Synthesis Paper: Voluntary Carbon Markets for Soil Carbon

Content

1 Global Frame

Global demand for the production of food is continuously increasing with a growing global population. At the same time, global food production is challenged by ongoing land degradation and climate change. Nearly 1/4 of the world's landscapes are considered to be degraded, while rising temperatures and changes in precipitation patterns are likely to further increase the risk of land degradation (IPCC, 2019). Without the implementation of measures to protect and restore soils through sustainable land management (SLM), continuous degradation will have serious consequences on soil and its ecosystem services, such as producing food and fiber, supporting nutrient and water cycling, and providing the largest terrestrial carbon sink (Chotte et al., 2019).

SLM generally provides multiple benefits related to soil and agriculture, such as enhancing resilience of agricultural systems, maintaining or enhancing food production, enhancing soil capacity to buffer against degradation processes, improving nutrient cycling, and protecting and sequestering soil organic carbon (SOC) (Gabathuler et al., 2009). With proper management using SLM (Figure 1), carbon sequestration in soils and vegetation can contribute to climate change mitigation through negative and prevented emissions (IPCC, 2014), as well as adaptation by impeding land degradation and providing multiple co-benefits for food security and biodiversity (Sykes et al., 2019).

The Agriculture, Forestry and Other Land Use (AFOLU) sector is one of the biggest emitters of greenhouse gases (GHG), with unsustainable land uses contributing 10-12 GtCO2e per year (ca. 25% of global emissions). About half of this is due to agriculture, which is also the sector which is most vulnerable to climate change (IPCC, 2019). Yet, the land sector, holds a large mitigation potential. The global soil carbon mitigation potential from agricultural soil is estimated to be 2-5 GtCO2eq per year (Fuss et al., 2018; Smith et al., 2019), with sequestration rates due to management practices in agricultural lands estimated in the range of 0.2-0.8 t C/ha/year (FAO, 2020). A large proportion of this SOC sequestration potential lies in developing countries, although the specific magnitude and rate of SOC sequestration can vary greatly as a function of land use, management practices, soil characteristics, vegetation, topography, climate and historical carbon loss (FAO, 2020; Sanderman et al., 2018; Wiesmeier et al., 2019; Zomer et al., 2017)(Griscom et al., 2020; Zomer et al., 2017).

