An African Agricultural Carbon Facility

Feasibility Assessment and Design Recommendations

Forest Trends, The Katoomba Group, Ecoagriculture Partners, and Climate Focus
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Any errors in the report are those of the authors alone. Please direct comments or questions to swaage@forest-trends.org

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EXECUTIVE SUMMARY

Africa faces emerging challenges around climate change, soil fertility loss, and food security. Can carbon finance contribute to addressing these issues? Is there a role for carbon finance in catalyzing efforts that would lead to a 'triple win': reducing emissions, increasing agricultural productivity and yields, and contributing to climate change adaptation for farmers?

This report lays out a pathway for developing new scalable carbon finance transaction models that will offer African smallholder farmers a 'bridge' to mitigating climate change while transitioning to more sustainable farming, with greater adaptive capacity.

To date, carbon finance has not engaged significantly with African agricultural / terrestrial carbon opportunities. The reason is simple. Carbon markets have neither worked well for agricultural and terrestrial carbon nor for Africa. Market rule making has been biased toward industrial emissions and buyer's short-term compliance needs rather than long-term mitigation potential. As a result, while the market for carbon credits has boomed, it is barely reaching Africa.

Yet, the carbon sequestration potential of agricultural systems has been recognized by scientists for at least fifteen years. The Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report, issued in 2007, detailed scientific evidence of carbon sequestration and storage potential through agricultural and land management practices—70% of which are in the developing countries. In addition, research has shown that African farmers can reduce GHG emissions, increase carbon sequestration, and maintain above- and below-ground carbon stocks at relatively low cost, while improving food production and livelihoods.

Building on these insights, our 2009 feasibility assessment findings are that at least two key African farming systems—including coffee and maize—offer sufficient size and carbon sequestration potential to support efficient, large-scale projects (≥10,000 ha and 30,000 tCO2e/year). In coffee-based systems, increasing tree cover and composting of husks with manure prior to spreading on field sites showed significant carbon sequestration potential, with assumed annual additional sequestration potential of 1.8 tCO2/ha/year. Extension services for coffee farmers are readily available, which can be leveraged to deliver carbon-focused assistance. In addition, organic or fair-trade certified coffee systems commonly have a quality control entity that interfaces with farmers and could play a role in carbon measurement, reporting and verification (MRV). It is expected that carbon-friendly coffee practices will have high adoption rates and permanence due to yield increases that have been demonstrated.

The maize farming systems showed similar levels of soil organic carbon sequestration potential if residue production is increased, crop residuals composted and applied as manure, and a few additional fruit or fuel wood trees planted, with an assumed additional annual sequestration potential of 2.1 tCO2/ha/year. This finding is important as maize is the main staple food in sub-Saharan Africa and covers large areas of small-holder farms. While systematic evaluation of other farming systems in different agro-ecological zones is needed to assess their carbon finance potential, these findings offer promise for engagement with African terrestrial carbon.

Commodities like coffee offer promising institutional contexts within the existing technical assistance arrangements. For staple crop production like maize only limited technical assistance is provided at the village level by government agencies or NGOs. Knowledge about carbon-friendly agricultural practices could be disseminated by existing institutions. This approach is more cost-effective and straight-forward than establishing a new institutional context for farmer outreach. In the case of mixed maize systems, carbon finance could be used to expand the geographic reach of pre-existing watershed and sustainable land management technical assistance programs to new groups of farmers who would otherwise not be served. In the commercial coffee case, the existing commodity supply chain actors could provide finance and technical assistance to coffee farmers to undertake carbon-sequestration activities that both generate carbon credits and increase coffee productivity or market value. One prospective buyer for these credits would be the coffee buyer, who could be offered carbon-neutral coffee.

The challenge is that the commercial feasibility of African agricultural carbon projects and investments has not yet been proven, particularly at large, landscape-level scales. The focus to date has been on demonstration projects testing methodologies rather than sustainable business models around carbon finance. These efforts have largely been ineffective in transferring project development skills or delivering emissions reductions at scale, which in turn has not triggered significant investment. While pilot projects to date offer promising results, particularly in terms of the technical feasibility, the large-scale 'proof of concept' remains an issue.

In addition, a range of constraints exist, such as the lack of widely tested, cost-effective carbon monitoring and measurement techniques as well as proven farmer outreach approaches across large landscapes. Project developers also face challenges in the form of high costs and uncertainties due to data gaps for many African farming systems and limited access to technical and financial expertise. Responsible planning of carbon projects with smallholder farmers will require a fair amount of time due to the need for close attention to issues such as: the need to mitigate livelihood risks, protect other ecosystem services, address asymmetric negotiating power, secure up-front finance, adapt payment structures to local economic conditions, and aggregate large numbers of smallholders.

Given these opportunities and challenges, we propose a phased approach—from feasibility assessment through demonstration, bridging, and commercialization—to establishing an African Agricultural Carbon Facility. Such a Facility would serve as conduit for carbon finance transactions and technical assistance to achieve emission reductions while boosting adaptive capacity in-region. The Facility would be able to—through core capabilities and partnerships—support the design, development and maintenance of GHG reduction and sequestration projects and subsequent Nationally Appropriate Mitigation Actions (NAMA) programs in countries where adequate policies are in place. Farmers would participate in the design of the Facility through the development of sound practices and guidelines based on experience, supported by field testing, rather than solely market forces or government mandates.

A phased launch allows for gradual expansion while developing methodologies and defining appropriate interventions. It also enables progression from today's high-risk, low certainty environment, to one in which private markets are expected to make investments in emission reductions. As a result, the proportion of public to private investment in a Facility will decrease as methodologies are issued and financial returns will become more predictable as income becomes available to finance subsequent upfront costs.

Table 1: A Phased Approach to Building an African Agricultural Carbon Facility Following from the Feasibility Assessment (Phase 1)

Phase 2: Demonstration (2010-2012)	**Phase 3: Bridging** (2012-2015)	**Phase 4: Commercialization** (2015 onward)
○ Identify and launch demonstration projects to deliver proof of concept and increase capacity among key collaborators engaged with smallholders ○ Synthesize existing evidence on technical issues in targeted, phase 1 sites ○ Secure funding from ODA / public finance	○ Scale activities on a regional or landscape level through coordinating actors ○ Monetize credits or activities ○ Attract private investment to agricultural communities ○ Ensure at least limited commercialization ○ Continue with research to identify and develop activities as needed ○ Secure funding from ODA / public sector, but ensure that additional funds are being brought in so that percentage of ODA is declining	○ Direct large volumes of private financing into activities that generate verified emission reductions and removals ○ Catalyze large-scale, long-term changes to agricultural management practices ○ Secure majority of funding private private markets, with ODA / public funding only covering specific infrastructure and services that are closely tied to farmer's needs

The Facility will build on key partnerships between international, national, and regional institutions with in-depth knowledge of:

- Carbon markets, including *the World Bank, Forest Trends*, *the Katoomba Group,* and *Climate Focus*
- Carbon asset management and commercialization, including *EKO Asset Management Partners*
- Financial services provision in Africa, including the *Equity Bank*, which is the largest bank in the East African region and one of the most capitalized
- African policy-makers and African agendas for the future, including *the New Partnership for Africa's Development (NEPAD)*, which is *a program of the African Union* and will ensure that the initiative is integrated within national/regional development strategies; relates to sustainable capacity in African systems/institutions and is consonant with Africa's own agenda and targets on productivity and food security
- Farmer's on-the-ground needs, including the *Eastern Africa Farmer's Federation*, an association that brings together the members of national farmers' organizations
- Eco-agriculture practices, through regional and in-country networks of *Ecoagriculture Partners*

These partnerships will offer the potential to gain economies of scale in (a) finding and negotiating with project developers, (b) managing, monitoring, reporting, and verifying projects, and (c) accessing and building documentation of soil carbon data as well as agricultural benefits and responses to interventions. A major focus will also be to identify or develop innovative aggregation instruments.

While exact institutional and governance details will be determined in the next phase, through in-depth discussion with implementation partners, one possible approach is to create a strong link between financing and technical support around pipeline development. In this model, the agricultural technical assistance would be independently managed by entities that are already engaged with farmers, but would receive support from a Carbon Technical Support Unit linked to the carbon finance program of the Facility. A strong emphasis will be placed on knowledge-sharing, capacity building (learning by doing), and increasing the number and range of Africans engagement with project design, MRV, and implementation.

Offices of the proposed Agricultural Carbon Facility will be based in Africa, with clear African ownership, through the organization itself, Board structure, Advisory Board including diverse stakeholders, or other mechanisms. A non-political, autonomous organization is essential, as are mechanisms to ensure transparency.

With the right structure, alliances and approach, the project pipeline will be built from the growing set of pre-existing sustainable agriculture investments—few of which would be able to realize a carbon project without external assistance. With carbon project development support, there will be available funds to access technical carbon expertise while engaging in carbon-related capacity building with institutional partners. Similarly, legal experts will be hired to assess the national policy framework and ensure that policy, legal and implementation risks are appropriately mitigated in the carbon deals and contracts. Finally, other institutions' contacts with farmers will be the pathway for finding and negotiating with sellers as well as achieving efficiencies in project management, measuring, reporting, and verification. Agreements will be made with national or regional universities to build documentation of soil carbon data as well as agricultural benefits and responses to interventions.

The next step to follow on this feasibility assessment is demonstration. If funded, the demonstration phase will invest in projects with clear potential for scaling up sustainable financing, while assuming initial upfront and transaction costs which now constrain market potential. Financing terms will ideally provide long-term sustainable support for farmers and other project entities that cannot manage market risk. Upside incentives will be offered to encourage improved activities and management. Downside risks must be reduced or eliminated to encourage adoption for individuals and communities with little or no capacity to absorb financial and economic losses.

As the demonstration phase shifts to a bridging phase, and ultimately commercialization, it will result in an innovative set of transaction models that can be used by governments and non-state actors to access carbon and other climate finance sources for climate mitigation and agricultural adaptation that helps African smallholder farmers.

