbank.org/4IY4O4P960>. Accessed 31 March 2016.
24. The World Bank. Kenyans earn first ever carbon credits from sustainable farming. In: The World Bank. 2014. <http://www.worldbank.org/en/news/press-release/2014/01/21/kenyans-earn-first-ever-carbon-credits-from-sustainable-farming>. Accessed 31 March 2016.
25. Recha J, Shames S, Heiner K, Wekesa A, Kapukha M. Sustainable agriculture land management practices for climate change mitigation: a training guide for smallholder farmers. In: EcoAgriculture Partners. 2014. <http://ecoagriculture.org/publication/sustainable-agriculture-land-management-practices-for-climate-change-mitigation/>. Accessed 31 March 2016.
26. ECOTRUST. Trees for global benefit. In: ECOTRUST. 2015. <http://ecotrust.or.ug/?project=trees-for-global-benefit>. Accessed 31 March 2016.
27. Masiga M, Nantongo Kalunda P, Kiguli A, Ssempala A, Shames S, Heiner K, Miller M. Smallholder agricultural carbon projects in Eastern Africa Trainers Manual. In: EcoAgriculture Partners. 2014. <http://ecoagriculture.org/publication/smallholder-agricultural-carbon-projects-in-eastern-africa/>. Accessed 31 March 2016.

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