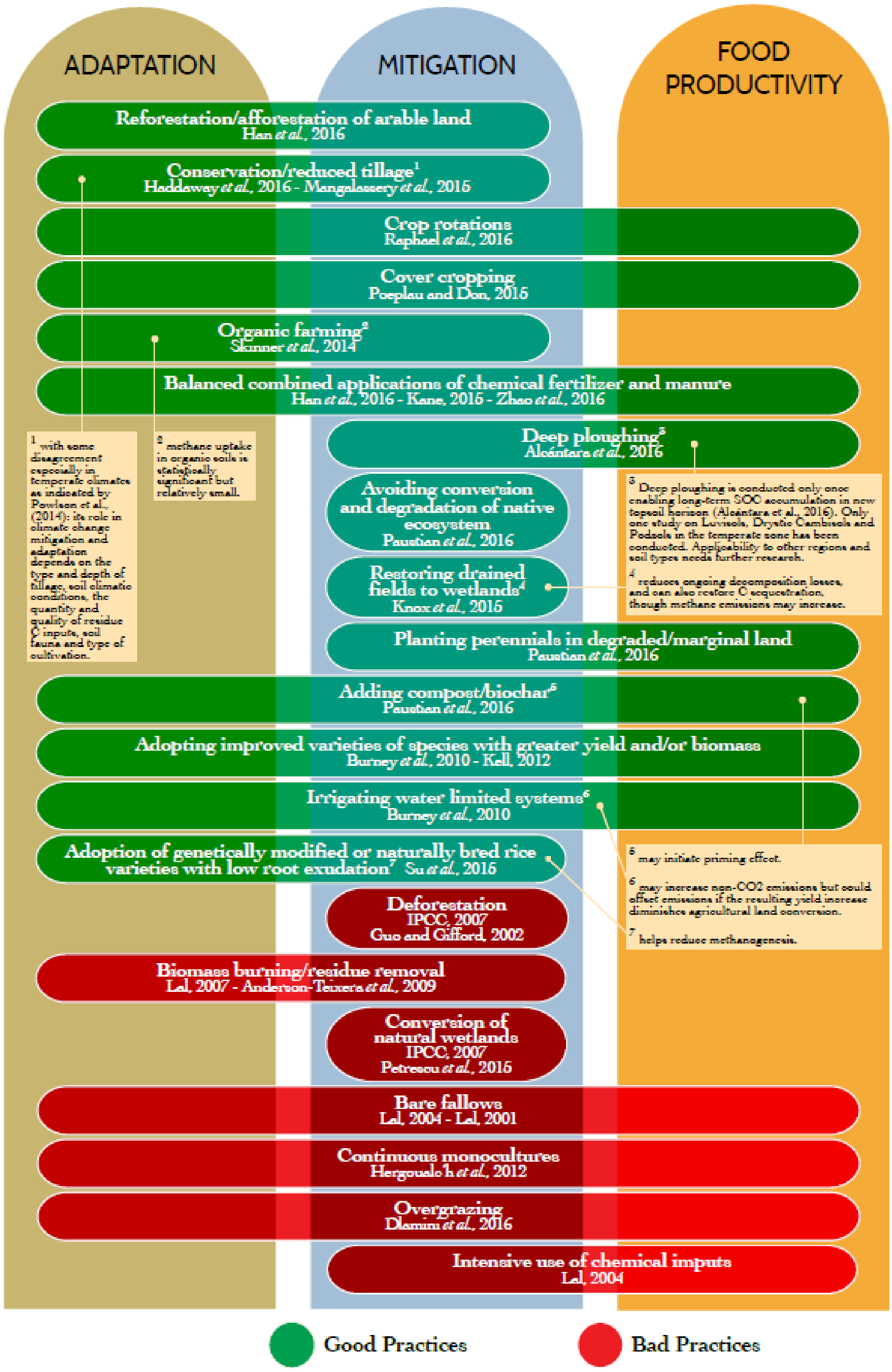

Figure 1. Suggested and dissuaded management strategies for soil carbon sequestration and their impact on food productivity and climate change mitigation and adaptation (Source: (FAO, 2017)*).*

During the past five years there has been an increase in the development of an enabling political-instrumental environment that would support the adoption of SLM practices that support SOC protection and sequestration. From a climate change perspective, this is illustrated through the Paris

Agreement (United Nations, 2015), the Koronivia Joint Work on Agriculture (KJWA) (UNFCCC, 2018), and the Intergovernmental Panel on Climate Change (IPCC) Special Report on Climate and Land (IPCC, 2019) under the UNFCCC. In terms of land degradation, the UNCCD has set Land Degradation Neutrality (LDN) by 2030 as its main target. LDN is also the goal of Sustainable Development Goal (SDG) 15.3 with its indicator 15.3.1 ("proportion of land that is degraded over total land area") which consists of three sub-indicators and metrics that includes SOC (Orr et al., 2017).

As the importance of SLM in relation to SOC is increasingly recognized and encouraged globally, so national commitments may need to be adjusted accordingly. For example, out of 184 Nationally Determined Contributions (NDCs) submitted to the Paris Agreement (by 24 November 2019), only 28 addressed specific measures, policies or targets related to SOC protection or sequestration. Of the 28 NDCs, only three provided quantified targets for SOC specifically (Wiese-Rozanova et al., 2020). With the second round of NDC submission starting in 2020, clear integration of SLM directly related to SOC can therefore be improved and existing national actions and policies related to SOC can be better reflected.

Although gradually, soils and SOC are increasingly included in national and global climate finance. To date, the AFOLU sector accounts for a very small proportion of climate finance. In the two years of 2017-2018 the tracked, annual climate finance flow amounted to an average of US$579 billion. The annual investment in land-use mitigation was limited to US$11 billion, and US$7 billion was invested in land-use adaptation, lagging behind other sectors such as energy projects. By comparison, approximately US$91 billion was spent on energy efficiency and renewable energy (CPI, 2019).

Besides financing from larger development banks and initiatives, a promising way to raise finance for SOC enrichment is to include SLM into carbon markets. Carbon markets are designed to hold the possibility of valorizing the ecosystem services of soil. Despite low average cost per sequestered ton of CO_2, soils have been mostly absent in carbon markets.

Therefore, in the following chapters, we will give further information on the discourse around the integration of soils, SOC, and more generally SLM, into carbon markets. We will highlight crucial aspects for the integration and present case studies, in which soils have been integrated into the carbon market.

2 SOC in Voluntary Carbon Markets: Requirements and approaches

2.1 Role of soils in carbon markets (past, present and future)

Since the adoption of the Kyoto Protocol in 1997, large sources of GHG emissions from the land use, land-use change and forestry (LULUCF) sector have been excluded from carbon compliance markets. The Kyoto Protocol limited the accountability of emission reductions from the LULUCF sector in the Clean Development Mechanism (CDM), to afforestation and reforestation and methane emissions from agriculture.