The reality is that Africa's ability and means for mitigating climate change lies in agricultural and terrestrial carbon. This contribution would concurrently bolster African food security, through increased investments in sustainable land management practices that are carbon-friendly. In addition, agricultural carbon activities offer significant co-benefits through rehabilitating degraded soils, increasing productivity of agricultural landscapes, and expanding capacity of communities to cope with both food provision demands as well as environmental stresses. The opportunity is matched by the need.

I: INTRODUCTION

African farmers have the potential to both reduce greenhouse gas emissions (GHG) and increase agricultural yields. With the promise of emission reductions, carbon finance could underwrite the training of farmers in new practices as well the establishment of MRV systems to track that both carbon and agricultural benefits are accrued.

Despite this potential, traditional carbon funds have largely excluded both terrestrial projects and Africa from carbon finance opportunities. The list of obstacles is long and has included a lack of credible methodologies, permanence concerns, scarce regional technical expertise, uncertainty around measuring and monitoring of emission reductions, and difficulties coordinating large numbers of smallholder farmers.

Yet, the reality is that Africa's ability and means for mitigating climate change lies in agricultural and terrestrial carbon. This contribution would concurrently bolster African food security, through increased investments in sustainable land management practices that are carbon-friendly. Agricultural carbon activities also offer significant co-benefits through rehabilitating degraded soils, increasing productivity of agricultural landscapes, and expanding capacity of communities to cope with both food provision demands as well as environmental stresses.

The time is increasingly ripe for African terrestrial carbon, as interest in both African carbon and agriculture is on the rise. Private sector demand for emission reduction credits from Africa appears to be growing. At the same time, the international community has moved agricultural assistance to Africa up the agenda, as evidenced in the 2009 pledge of the G8 Summit for about US$20 billion toward Africa's sustainable agriculture initiatives.

Within this context, this report describes how carbon finance could be leveraged to realize the dual opportunity of climate mitigation and agricultural adaptation for smallholders in sub-Saharan Africa. The carbon market context is laid out in section II, with an overview of markets, agricultural carbon projects, and African engagement to date. Section III highlights the potential for Africa agricultural and terrestrial carbon sequestration. Section IV presents an illustrative analysis of the financial potential for African agricultural and terrestrial carbon projects based on the cost assessments that have been completed to date. Section V describes key elements of an African Agricultural Carbon Facility and proposes a phased approach to establishing such a facility in sub-Saharan Africa. Finally, extensive supplemental materials are provided, in a separate document, on increasing yields through carbon-friendly practices as well as current constraints to increasing the size of carbon markets.

Following on the findings of this feasibility assessment, we propose a demonstration phase that will test whether an agricultural carbon facility can provide a sound investment proposition backed by emission reductions, improved food security and ecological resilience.

The opportunity is matched by need. Africa faces fundamental risks from climate change. Uncertain weather patterns combined with diminishing soil productivity pose unprecedented challenges. Deeply reliant on farming, declines in agricultural productivity could lead to malnutrition, starvation, village dislocations, or even mass migrations as well as drops in exports and foreign exchange. As with all issues related to climate change, time is of essence in proactively building further resilience into systems—particularly those systems that are most fragile and tied to subsistence, as are African farming systems.

II. Africa and the State of Global Carbon Finance

Global carbon markets trade products that relate to GHG emission allowances, offsets, and reductions. There are two kinds of markets:

- *Regulatory markets* are the main drivers of global carbon trading and usually linked to cap-and-trade mechanisms imposed by governments, such as the European Union Emissions Trading Scheme (EU ETS) and the Kyoto Protocol's compliance carbon markets.
- *Voluntary markets* and voluntary transactions service companies and individuals without government-mandated obligations who wish to reduce their emissions. These markets create emission reductions that are not recognized under a regulated scheme and cannot be used as compliance tool. Therefore, voluntary transactions can apply private standards—such the Gold Standard or the Voluntary Carbon Standard—or simply be based on the agreement between the transacting parties.

Measured by volume, carbon markets are the largest type of environmental market in the world. In 2008, the value of global carbon market reached US$118 billion, up from US$64 billion in 2007 and US$31 billion in 2006.

The largest regulatory market is the EU ETS, which covers at least 11,000 industrial and power facilities in 30 European countries that emit approximately two billion metric tons of CO_2 (2005), or 45% of the EU's GHG emissions.[1] In 2008, the EU ETS was valued at US$94 billion, which was up from US$50 billion in 2007 and represents 79% of the global carbon market.

Other regulatory markets include national schemes—such as, Japan's Voluntary Emissions Trading System—as well as state-level markets, particularly in the US, Canada and Australia, which have emerged in the absence of federal action on climate mitigation, but are likely to be integrated into any national cap-and-trade system. The regional US systems include the US Regional Greenhouse Gas Initiative with 10 states participating.

The challenge for Africa is that regulatory carbon markets focus on industrial and energy sectors. The EU ETS excludes any type of land use carbon. The Kyoto Protocol limits the eligible Clean Development Mechanism (CDM) project classes in the land-use area to afforestation and reforestation, specifically excluding any crediting for agricultural or forest management, avoided deforestation or degradation, and soil carbon storage in developing countries. Further hampering growth of these project types, the CDM awards afforestation / reforestation activities only temporary carbon credits that have limited fungibility with other traded carbon credits.

The net effect is that regulatory markets' rules discriminate against terrestrial projects,[2] as evidenced by project numbers. Although the CDM recognizes nine (9) different afforestation / reforestation methodologies and five (5) agriculture methodologies,[3] only fourteen (14) afforestation / reforestation projects have been approved out of 2024 approved CDM projects.[4] The agricultural sector has been involved, but primarily in projects to reduce methane and other emissions from agricultural wastes—such as waste water treatment from palm oil and wine—as well as decrease energy emissions in processing.

Given this context within regulatory markets, the majority of the activity associated with terrestrial carbon has been within the voluntary markets. The voluntary carbon market is not regulated, not commoditized and largely non-transparent. Yet, its estimated growth is up to US$500 million in 2008, up from US$265 million in 2007

[1] Jaffe, J. and Stavins, R.N. 2008. Linkage of Tradable Permit Systems in International Climate Policy Architecture. Discussion Paper 2008-07, Cambridge, Mass.: Harvard Project on International Climate Agreements..

[2] A noticeable exception exists in the Canadian province of Alberta which includes agricultural activities within its offset system, such as tillage management, innovative feeding of livestock and the management of agricultural residues through anaerobic digesters. For more information, see full Alberta quantification protocols at http://carbonoffsetsolutions.climatechangecentral.com/offset-protocols/approved-alberta-protocols

[3] For more information please see: http://cdm.unfccc.int/methodologies/

[4] http://www.unfccc.org

and US$70 million in 2006. It is noteworthy that there are significant price variations as a function of standard and individual projects. Current estimates of developing country terrestrial carbon projects are ~US$5 to US$10 million worldwide, mostly through the World Bank's BioCarbon Fund.[5] Further detail on the level of engagement is detailed in table below.

Table 2:
Land-Based Credits Sold in the 'Over the Counter' Voluntary Carbon Market (2007 vs. 2008)

Project Types	Volumes of land-based credits (ktCO2e)		Market share of land-based credits relative to the total Project Type	
	2007	2008	2007	2008
Aff./Reforestation Mix	673	646	2%	1%
Aff./Reforestation Mono	2,157	3,399	8%	7%
Avoided Deforestation (REDD)	1,421	730	5%	1%
Forestry Management	-	431	-	1%
Agricultural Soil	820	267	1%	0.5%
Other Land-based projects	-	130	-	0.3%
Total	**5,071**	**5,603**	**16%**	**11%**

Excerpted from: Hamilton, Katerine, Milo Sjardin, Allison Shapiro, and Thomas Marcello. 2009. *Fortifying the Foundation: State of the Voluntary Carbon Markets 2009.* Washington, D.C.: Ecosystem Marketplace and New Carbon Finance (page 8). (http://ecosystemmarketplace.com/documents/cms_documents/StateOfTheVoluntaryCarbonMarkets_2009.pdf)

Stymied by regulatory market rules and voluntary market project development costs, Africa's role in carbon markets has been miniscule to date. Less than 1% of the credits traded in the voluntary and compliance markets for GHG emission reductions originated in Africa.[6] As of February 2010, only 19 CDM projects had been registered in Africa through the CDM. While terrestrial carbon project developers have often turned to voluntary markets—due to challenges within regulatory markets—the number of transactions has been relatively small in these markets as well, with Africa only representing 11% of total forest carbon transactions.[7]

Looking forward, there is growing support within the EU for including incentives, perhaps within or outside of carbon trading, for sustainable land use in post-2012 climate agreements. Terrestrial carbon in Europe therefore may be the focus of other, non-market, funding streams. If so, these efforts will have the potential to drive innovation around carbon-friendly agricultural practices and measurement, reporting and verification systems.

In the US, low-carbon land use is a key component of proposed legislation. If terrestrial carbon remains in the legislation, and it is passed, then a US cap-and-trade system would permit trading of billions of offsets during its first phase, half of which may come from international sources. Therefore, if US markets are opened up to agricultural projects, then a significant new demand will emerge for agricultural carbon projects.

Finally, although the future of the Kyoto Protocol remains unclear, the most recent session of the 'conference of the parties' to the UNFCCC (COP 15) did reveal growing support for terrestrial carbon finance. For the first time, an Agriculture and Rural Development Day was organized alongside a UNFCCC meeting to highlight agriculture and climate change connections. More than 350 policy makers, farmers and scientists gathered to discuss how the agricultural community can support climate change efforts while improving farmers' capacity to feed a growing global population. In another substantial step forward, 21 countries pledged US$150 billion to a Global Research Alliance on Agricultural Greenhouse Gases.