The European Union ETS was the first compulsory scheme to include private parties and has become a blueprint for ETS designs worldwide. The exclusion of the land sector was supported by a broad alliance of NGOs, which questioned the environmental and ethical integrity of trading systems, claiming it would legitimize ongoing pollution. The main concerns of the parties leading to this decision have been the permanence risk of land-based emission reductions and high costs for monitoring systems and protocols to track GHG fluxes. Unlike the compliance markets, the voluntary market was open to the LULUCF sector, although its size is small and the carbon prices generally modest.

Thus, SOC projects have been largely absent from carbon markets in the past. However, there are several indicators that this will change in future. Nowadays, methodologies and monitoring systems exist for almost every type of land management project. This allows project developers to adequately deal with various technical challenges, such as tracing GHG fluxes or mitigating risks of carbon losses. (Unger & Emmer, 2018).

Under the Paris Agreement, Article 6 provides for a number of emissions trading instruments which would allow countries to cooperate with one another to channel climate finance into land use and particularly soil-based interventions (Unger and Emmer, 2018). Furthermore, the Agreement puts high emphasis on the promotion of sustainable development and ensuring environmental integrity through the available cooperation mechanisms (United Nations, 2015). However, a detailed rulebook is still needed to implement the Paris Agreement and countries are yet to agree on implementation rules and an accounting system for Article 6. Such an accounting system is required to account for emission reduction transfer to avoid double accounting and ensure that the environmental integrity of the Agreement is upheld by ensuring additionality and increased ambition and progression. There is also still a question of how certificates generated under the Kyoto Protocol should be dealt with and whether countries would be able to use them under the Paris Agreement (BMU, 2020; Re, 2019). Ultimately, the Paris Agreement may lead to an increased focus on soil carbon activities since it encourages countries to focus on sequestration to balance out GHG emissions across sectors, including the land-use sector (Unger and Emmer, 2018).

The Paris Agreement paves the way for SOC being recognized for its potential to contribute to net zero emissions targeted under the Agreement. Carbon projects are an important pathway to spreading to necessary technologies and skills required, but would require support from governments through legal and governance reforms, planning security and scaling mechanisms (Unger and Emmer, 2018).

2.2 Methodologies for soil carbon project certification

SOC projects can account for GHGs by creating carbon sinks to sequester CO2 from the atmosphere in vegetation or enhancing carbon storage in soils, or by protecting soils from degradation to avoid the release of GHGs into the atmosphere (Unger and Emmer, 2018). A summary of the types of project interventions is provided in Box 1.

Box 1. List of potential carbon project intervention types for carbon sequestration or protection

Activities and Technologies in Soil Carbon Projects

Various sources categorize intervention types in different ways. At a general level, a distinction is being made between avoided conversion and carbon sequestration. In the literature, assessments of the mitigation potential, in summary, list the following:

• Avoided conversion of grasslands, savannahs and peatland which involve protection of ecosystems against conversion to cropland or grazing land.
• Cropland and pasture management
• Peatland rewetting or restoration

Cropland and pasture management can be broken down into addition of organic manures, compost or mulch, cover cropping, use of perennials or deeperrooted cultivars, conservation tillage, agroforestry, enhanced crop rotation and rotational grazing.

Voluntary carbon standards define project categories at a similar general level and leave it to compliant GHG accounting methodologies to define which are eligible intervention types. Project activity categories include:

• Agricultural Land Management (VCS and ACR)
• Restoring Wetland Ecosystems (VCS and ACR)
• Avoided Conversion of Grasslands and Shrublands (VCS, ACR and CAR)
• Conservation of Intact Wetlands (VCS and ACR)

2.2.1 Standards

Numerous methodologies have emerged over the past two decades to calculate mitigation benefits and issue carbon credits in a wide range of project activities under AFOLU covering croplands, grasslands, savannahs, peatlands and coastal wetlands. These carbon accounting methodologies include both biomass and SOC as major carbon pools and sources of GHG emissions. Although small, there is sufficient experience with SOC projects to support the development of mitigation plans with confidence at larger scales (Bossio et al., 2020; Unger and Emmer, 2018). Several internationally active voluntary standards have developed specific methodologies and project formats have been developed for the AFOLU sector, including the Verified Carbon Standard (VCS) (Verra, 2020), the American Carbon Registry (ACR) (American Carbon Registry, 2020), the Climate Action Reserve (CAR) (Climate Action Reserve, 2020), Plan Vivo (Plan Vivo, 2020), and Gold Standard (The Gold Standard, 2020) (Box 2).