African voices were particularly strong at COP 15 on the linkages between climate change and agriculture. Few African countries stand to benefit from land-use climate finance that focuses exclusively on forests. Far more African land is characterized by heterogeneous agricultural landscape mosaics. Countries where agricultural

[5] Newcombe, Agroecosystem Carbon Markets
6 Only 3 of 1,150 registered CDM projects are in sub-Saharan Africa
[7] http://moderncms.ecosystemmarketplace.com/repository/moderncms_documents/SFCM.pdf

landscapes prevail are interested in finding ways to link with the international climate change community. For example, both the governments of Kenya and Mali hosted side events highlighting the potential for African farmers to participate in carbon offset markets and ways in which climate finance could contribute to food security and climate adaptation efforts.

COP 15 also drew the forest and agriculture carbon work more closely together. A joint side event was held to report on the outcomes of Forest Day and Agriculture and Rural Development Day and make a joint statement about a common vision for future land use and climate change work.[8] Although the forestry and reduced emissions from deforestation and forest degradation (REDD) agenda remains more advanced than agriculture within the UNFCCC negotiations, COP 15 showed that agriculture is rising on the agenda and that forestry / REDD may soon broaden to include agriculture.

The growing interest in agricultural carbon heard at the COP meetings is also evident in Africa, as national governments are establishing carbon positions and in some cases creating new departments. Prospects for agricultural carbon projects are on the rise as NGOs are stepping into the carbon project domain, while donors are also investing in carbon-friendly sustainable land management practices—such as the Norwegian Government's support of conservation tillage and agroforestry in Zambia and TerrAfrica's new program on climate and sustainable land management.

At the same time, there has been an increase in the level of support for sustainable agricultural land management activities in sub-Saharan Africa in recent years. Though most of these new investments were not originally designed for carbon mitigation projects, they have the potential to be leveraged to create a sizeable pipeline of potential projects. For example, under Pillar 1 of the Comprehensive Africa Agriculture Development Program (CAADP), US$1 billion has been earmarked by the Global Environment Facility's (GEF) Strategic Investment Program (SIP) Sustainable Land Management in sub-Saharan Africa. The TerrAfrica Platform's Country Flagship Program for Climate Change, Land and Water is building on these SIP resources and channeling grants directly to land-based climate change mitigation and adaptation activities.

Outside of the multilateral entities, the US Millennium Challenge Corporation has already invested nearly US$ 1.7 billion in African agricultural development. USAID will be increasing investments in both agriculture and climate change in Africa. Other bilateral donors are following similar trends. In the private foundation realm, the Alliance for a Green Revolution in Africa (AGRA) has invested US$330 million across the agricultural value chain on seeds, soil health, market development, agricultural education and policy and is committed to increasing this amount over the coming years. Concurrent with growing sustainable agriculture efforts, African governments have been investing a greater portion of national budgets into agriculture following on commitments made in 2003 that at least 10% of total budgets would go to agriculture over the next five years, which has been partially realized.

Agribusiness with African supply chains are also likely to explore the potential of engaging with African carbon projects. These businesses could gain a 'triple win' by investing in agricultural carbon projects that would 'decarbonize' supply chains, introduce greater adaptability to climate change, and enhance the brand among key in-region suppliers. The opportunity is not only one of engaging with agribusiness as prospective buyers of credits or offsets, but also potentially establishing as an incentive mechanism for farmers if agribusiness adds carbon-friendly sustainable land management protocols to lists of recommended grower practices. Companies also offer a technical assistance delivery mechanism for farmers, given regular corporate trainings of farmers in recommended agricultural practices. These possibilities are most likely with companies engaged in other sustainable agriculture initiatives, such as Sustainable Agriculture Initiative Platform, which includes Nestle, Unilever, Group Danone, McDonald's, Coca Cola, Kellogg's, General Mills, and others.

[8] The side event was titled: "Beyond Copenhagen: Agriculture and Forestry Are Part of the Solution." For further information, please see: http://www.donorplatform.org/content/view/348/210

As potential interest in African agricultural carbon projects grows, the pipeline of prospective projects is also expanding. The table below provides illustrative examples of the diverse types of projects, farmers, and developers. Many more are in the pipeline, supported by private, government, inter-government and civil society organizations. Due to the already established eligibility of afforestation / reforestation, the first generation projects with farmers are focused on agroforestry tree-planting. However, a growing number of pilots are exploring the potential of agriculture and soil carbon projects.

Table 3: Illustrative Emerging Agricultural Carbon Projects in Africa

Country & Project Name	Key Institutions	Climate-Friendly Practices Promoted	More Information
Ethiopia: Humbo Assisted Regeneration	• Community has developed 7 community cooperative societies • The Ethiopian Forestry Department, and the Ethiopian Agriculture, Rural Development and Forestry Coordination Office, in collaboration with World Vision, jointly implement the project	Farmer-Managed Natural Regeneration (FMNR) approach in which existing tree and shrub root material in the soil is identified, selected, pruned, and managed to enable re-growth. Only native species.	http://wbcarbonfinance.org/Router.cfm?Page=Projport&ProjID=9625
Kenya: Green Belt Tree-Planting Project	• Community Forest Associations plant the trees • NGO Greenbelt Movement manages projects, aggregates credits and sells to the World Bank • Kenya Forest Service owns the land and gives the carbon and NTFP rights	Tree planting with a long term goal to use the re-grown forest in a sustainable manner for a variety of products	http://wbcarbonfinance.org/Router.cfm?Page=BioCF&FID=9708&ItemID=9708&ft=Projects&ProjID=9635
Kenya: Smallholder Coffee Carbon Project	• Project developer is ECOM Agroindustrial Corp.which is working with Komothai smallholder farmers cooperative to aggregate	Transitioning from full sun to shade grown coffee	http://siteresources.worldbank.org/INTARD/Resources/335807-1236361651968/Timm_RWsideevent.pdf
Kenya: Western Kenya Smallholder Agriculture Carbon Project	• Project developer is VI-Swedish Cooperative Centre (SCC) • Farmer associations aggregate the credits	Farm enterprise approach adopting sustainable agricultural land management practices and planting fruit and fuelwood trees	http://siteresources.worldbank.org/INTARD/Resources/335807-1236361651968/Timm_RWsideevent.pdf
Tanzania: Uchindile and Mapanda Forest Project	• Green Resources developed reforestation project validated and registered according to the VCS standard	Tree planting	http://www.forestcarbonportal.com/inventory_project.php?item=282
Uganda: Trees for Global Benefits	• Farmers receive carbon payments directly • Ugandan NGO Ecotrust manages projects and acts as aggregator • USAID supports baseline costs	Trees planted provide for soil conservation, food (cashews), fodder for livestock and medicinal values	http://www.planvivo.org/fx.planvivo/scheme/ugandadocuments.aspx
Zambia: ICRAF	• ICRAF project focused on intercropping in maize farming systems	Gliricidia-maize intercropping system with application of gliricidia prunings to soil	http://worldagroforestry.org/af/

As a set, these developments signal expanding support for agricultural and terrestrial carbon inclusion in future carbon finance mechanisms. Increasingly, therefore, it appears that the agricultural carbon is at the cusp of a new era—marked by significant growth in the potential for African carbon projects and opportunities for farmers.

III. The Potential of African Agricultural / Terrestrial Carbon

The carbon sequestration potential of agricultural systems has been recognized for at least fifteen years. The IPCC's Fourth Assessment Report, issued in 2007, detailed scientific evidence of carbon sequestration and storage potential through agricultural and land management practices—70% of which are in the developing countries.

Research has shown that farmers can reduce GHG emissions, increase carbon sequestration, and maintain above- and below-ground carbon stocks at relatively low cost, while also improving food production and livelihoods through practices including[9]:

- *Agronomy*, which include practices that increase yields and carbon sequestration through using improved crop varieties, extending crop rotations through selection of perennial crops, growing cover crops which allows for 'green manuring, adopting a multiple cropping and crop rotation approach (e.g. planting cereals, legumes and root crops in a sequence) or intercropping (planting two or more crops in the same field).
- *Nutrient management*, which includes identification of sites where inorganic fertilizer is used inefficiently by crops and, for those areas, switching to organic fertilizers—such as manure and compost, both of which have high soil carbon sequestration potential.
- *Tillage and residue management* which includes reduced tillage and no till agriculture as well as mulching, composting and integrated livestock and manure management—all of which increase soil carbon in the upper layers of the soil.
- *Agroforestry* where woody perennials (trees, shrubs) are used in the same land management unit as agricultural crops.

By selecting among and adopting these management practices, where appropriate, African croplands could potentially reduce GHG emissions by 2.0–3.5 million tons of CO2eq per hectare per year[10] or a total of 52.3–91.5 million tons of CO2eq[11] equal to 5-9% of annual African fossil fuel emissions in 2005.[12] Even in semi-arid lands, agroforestry systems like intercropping or silvopasture, with 50 trees per hectare, can store 110 to 147 tons of CO_2eq per hectare in the soil alone.[13] Details on carbon sequestration potential of various agricultural interventions are offered in the following tables.[14]

Table 4: Estimated Mitigation Potential for Different Practices by Climate Region

Global annual mitigation potentials ($tCO_2e/ha/yr$)												
	COOL-DRY			COOL-MOIST			WARM-DRY			WARM-MOIST		
	Mean	low	high	mean	low	High	mean	low	high	mean	Low	High
Agronomy	0.29	0.07	0.51	0.88	0.51	1.25	0.29	0.07	0.51	0.88	0.51	1.25
Nutrient mgmt.	0.26	-0.22	0.73	0.55	0.01	1.10	0.26	-0.22	0.73	0.55	0.01	1.10
Tillage & residue mgmt.	0.15	-0.48	0.77	0.51	0.00	1.03	0.33	-0.73	1.39	0.70	-0.40	1.80
Agroforestry	0.15	-0.48	0.77	0.51	0.00	1.03	0.33	-0.73	1.39	0.70	-0.40	1.80

Note: Potentials include both practices that reduce emissions and those that sequester carbon (drawn from IPCC 2007)

[9] The list of practices is from: Smith, P. *et al.*. 2007. "Agriculture," in *Climate Change 2007* (IPCC, 4th Assessment Report)
[10] Smith and Martino. 2007. Agriculture. In: Climate Change 2007 (IPCC, 4th Assesment Report)
[11] www.faostat.fao.org
[12] Canadell, Raupach and Houghton. 2009. Anthropogenic CO2 emissions in Africa. Biogeociences 6:463-468
[13] Nair et al. 2009.Soil Carbon Sequestration in Tropical Agroforestry Systems: a Feasibility Appraisal. Environmental Science and Policy (in press)
[14] It is noteworthy that significant amounts of research are ongoing in Africa on the issue of terrestrial carbon sequestration potential. This work is generating the datasets that will be needed to run models comparing various potential interventions within specific contexts. In addition, long-term field studies are being established to measure systems over long periods, under diverse management. Concurrently there is effort going into extrapolating from research that has been done for other purposes in recent decades. The net effect is that carbon sequestration estimates are being developed and used with increasing reliability for specific sites.

Table 5: Estimated Economic Mitigation Potential by Management Practice and African Region By 2030 at Carbon Prices up to US$20/t of Co_2e emission reductions

	Cropland Management ($MtCO_2e$/yr)	Grazing Land Management ($MtCO_2e$/yr)	Restoration of Organic Soils ($MtCO_2e$/yr)	Restoration of Degraded Land ($MtCO_2e$/yr)	Other Practices ($MtCO_2e$/yr)	Total ($MtCO_2e$/yr)
East Africa	28	27	25	13	15	109
West Africa	16	15	14	7	8	60
Central Africa	13	12	11	6	7	49
North Africa	6	6	6	3	3	25
South Africa	6	5	5	3	3	22
Total	**69 (26%)**	**65 (25%)**	**61 (23%)**	**33 (12%)**	**37 (14%)**	**265**

Source: Smith et al (2008) in Pender et al (2009)

For farmers, the benefits of moving towards more sustainable agricultural practices include increasing agricultural profitability and yields as well as emission reductions. For example, out of 41 sustainable land management interventions studied, nearly all of them demonstrated significant yield increase, with 24 interventions showing a yield increase greater than 100%.[15] Another 45 sustainable land management interventions examined in Sub-Saharan Africa found that cereal yields increased between 50% and 100% in almost all of the cases.[16] Almost all of these land use practices also showed significant profitability for farmers.[17]

Overall, work to date has documented benefits of "sustainable land management-plus-carbon" programs as triple: (1) sequestering carbon and reducing emissions, (2) increasing productivity and yields, (3) contributing to climate change adaptation and ecosystem resilience.[18] For governments, this synergy enables a focus on integrated policymaking around agriculture, climate adaptation, and climate mitigation, thereby streamlining a range of (often discrete) efforts.

Achieving these benefits from agricultural carbon finance at scale will require addressing current constraints, which include the challenges of carbon monitoring and measurement; coordinating with smallholder farmers across large landscapes; and limited access to regional technical and financial expertise. In addition, data gaps about many African farming systems and lack of adapted monitoring and measurement methodologies initially increase costs and uncertainties for project developers. And responsible planning of carbon projects with smallholders requires greater attention to a range of issues, such as: mitigating livelihood risks, protecting other ecosystem services, asymmetric negotiating power, securing up-front finance, adapting payment structures to local economic conditions, and aggregating large numbers of smallholders. Pathways forward are outlined in the table below.[19]

[15] Pender, J. December 2008. The World Food Crisis, Land Degradation and Sustainable Land Management: Linkages, Opportunities and Constraints. International Food Policy Research Institute.
[16] Pretty, J.N., A.D. Noble, D. Bassio, J. Nixon, R.E. Hine, F.W.T. Penning de Vries, and J.I.L. Morison. 2006. Resource conserving agriculture increases yields in developing countries. *Environmental Science and Technology* 40(4): 1114-1119.
[17] A summary of the findings from key studies is provided in the supplementary materials.
[18] For further justification for investment in Africa's biocarbon potential, please see: http://www.worldagroforestry.org/downloads/publications/PDFS/BR09048.PDF
[19] An in-depth analysis of these constraints and ways to address each is offered in Annex A. The cases presented in section IV illustrate that carbon investments can be financial viable where these constraints are overcome.

Table 6: Key Institutional Issues

	ELABORATION
The principle direct benefit to farmers will be higher agricultural yields, *not* direct carbon payments. Much of the carbon finance generated from these projects will be needed to defray costs of project management and technical support. Success will hinge on a high degree of transparency.	There are a combination of factors that inform this stance, including: • high transaction costs, • long value chains, • modest sequestration rates per farmer, • low carbon prices in the voluntary markets, and • linkages between sustainable land management practices, of which most carbon-friendly actions are, and higher yields.
Project development financing will be essential. Clarifying the potential and appetite for the provision of up-front finance will be critical to success, as is the issue of how the funds will be replenished by private payments for carbon offsets as they are produced and verified.	A large share of the cost of producing offsets is in the planning and establishment phase. Therefore, it will be essential to raise up-front finance, from: • investors (including impact investors) and future buyers, • philanthropic or government institutions (through the Technical Support Unit), • field project management institutions (who are interested in the co-benefits, rather than the carbon) or independent micro-finance institutions willing to operate on a multi-year basis (e.g, IBM carbon micro-finance initiatives) • Farmers' self-financing.
The institutional prerequisites for working with smallholders on carbon projects include: • strong farming / community organizations, • social cohesion, and • pre-existing dialogue within and among communities in the landscape/program area	Without these elements, there is not enough trust or local expertise to implement a carbon project. Projects should not be undertaken until farmer organizations have evaluated their agriculture and ecosystems and determined how carbon payments / investments could best meet their objectives.
At present, there is limited capacity in Africa to support the technical carbon elements of projects.	Much of this expertise is available within institutions operating in Africa, but has not been drawn into one place, and is insufficient to support a much larger portfolio of projects.
Current projects promoting sustainable land management practices that sequester carbon are of highly variable management quality.	There will be a need to play a filtering role to identify well managed field projects that are in a position to absorb the technical capacity support provided by the facility and its partners.
Project identification can be assisted by linking to ecosystem-scale initiatives.	The number of landscape scale sustainable land management is growing. Most are government-implemented, often with NGO and farmer input. These projects have well trained and experienced field staff and the greatest potential for scaling up. In addition, smaller scale, experimental projects implemented by NGOs, farmer organizations, or food industry/agribusiness groups offer promise for carbon project identification.
The individual carbon projects or programs must have some guarantee of long-term institutional support.	Most sustainable land management programs and projects in Africa have relatively short time-horizons. There are some notable exceptions of long-term investments, which will be essential to identify and establish partnerships with in order to ensure that full carbon offset benefits are produced, monitored and delivered to buyers.
The issue of pre-financing carbon projects will be critical.	Many of the facility's projects may take a number of years before they begin sequestering carbon and generating carbon credits. The interventions at farm scale and for technical assistance, tree nurseries or other collective costs, will need to be financed. The role of carbon finance in maintaining these flows for future projects needs to be discussed.
It will be essential to link with other African agricultural carbon projects.	Other initiatives are being developed in Africa to use carbon finance for agricultural development, including COMESA/TerrAfrica, the Convention to Combat Desertification, the Agroforestry and Conservation Tillage initiative, the BioCarbon Fund Phase 3, and a number of NGO-led projects. Strategic partnerships with these groups will be important for success.

IV. Financial Viability of Agricultural / Terrestrial Carbon Investments in Africa

To explore the financial feasibility of altering farm management practices through carbon finance incentives, we examined two BioCarbon fund cases of common small-holder agrarian systems in Kenya, including:

- a low-intensity subsistence food crop on degraded or marginal lands, and
- a higher-intensity smallholder coffee plantation.

These case studies were selected in order to: illuminate the drivers of carbon sequestration and stock increase, identify cost-effective investments in GHG abatement from terrestrial carbon, catalogue co-benefits associated from these practices, and calculate generalized costs and benefits to instruct agricultural carbon projects.

The research considered economic abatement potential under existing agricultural conditions, particularly related to soil clay content, temperature and precipitation which all define the ability of agricultural systems to store carbon. Smallholder farming areas best suited for carbon projects were examined in light of existing institutional arrangements, agricultural systems as well as soil and climate zones in the central Kenyan region, where the cases are sited. These potential smallholder farming areas were stratified to identify systems with the highest potential for carbon emission reduction and storage.[20] From this data, field sampling and soil carbon modeling were used to verify where GHG benefits appeared most promising, while increasing the productivity of the agricultural systems.

The findings suggest coffee and maize offer sufficient size and carbon sequestration potential to support efficient, large-scale projects (≥10,000 ha and 30,000 tCO2e/year).[21]

Table 7: African Agricultural Carbon Case Studies: Maize & Coffee Systems[22]

	Western Kenya Smallholder Agriculture Carbon Project	Kenya Smallholder Coffee Carbon Project
Project region	Western Kenya	Central Kenya
Project Area	60,000 ha out of potential 116,000 ha	Phase I: 8,500ha; *(50% coffee, 50% subsistence agriculture)* Phase II: 10,000 ha
Project developer/ extension agent	VI-Swedish Cooperative Centre (SCC)	ECOM Agroindustrial Corp
Aggregator	Registered farmer associations covering an area with about 65,000 farms	Komothai smallholder farmers cooperation, 9000 members
Agricultural Objectives	Restoring agricultural production, adopting farm enterprise approach, Reducing climate change vulnerability	Restoring coffee production & producing certified specialty coffee using best coffee practices Reducing climate change vulnerability
Expected VERS*	516,000 tCO2e/yr (maximum)	~30,000 tCO2e/yr, phase I
	1.5tCO2e soil ha/y 4.5tCO2e biomass ha/y	2.4 tCO2e soil organic carbon ha/yr 1.6tCO2e biomass ha/yr

* without considering non-permanence risk buffer.

[20] For details on the approach, please see supplementary materials.

[21] These findings, and data, are based on a multi-year project (2007-ongoing) carried out in Kenya examining cropping systems with economic mitigation potential for carbon finance supported by the World Bank BioCarbon Fund and the Government of Kenya. Participants of the study include ViAgroforestry, SMS/Ecom, World Bank, Unique Forestry Consultants, Joanneum Research, and the University of Aberdeen. The carbon accounting methodology used is currently under validation by the Voluntary Carbon Standard.

[22] Tennigkeit and Woelcke 2009

In coffee-based systems, increasing tree cover and composting of coffee husks with manure prior to spreading on field sites showed significant carbon sequestration potential—with assumed annual additional sequestration potential of 1.8 tCO2/ha/year. In other words, converting sun-grown into shade-grown coffee, represents a promising commodity-based option for agricultural mitigation in Kenya as substantial amount of additional terrestrial carbon can be stored. Extension services for coffee farmers are readily available, which can be leveraged to deliver carbon-focused assistance. In addition, organic certified coffee systems commonly have a quality control entity that interfaces with farmers and could also play a role in carbon MRV. It is expected that carbon-friendly coffee practices will have high adoption rates and permanence due to yield increases that have been demonstrated.

The overlap between carbon and coffee is fortuitous as it is among the most important agricultural commodities in east and southern Africa. It also offers significant benefit to smallholders since at least 70% of the global crop is produced by smallholder farmers.[23] Cooperatives in places such as Ethiopia have already shown an interest in sustainable land management techniques, along with coffee traders and roasters, suggesting great potential for scaling up effective projects in this sector.

The maize-based farming systems showed similar levels of soil organic carbon sequestration potential if residue production is increased, crop residuals composted and applied as manure, and fruit or fuelwood trees planted[24]—with the assumed annual additional sequestration potential in maize-based systems 2.1 tCO2/ha/year. This finding is important as maize is the main staple food in sub-Saharan Africa and covers large areas of small-holder farms.

Given its role in subsistence farming, mixed maize systems are the focus of many donor funded sustainable land management initiatives with numerous on-the-ground organizations, ranging from NGOs through cooperatives. Preliminary discussions indicated interest among entities working with smallholders in learning about carbon-friendly sustainable land management and delivering this technical assistance to farmers. This positive institutional context is coupled with the potential for poverty reduction, due to productivity / yield increases associated with many of the practices, which will be key elements in justifying the investment to get maize-based agricultural mitigation projects off the ground.

Overall, both coffee and maize carbon projects can be supported by existing technical assistance arrangements. An addition of carbon-friendly agricultural practice knowledge would be needed, but this task is significantly lower cost than establishing a whole new institutional context for farmer outreach, given that it could be added to existing institutions. In the case of mixed maize systems, carbon finance could be used to expand the geographic reach of pre-existing watershed and sustainable land management technical assistance programs to new groups of farmers who would otherwise not be served. In the commercial coffee case, the existing commodity supply chain actors could provide finance and technical assistance to coffee farmers to undertake carbon-sequestration activities that both generate carbon credits and increase coffee productivity or market value. One prospective buyer for these credits would be the coffee buyer, who could be offered carbon-neutral coffee.

Costs[25]

The financial potential of carbon projects within these two agricultural systems was assessed in terms of costs and benefits to farmers, or their associations, as well as costs for collaborators who design and support the carbon projects, through extension services to farmers, aggregation, risk pooling, management, and MRV are estimated below. These cost structures are, of course, highly variable across farms and locations in Africa, due to heterogeneity and poorly integrated input and output markets. Therefore, the figures below should be considered illustrative and in need of broader field testing in a demonstration phase following on this assessment.

[23] Woelcke and Tennigkeit 2009

[24] In the baseline maize residues are burned or not composted. Potential trade-offs have to be considered, such as if residues are used as feed.

[25] All assumptions and estimated costs used in this section are based on experiences in SSA (literature, experts judgments, field assessments).

In addition, it is noteworthy that carbon-friendly sustainable land management practices carry implicit costs for African farmers as they may internally transfer biomass resources and change labor distribution in ways that need to be assessed and understood prior to scaling. The reason is simple: agricultural residues are valuable, non-market resources to smallholder farmers. Therefore, while improvements in soil carbon are associated with higher long-term yields, the initial agricultural practice changes will require proper incentives to motivate action.

Overall, we found that the costs of incorporating a carbon component into an agricultural commodity or sustainable land management project remain relatively constant after reaching a project size of about 200,000 hectares. The minimum size is determined mainly by the minimum amounts of carbon that the project needs to cover, which is about 50,000 tCO2/year. Operational costs scale with the physical size of the project. The insurance pool or carbon buffer—setting aside a certain number of carbon credits—is intended to cover the project proponent against project risks. These costs will also scale with the number of credits. It is further assumed that project proponents, particularly within the private sector, will require a profit margin of at least 15%.

Table 8: Estimated Input Costs & Illustrative Agricultural Sequestration Projects in Kenya[26]

Project duration	20 years
Maize price ($/kg)	US$0.15
Current maize yield (kg/ha)	1,000
BAU maize yield decline rate	0.001
Land ownership (ha/farmer)	1.50[27]
Labor cost ($/day)	US$1.50
Fertilizer delivered cost ($/kg)	US$0.40
Seed cost ($/kg)	US$0.80
Agroforestry seed cost ($/kg)	US$2.00
Farmer discount rate	30%
Fixed costs of network establishment	US$300.000
Operating costs ($/ha)	US$2.39
Project developer profit (% rev)	15%

These costs include wages for management and extension staff, monitoring, verification, and enforcement costs, as well as the project developers profit requirements. A project of 200,000 hectares—with an average farm size of 1.5 hectares per household, and 40 households per farmer group—would need extension for 3,333 farmer groups. Assuming that each extension worker can manage 30 farmer groups, the project would need to hire 111 extension workers.

There are likely to be economies of scale between agricultural extension / technical advising of farmers and MRV. The MRV costs are assumed to be low (US$0.50) on a per hectare basis.

The accuracy of this MRV is relatively high assuming accurate reporting of harvests, and thus residual biomass volumes, as well as effective soil carbon modeling, both are currently tested in the Kenyan sites, with field

[26] Sources: Maize seed inputs are authors' estimates; agroforestry seed estimates are based on Amadalo et al. (2003), N fertilizer delivered costs are based on Nkonya et al. (2005). Labor costs are authors' estimates. Maize farm gate prices are based on a mid-range value from Woelcke et al. (2006), Djurfeldt et al. (2005), and 1991-2006 FAOSTAT data on producer prices in 21 sub-Saharan African countries. Current maize yield is a conservatively low estimate based on 1980-2006 historical data for East African countries from FAOSTAT.

[27] Land holdings vary significantly across sub-Saharan Africa, from land poor countries like Rwanda (mean 0.71, 2000) to land rich countries like Zambia (mean 2.76, 2000), with significant variation in land holdings within countries as well (UNCTAD, 2006). Tschakert (2004) reports land holdings ranging from 4 ha to 11 ha in a household survey in Senegal. In surveys in Uganda and Tanzania in 2001, Bahiigwa et al. (2009) found an average farm size of 1.43 ha (Uganda, 0.6-2.15) and 1.54 (Tanzania, 0.94-2.13). In Kenya, Mureithi et al. (2007) report average farm sizes of 0.93 ha to 1.25 ha. Based on these ranges, we use a conservative value of 1.5 ha per household in this analysis.

based measurements used to verify modeling projections. Future pilot testing will, however, have to demonstrate whether scaling these activities results in the same level of accuracy.

Table 9: Extension Requirements for a 200,000 ha Commodity Chain Type Carbon Finance Project

	Cost Breakdown	Total Annual Cost	Annual Cost per Ha
Extension workers	111 x US$2,500/year	US$277,500	US$1.39
Management staff	2 x US$25,000/year	US$50,000	US$0.25
Project director	1 x US$50,000/year	US$50,000	US$0.25
Total staff costs		US$377,500	US$1.89
MRV costs		US$100,000	US$0.50
Total operating costs		US$477,500	US$2.39

In summary, although costs are highly context-dependent, an agricultural carbon project that funds extension workers, management staff, and MRV is likely to spend approximately US$ 2.39 per hectare annually, for a 200,000 hectare commodity chain project. This figure does not include establishment costs, marginal operational costs for improved agricultural practices and the operational costs of 'business as usual' planting and harvesting—though most if not all of the latter is covered by the sale or consumption of the crop itself and carbon revenue may be used to cover shortfalls.

The key in this equation is scale, or rather aggregation. Under the study assumptions, a project of 5,000 hectares can only generate credits representing ~ 8,000 tCO2e, which is valued between US$ 41,000 and US$ 244,000. However, a project of only 5,000 hectares is roughly one twelfth of the expected minimum efficient size of 62,500 hectares, which is equivalent to ~ 50,000 tCO2e/year. This cost to size of project relationship is due to the minimum fixed cost of a project. Scaling up reduces the relative cost of establishing and operating the project. The table below illustrates funding levels at different levels. As projects approach 100,000 hectares in size, revenues rise into millions of US dollars that are more likely to support the robust institutional frameworks. It is essential to note that the sustainable land management projects themselves would not likely be managed at these large scales in most of Africa. Rather only the management of the carbon components of these projects needs to envision aggregation across many field projects to be financially sustainable.

Table 10: African Agricultural Carbon Project Size and Annual Revenue Potential

Project size (ha)	Revenue	
	Low (USD5/tCO2e)	*High* (USD30/tCO2e)
5,000	41,000	244,000
62,500	508,000	3,050,000
100,000	813,000	4,880,000
200,000	1,627,000	9,760,000
500,000	4,067,000	24,400,000

Returns will not be realized immediately. This assume a risk buffer of 23% on potential credits. Projects require lead times of several years. In addition, potential for failure exists for all of these projects, which translates into high risks.

Benefits

The benefits associated with these carbon-friendly sustainable land management practices for maize and coffee agricultural systems are expected to fall into three categories:

- Yields / productivity benefits[28]
- Carbon stocks / carbon benefits
- Ecological resilience and food security benefits

The increase in above and below-ground carbon should result in productivity gains quantified below. Systematic and long-term benefits from more drought-resistant and biodiverse agricultural landscapes are also important benefits, although not explicitly calculated in this cost-benefit analysis.

For maize, the maximum yield of 4.5 t/ha/year can be reached within a few years. The baseline reduction in yield (.005 per year) falls as fallow times shrink and agriculture intensifies without inputs.

Table 11: Maize Yield Response to Adopting SLM+C Practices

Initial Year Yield (tCO2e/ha)	1.5
Crop Response Rate - Low (/year)	0.03
Crop Response Rate - Medium (/year)	0.1
Crop Response Rate - High (/year)	0.25
Maximum Yield (t/ha)	4.5
Rate of BAU Yield Decline (/year)	0.005

For coffee, most plantations are poorly managed and average 0.5 tons of cherry/hectare, which can be brought up to 1 ton/hectare with proper management and 1.5 tons given larger investments of time and effort.

Table 12: Coffee yield response to adopting SLM+C practices

Initial Year Yield (t/ha) (tons of cherry per tree)	0.5
Crop Response Rate - Low (/year)	
Crop Response Rate - Medium (/year)	
Crop Response Rate - High (/year)	0.2
Maximum Yield (t/ha)	1
Rate of BAU Yield Decline (/year)	

The carbon stock changes are tied to agricultural residues—the carbon-rich organic matter left over from crop production—which in turn is directly related to yields. This relationship tightly links farmers' welfare, in the form of agricultural harvests, to emission reductions measured in the tons of carbon sequestered and stored per hectare annually.

This direct relationship between yield and carbon stocks simplifies MRV since yields are an effective proxy for residues, which is the dominant factor in emission reduction potential after environmental conditions. Thus, the annual emission reductions can be effectively estimated using the precise and easily verified estimates of harvested yields. Manure inputs, similarly, can be effectively tracked. Given this correlation, a 'look up table' approach can be developed to estimate the carbon benefits associated with yield increases in the maize agricultural systems. The coffee system relies on a much simpler approach of increasing yields through standardized intensification and therefore can be guided by a set of basic guidelines.[29]

[28] Long term yield studies are rare, but realistic ranges were estimated as they are a crucial long term driver of emission reduction permanence.

[29] For further details and an illustration for maize systems, please see supplemental materials.

The benefits of carbon-friendly sustainable land management practices will not only improve yields but also contribute to food security through more resilient and productive ecosystems. In addition, benefits are likely in terms of fertilizer and water absorption capacity, as well as resilience of farming systems to extreme weather events, especially droughts which are expected to grow more frequent and intense in areas of sub-Saharan Africa. Although these additional benefits have not yet been directly quantified in this model, these factors will likely affect cost-benefit accounting for farmers as well as public sector entities.

Overall, under present conditions, our assessment suggests that carbon finance alone will be inadequate to defray the risks and costs of interventions affecting agricultural carbon stocks at a regional or landscape-scale. The low carbon yields over long periods and the lack of widely-approved methodologies for appropriate activities, implies that the risks will be high and returns low initially. Improved yield and other co-benefits that accrue to farmers and communities could serve as important incentives for carbon projects, but our analysis implies that the role of the private sector in carbon investments initially will be in implementation rather than financing. Therefore, public sector or philanthropic funds will be essential for launching efforts and providing 'proof of concept' at landscape-level scales.

Further bolstering the need for public funds is the challenge in the timing of costs—which come early in the project—and accumulate gradually over years or decades. Due to agricultural systems' relatively high productivity and management intensity, carbon finance can bridge the time gap between purchasing inputs and reaping benefits and revenues from yield improvements. This ability of carbon finance to provide bridge financing will be contingent upon investors or donors offering upfront payments against credits delivered during the first two to five years, the most critical period to overcome initial cost hurdles for farmers.

For all of these reasons, it is essential to combine public and private finance to bridge the interim financing gap, and develop the necessary knowledge, expertise and institutions. Future financing from voluntary markets or regulatory inclusion of terrestrial carbon credits can then be tapped, with private sector involvement in the implementation, development and management of these practices.

V. PATHWAYS FORWARD: AN AFRICAN AGRICULTURAL CARBON FACILITY

Given these findings, the recommended approach is to move quickly toward demonstration that will lead to commercialization of a tailored agricultural carbon facility in sub-Saharan Africa. Such a Facility could serve as conduit for credit transactions and technical assistance to achieve emission reductions while boosting adaptive capacity. Specifically, this proposed Facility will be able to—through core capabilities and partnerships—support the design, development and maintenance of GHG reduction and sequestration projects in countries where adequate policies are in place. Farmers and the agricultural sector will participate in this process through the development of sound practices and guidelines based on experience, as well as field tests, rather than solely market forces or government mandates.

The Facility will rely on key partnerships with national and regional institutions, as illustrated in the figures below. These partnerships will offer the potential to gain economies of scale in (a) finding and negotiating with project developers, (b) managing, monitoring, reporting, and verifying projects, and (c) accessing and building documentation of soil carbon data as well as agricultural benefits and responses to interventions. To accrue carbon benefits at scale, it will be essential to engage with numerous individuals and villages spread out over large areas. Therefore, it will be imperative to have strong, on-the-ground organizations that can help identify, initiate projects, train people, provide ongoing support and monitoring services, as well as aggregate the carbon credits generated. These on-the-ground partners will in turn need to access carbon-specific legal, financial, and methodological support as they build in-house African expertise.[30]

The organization and governance of the Facility itself requires further consultation, as well as pilot testing, in the next phase. However, initial discussions in this feasibility assessment phase indicated that skills and capabilities in the Facility include:

- financial, legal, agricultural and carbon expertise;
- strong private sector linkages, expertise, and performance-based credibility;
- capacity to forge strong partnerships;
- expansion of existing African and Africa-focused institutions;
- strong national and international networks; and
- credibility and links with smallholder farmer organizations.

Concern was expressed throughout the feasibility assessment phase about the governance and management of the Facility, to ensure that it has credibility as representing the interests of African smallholder carbon offset sellers, rather than international buyers or the international carbon finance expert community. Moreover, it is important that carbon finance be aligned with strategies for smallholder agricultural development and ecosystem management.

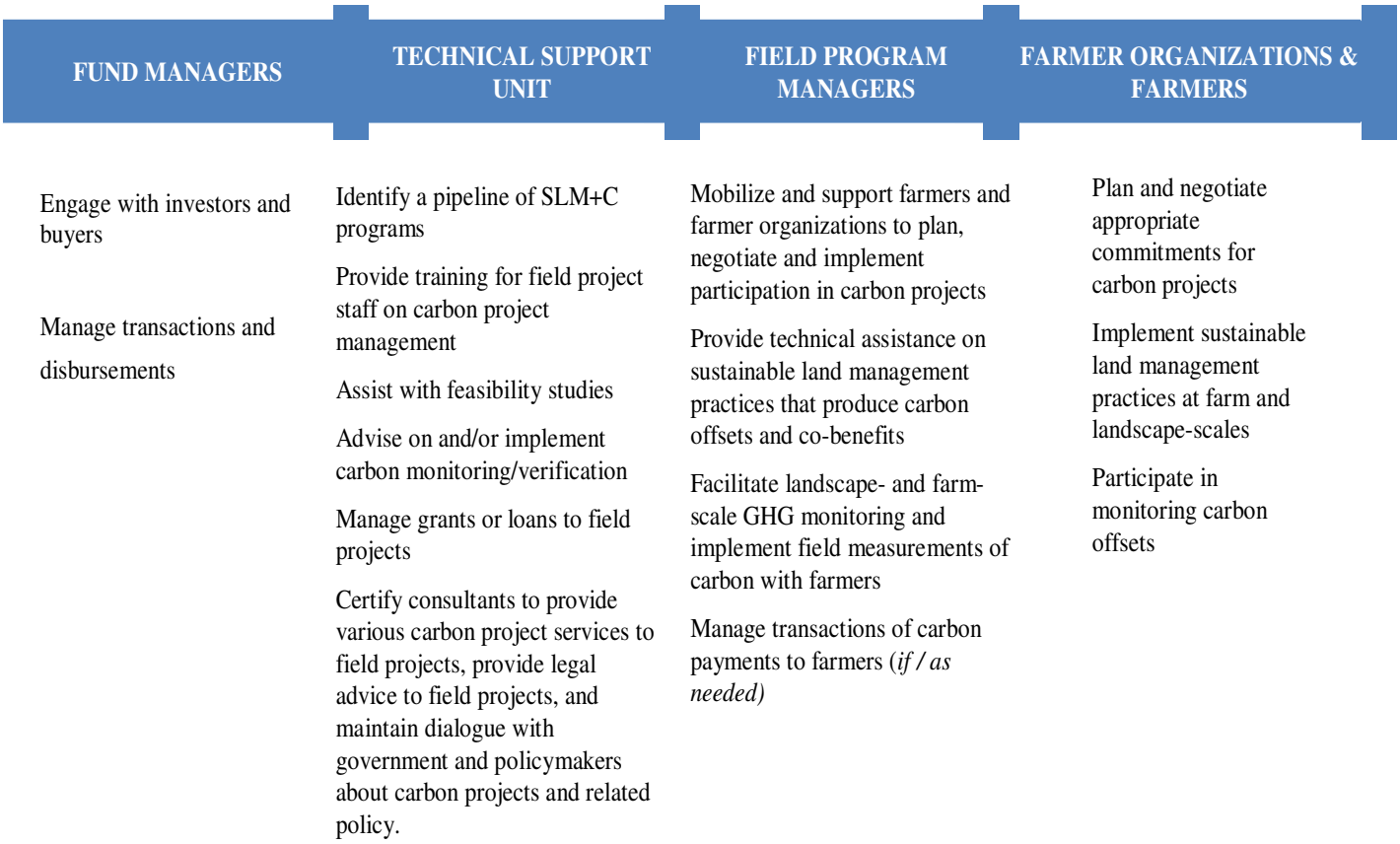
In response, we propose that offices be based in Africa, with clear African ownership—through the organization itself, Board structure, Advisory Board including diverse stakeholders, or other mechanisms. A non-political, autonomous organization is essential, as are mechanisms to ensure transparency.

With the right structure, alliances and approach, the pipeline could be built from the growing set of pre-existing sustainable agriculture investments—few of which would be able to realize a carbon project without external assistance. Concurrently, with carbon project development support, there would be available funds to access technical carbon expertise while engaging in carbon-related capacity building with institutional partners. Similarly, legal experts could be hired and cultivated to conduct national policy assessments ensuring that no significant policy obstacles exist that would obstruct carbon deals in-country. Finally, other institutions' contacts with farmers would be the pathway for finding and negotiating with sellers as well as achieving efficiencies in project management, monitoring, reporting, and verification. Agreements could be made with in-

[30] A growing number of actors in Africa already have functional skills needed to fill key roles in carbon markets. Illustrative groups with existing capacities to play field project management roles and technical support roles are listed in the supplemental materials.

country or regional universities to build documentation of soil carbon data as well as agricultural benefits and responses to interventions.

Figure 1: Key Roles & Partnerships Supporting an African Agricultural Carbon Facility



This proposed approach to an African Carbon Facility, when combined with the realities of carbon work in the region, lead to a set of core basic requirements for financing a facility, including:

- Finance must be available to identify and develop agricultural and terrestrial carbon projects that benefit smallholders, without the obligation to be repaid if the project does not generate credits according to schedule or not in sufficient quantities.
- Either carbon finance or other funds need to finance project implementation upfront as these costs will be significant, particularly at first, and available funding will decrease risk and therefore have the potential to attract other funders.
- Impatient carbon dollars that want fast returns and low risk need to be "cooled down" by intermediaries in order to be able to support individual farmers in the small quantities needed per farmer and at the time when investments need to be made.
- Finance needs to be sustainable, flexible, and visionary in order to accommodate various project structures, changing carbon market conditions, and learning that is likely to unfold as a new domain of practice emerges.

In response to these parameters, the Facility will pioneer the combining of new streams of climate finance producing broader lessons learned for sustainable agriculture and land management in Africa.

Prospective funders include the Official Development Assistance (ODA) and/or multilateral assistance communities—which can offer support in the forms of loans, grants, guarantees or equity investments. Philanthropic finance from NGOs and/or foundations offers another potential. In addition, there is a possibility of support from national and state governments, with greatest likelihood being those governments engaged with the CAADP program, Country Climate Flagship program, sustainable land management country-level initiatives, as well as governments that receive international or bilateral carbon funds as contributions to "nationally appropriate mitigation actions" (NAMAs) registered under the UNFCCC.[31] Additional finance may come from the Copenhagen Climate Fund, adaptation finance and other sources of climate finance. Finally, private sector investors will be sought out, particularly those who have an appetite for risk.

Clarifying the availability of up-front finance will be critical to the success of launching and maintaining an African Agricultural Carbon Facility. Ideally, once the facility is in full commercial operation, these project start-up costs can be reimbursed or replenished from private payments for carbon offsets as they are produced and verified.

Given the complexities of both financing and implementation, we propose that the process of launching an Agricultural Carbon Facility occur in three phases: demonstration, bridging and commercialization. The first step, the scoping and consultation for this feasibility study, has already been completed. The subsequent phases will allow a gradual expansion of the Facility while developing methodologies and defining appropriate interventions. They also permit a progression from today's high-risk, low certainty environment (demonstration phase) to one in which private markets are expected to make investments in emission reductions (commercialization). As a result, the proportion of public to private investment in the Facility should fall as methodologies are issued and financial returns are more predictable and as income from sales for credits are used to finance subsequent upfront costs.

Phase 2:
Demonstration

Activity: *Demonstration projects and capacity building*
Objectives: *Collect data, establish methodologies, and identify project types as well as intermediaries*
Finance: *High proportion of public finance*

The demonstration phase will identify feasible carbon transactions and finance solutions supporting sustainable agriculture in Africa. It represents the riskiest period for project proponents and investors combining large policy uncertainties with a lack of technical expertise.

In this phase, an initial portfolio of specific sites for carbon programs will be assembled based on a synthesis of existing data against key analytical screens, including carbon sequestration potential and institutional development in a given landscape. This initial portfolio of up to five large field programs—with the enrollment of at least several thousands of farmers in each ideally—will in turn develop innovative finance solutions for:

- carbon measurement methodologies,
- land management activities,
- outreach to, and training of, farmers,
- processes for aggregation of farmer agreements,
- monitoring and verification systems, and
- financial flows.

[31] Note that if credit is being given to countries for GHG reductions and removals, they cannot be sold to private markets without creating a double counting problem. In addition, it is noteworthy that NAMA funding may be a source of finance as long as adequate interventions have not been identified or where private compliance grade carbon offsets cannot be generated.

Due the complexity and interdependence of the full set of actors to bring carbon projects to market, this demonstration phase will need to be implemented in close collaboration with potential intermediaries, existing sustainable land management programs, and extension services working with farmers, as well as authorities and national governments to evaluate the use of climate funds for NAMAs to support appropriate activities.

Overall, the demonstration phase will lay the foundation for future credit or program-based finance by monitoring and measuring the co-benefits and emission reductions / removals of specific agricultural practices and launching on-the-ground relationships with key actors across such a facility. Ideally, there will be voluntary carbon market buyers committed to purchase the resulting offsets.

Financing Model for the Demonstration Phase
Capital deployed during this phase will likely to yield returns in enhanced knowledge rather than in profits. The private sector is unlikely to invest in activities and investment models that combine regulatory insecurity, poor data, high host country risk, and high costs of capital. Private capital is therefore unlikely to support African agricultural and terrestrial carbon projects or policies without subsidies or guarantees to underwrite risk.

For this reason, public and philanthropic finance is crucial during the demonstration phase to underwrite the development of methodologies, monitoring systems and project structures, as illustrated in the table below.

Table 13: Demonstration Phase Financial Model Summary

Source	*Crediting*	*Project or policies*	*Scale*	*Sources*
Public and philanthropic (primary); minimal private investment	Financing not performance-based; optional voluntary market credit sales	Mostly project, with limited policy activities	Small scale for research and testing approaching minimum efficient scale	Multi and bilateral institutions

Specifically, public funds during this time would:

- pioneer carbon finance models, methodologies, monitoring, and project classes;
- support capacity building and training;
- link carbon finance to ODA support for underlying projects;
- aggregate demand for agricultural carbon offsets;
- coordinate donor and public sector funding (non-investments);
- coordinate service providers and procurement for regional actions;
- advance knowledge, research and experimentation with new methods of SLM/carbon sequestration, and
- focus on the co-benefits and sustainable development role of forest carbon practices.

During the demonstration phase, the Facility will support activities through project development grants. Sale of offsets can partly pay back these advance payments. Financing for underlying project activities will be generated by partnering with NGOs as well as banks and institutions apt to provide financing for agricultural investment and extension services.

Phase 3:
Bridging

Activities:	*Project scaling and limited commercialization*
	Consolidation of project and financing institutions
Objectives:	*Prove and expand agricultural and terrestrial carbon projects*
	Attract private capital
	Build supply chains to deliver services and manage training as well as MRV
Finance:	*Large percentage of public finance, but decreasing fraction of overall budget*

The bridging phase will scale up the activities identified for carbon finance during the demonstration phase. During this phase, the Facility must identify and finance investments that expand demonstration activities to a meaningful scale for GHG mitigation and food security at the provincial or national level. It will build directly on expertise and methods developed in the demonstration phase, and could establish a more robust financing and technical assistance mechanism.

The establishment of a Facility that focuses on the generation and sale of verified emission reductions (VERs) is the simplest and most straight forward design option for this phase. The risk associated with making advance payments can be managed through a portfolio approach and is compensated by the prospect of high returns generated by the sale of VERs from performing projects. A purely VER trading fund is simpler to manage and can be designed following the models of existing carbon funds. Such a fund can be established as non-profit revolving fund that channels profits from successful projects and sales of VERs into the Facility to support more projects.

The project services offered by the Facility during this time could include project design and PIN formulation, baseline and carbon stock assessments, PDD development, validation support, and legal and carbon credit marketing services. In addition, such a Facility would include the following functions:

- Expand support services (agricultural extension, insurance, etc.) in the identified activities to alter farmers' practices across larger scales;
- Aggregate large numbers of small farms;
- Ensure actors in government, private sector and NGOs can organize to regulate, deliver and maintain agricultural carbon practices;
- Seek complementary public (national and private) financing sources;
- Market agricultural carbon credits on voluntary or compliance markets within international framework to credit and certify climate and social benefits from agricultural carbon activities;
- Work with local financial institutions and intermediaries to distribute and deliver funding to project actors; transparently administer large sums of international finance for domestic investment;
- Mobilize high risk public and private capital available for up-front financing, and
- Build government institutional support for land-scale level activities, which will include explicit integration of such activities in national low carbon development plans.

In addition, this phase would begin work on engaging with private buyers for carbon offsets with rural livelihood benefits, as well as attracting additional investors. To this end, a key goal will be to build the framework for private investment and large-scale carbon finance, which will require:

- cost-effective and rigorous monitoring and measurement;
- effective aggregation and technical implementation;
- certification of credible methodologies, and
- consistent carbon and agricultural productivity improvements.

Although demonstration activities may continue at this point, the emphasis will be on expanding the scale and scope of agricultural interventions that produce emission reductions and co-benefits. Expanded demonstration activities could be supported by public programs or by a pairing of public finance—that support the underlying activities—with private carbon finance investing in prospective emission reductions.

Financing Model for Bridging Phase
The bridging phase would test the viability and benefits of various activities and determine the mix of public and private funds needed to ensure large scale extension of successful project types. Financial terms during this period will, if possible, seek to cover project operating expenses, and ultimately debt payments, from credits sold on the emerging voluntary or compliance market for GHG emission reductions.

Public funding may be used to support initial investments. Markets that mobilize the much larger pools of private investment capital will be complementary, if not vital.

Ultimately, a combination of funding sources, with the public sector picking up activities too risky or unprofitable for the private sector with high co-benefits, is likely to be utilized during this phase. Therefore, public finance during this period is likely to provide the bulk of financing, although the activities funded during this period should pioneer carbon finance partnerships with the private sector.

Phase 4:
Commercialization

Activity: *Establishment of fund to finance projects and verified emission reductions and removals*
Goals: *Direct private capital into landscape-scale activities*
Enable market-based mechanisms to operation with minimal transaction costs
Finance: *Mostly private investment, with ongoing public finance for certain infrastructure and services*

The commercialization phase represents the financial goal of the Facility, which is to have private investment in agricultural emission reductions that generate significant co-benefits for smallholder famers in sub-Saharan Africa.

This phase will build on the methodologies and implementation experience of previous phases. Verified emission reductions and removals could be sold into international carbon markets or meet an international demand for regulated credits. As a result, the capital structure will include proportionally more private finance than public finance. At this stage, the technical assistance function is expected to be fulfilled largely by private sector entities, aggregators or sellers—ideally African organizations and nationals.

Commercialization can begin once conditions for private investment of emission reduction activities have been created including:

- a policy framework to ensure market demand (either compliance or voluntary);
- assurance of public support for enabling conditions (such as: land tenure enforcement, agricultural extension services, and other key elements);
- approved and feasible methodologies for agricultural carbon;
- track record in selecting and managing projects at reasonable MRV and transaction costs, and
- proven complementary revenue streams secured.

During this phase, the Facility will focus on the generation, not the purchase of credits. Specifically, the Facility could adopt one of two roles at this phase—either limited support for the development of carbon projects, without providing underlying finance, or extended financing for project development, in addition to carbon finance. The Facility's financial support to carbon projects could be structured as grants, loans, prepayments on the sale of credits, equity in the project, and/or a combination of these.

If expanding beyond project development support, the terms of the Facility's lending and financial support will depend strongly on how the Facility itself is financed. If the Facility receives grants—either provided by public or philanthropic sources, or generated from "surplus" on project loans—then loans issued to projects will likely be 'soft,' or below market rates with flexible repayment terms reflecting project circumstances.[32]

Overall, the Facility's financial relationship with projects should be guided by an attempt to mitigate farmer's systematic risks (those they cannot control or hedge), while leaving performance risk largely in the projects to sharpen their incentives for success. For instance, currency fluctuations, carbon pricing and country instability are not well managed by projects, but would be better mitigated through the Facility's diversified project portfolio, balance sheet and sophisticated financial instruments. The Facility can then apportion risk as it deems appropriate through contracts and hedging.

Financial model for Commercialization Phase

The financial structure of the Facility at this stage should be focused on private finance and scaling emission reductions within African countries through agricultural and terrestrial projects. Firms or private funds can manage implementation risks, increase operational efficiencies, and innovate or diversify products or services. Specifically, private finance would in this phase:

- finance and manage very large-scale agricultural mitigation activities backed by international capital markets;
- coordinate implementation of project activities on program or regional basis;
- identify and scale cost-effective interventions through existing supply chains, and
- invest in assets complementary to high-carbon agricultural production systems.

Public funding should be greatly reduced and highly targeted to compensate for market failures and inefficiencies, such as extending MRV systems or aggregation where scale and coordination are problematic.

[32] To illustrate, a few basic financing examples are described below that create the flexibility to apportion risk amongst both the Facility and projects:

- *Soft loans* which are below market loans with flexible repayment schemes
- *Secured or unsecured loans convertible into equity*, which are useful in cases where project cash flows may be interrupted, and the underlying asset is viable, then these loans may be converted into project equity preventing default and supporting operations
- *Additional loan guarantees* from outside parties that may bolster balance sheets
- *Variable interest rates* where the repayment amount can fluctuate according to indices tied to either the prevailing interest rates or the price of carbon that may insulate the project from cash flow problems tied to carbon prices and market volatility

VI. NEXT STEPS

This feasibility assessment has found that there is both potential and need for an African Agricultural Carbon Facility. A unique set of partners—spanning international, national, and regional institutions—stands ready to engage in a demonstration phase offering in-depth knowledge of:

- Carbon markets, including *the World Bank, Forest Trends*, *the Katoomba Group,* and *Climate Focus*
- Carbon asset management and commercialization, including *EKO Asset Management Partners*
- Financial services provision in Africa, including the *Equity Bank*, which is the largest bank in the East African region and one of the most capitalized
- African policy-makers and African agendas for the future, including *the New Partnership for Africa's Development (NEPAD)*, which is *a program of the African Union* and will ensure that the initiative is integrated within national/regional development strategies; relates to sustainable capacity in African systems/institutions and is consonant with Africa's own agenda and targets on productivity and food security
- Farmer's on-the-ground needs, including the *Eastern Africa Farmer's Federation*, an association that brings together the members of national farmers' organizations
- Eco-agriculture practices, through regional and in-country networks of *Ecoagriculture Partners*

If funded, the demonstration phase will invest in projects with clear potential for scaling up sustainable financing accounting for initial upfront and transaction costs that now constrain market potential. Financing terms will ideally provide long-term sustainable support for farmers and other project entities that cannot manage market risk. Upside incentives will be offered to encourage improved activities and management. Downside risks must be reduced or eliminated for individuals and communities with little or no capacity to absorb financial and economic losses to encourage adoption.

As the demonstration phase shifts to a bridging phase, and ultimately commercialization, it will result in an innovative set of transaction models that can be used by governments and non-state actors to access carbon and other climate finance sources for climate mitigation and agricultural adaptation that helps African smallholder farmers. This work will result transaction and finance models that have the potential for scaling up and strengthening other organizations to move into key carbon finance roles in Africa, as the volume of activity around agricultural and terrestrial carbon finance grows over the next decade.

The opportunity is matched by the need—for mitigating climate change, bolstering African food security, rehabilitating degraded soils, increasing productivity of agricultural landscapes, and expanding capacity of communities to cope with both food provision demands as well as environmental stresses. Demonstration of an African Agricultural Carbon Facility will provide an institutional example of a specific, tested pathway forward.

Forest Trends is an international non-profit organization that works to expand the value of forests to society; to promote sustainable forest management and conservation by creating and capturing market values for ecosystem services; to support innovative projects and companies that are developing these new markets; and to enhance the livelihoods of local communities living in and around those forests. We analyze strategic market and policy issues, catalyze connections between forward-looking producers, communities and investors, and develop new financial tools to help markets work for conservation and people.

The Katoomba Group is an international network of individuals working to promote and improve capacity related to markets and payments for ecosystem services (PES). The Group serves as a forum for the exchange of ideas and strategic information about ecosystem service transactions and markets, as well as a means for collaboration between practitioners on PES projects and programs. It has held numerous global conferences, published and contributed to a number of publications, and supported the development of a range of new PES schemes including the BioCarbon Fund at the World Bank and the Mexican PES Fund. The Katoomba Group has also advised national policy discussions on financial incentives for conservation in numerous countries including China, Brazil, India, and Colombia.

Ecoagriculture Partners is an international NGO working worldwide to mobilize and support cross-sectoral landscape-scale initiatives to jointly achieve agricultural development, rural livelihoods and healthy ecosystems. Ecoagriculture Partners develops methods and tools for multi-stakeholder groups to plan, assess and monitor ecoagriculture landscapes. EP synthesizes and disseminates state-of-the-art information about technical and institutional innovations for ecoagriculture, including the role of agriculture in climate change adaptation and mitigation. The organization supports and strengthens leaders in ecoagriculture.... EP works collaboratively to promote alignment of policies for agricultural development, ecosystem management and climate action. The organization promotes markets that provide incentives for scaling up of ecoagriculture approaches, with a focus on payments for ecosystem services (PES), eco-certification, and market diversification. Ecoagriculture Partners coordinates a new global network on PES in agricultural landscapes and publishes a quarterly international newsletter, *ecoagriculturePES.* EP provides advisory services to organizations working in agriculture, environment and rural development, including the World Bank, the Inter-American Development Bank, the Bill and Melinda Gates Foundation, the David and Lucile Packard Foundation, FAO, UNDP, and others.

Climate Focus is a proven international leader in providing advisory services on climate change regulation and the carbon trading market. Climate Focus' technical, financial and legal teams work in tandem to provide a comprehensive suite of services to respond to your particular needs. Climate Focus' expertise reaches back to the inception of the carbon market over 10 years ago. The founders are internationally recognized experts that helped create the carbon market through their work in the Dutch government and the World Bank – pioneer organizations in defining the rules of the international carbon market. These founders now lead an international team of experts that provide the specific technical and legal expertise necessary for success wherever your organization or project is located. Climate Focus has worked with clients and projects in over 50 countries, including AES, Avoided Deforestation Partners, Banco Santander, California Climate Action Registry, Dong Energy, Endesa, Holcim, Hong Kong Stock Exchange, Rabobank, Saint Gobain, Statkraft, the UNFCCC Secretariat, the David and Lucile Packard Foundation, WWF, and the World Bank. The Climate Focus legal team is one of the most experienced and respected in the industry. Matching this experience and respect, the Climate Focus technical team has been instrumental in not only evaluating and implementing hundreds of emission offset projects, the team has also developed several of the standards by which such projects are assessed.