Verra

VCS (Verra, 2020) is the world's largest voluntary standard in terms of the number of projects and credits and offers methodologies across the full range of AFOLU, with a number of methodologies related to soil management, as well as peatland and wetland restoration and conservation as listed in Box 2 (Unger and Emmer, 2018). VCS projects are still considered to be of small scale, the first of which was the Kenya Agricultural Carbon Project (KACP) which focused on soil carbon sequestration under the 2011 approved Sustainable Agricultural Land Management (SALM) Carbon Accounting Methodology (VM0017) (VCS, 2011a) which focuses on croplands

The SALM methodology aims to estimate and monitor GHG emissions resulting from project activities that reduce emission in agriculture through the adoption of SALM practices. The methodology is relevant for areas where SOC content would remain constant or decrease in the absence of the project. The standard defines SALM as any practice that increases the carbon stocks on the land, such as manure management, using cover crops, incorporating trees into the agricultural landscape, and more.

In terms of modeling changes in SOC, only the Roth-C model is applicable for use since estimates of uncertainty and Activity Baseline and Monitoring Survey (ABMS) are only adapted for the Roth-C model. Selected carbon pools include only woody biomass above and below ground, and SOC. Emission sources considered the use of fertlizers (N_2O), N-fixing species (N_2O), biomass burning (CH_4, N_2O), and burning of fossil fuels (CO_2, CH_4, N_2O).

Six conditions apply to the applicability of the methodology to projects that introduce SALM practices, for example, land has to be under grassland or cropland at the start of the project, land is currently continuously degrading (projects would need to provide proof of such degradation), and there must be studies available to prove that the Roth-C model is appropriate for application in the local context. The standard describes the relevant steps in terms of establishing the project baseline, methodology and monitoring, including the listing of tools to show additionality and estimate leakage. Changes in SOC density are modelled every five years based on management practices applied.

Gold Standard

Gold Standard very recently introduced its first methodology targeting SOC through its Gold Standard Soil Organic Carbon Framework Methodology (Gold Standard, 2020). The methodology presents requirements to quantify changes in GHG emissions and SOC stocks resulting from the adoption of improved agricultural practices which may include both avoided emissions and SOC sequestration. The SOC methodology differs from the VCS SALM methodology by providing three approaches to quantify SOC improvements for baseline and project scenario development to accommodate the reality that not all relevant measurements and parameters may be available in all project cases. SOC quantification can therefore be done through direct on-site measurements of SOC stocks, by using peer-reviewed publications to quantify baselines and project SOC stock levels, or by applying default factors. Eligible soil sampling protocols for application in this standard are the ICRAF protocol and VCS SOC Module.

Projects are eligible in all countries, but may be limited to certain geographic areas based on limiting results obtained from the compulsory SOC Activity Module development. In terms of land use, managed cropping systems must have been in place for at least 5 years prior to project implementation and project implementation may not lead to changes in land use. Furthermore, projects should exclude wetland and forest areas. Project activities should result in at least the same crop yields as the baseline, or improvements in baseline yields.

The only carbon pools to be included in the project, baseline and leakage calculation are SOC and wood products (i.e. furniture, construction material, etc). In terms of leakage estimation, additional pools include changes above (stems, branches, bark, grass, herbs, etc.) and below ground (roots of grass, trees, herbs) biomass carbon.

CO_2 is the primary GHG gas to be monitored with all SOC activities, while additional gases of CH_4 and N_20 may be required in respective Activity Modules. In principle, all GHG sinks and sources affected by project activities should be monitored where measurability allows. The methodology provides requirements to avoid double counting and benefits overlap, provide for project buffering, address leakage, and ensure additionality.

In terms of monitoring, SOC density determination is required at each performance certification.

Box 2. Methodologies Available for Soil Carbon Projects (Sources: .

Verified Carbon Standard (VCS)
Avoided Conversion of Grasslands and Shrublands (ACoGS)
• Methodology for Avoided Ecosystem Conversion VM0009

Agricultural Land Management (ALM)
• Adoption of Sustainable Agricultural Land Management (SALM) VM0017
• Soil Carbon Quantification Methodology VM0021
• Sustainable Grassland Management (VM0026)
• Sustainable Grassland Through Adjustment of Fire and Grazing (VM0032)

Peatland restoration and conservation (Restoration of Wetland Ecosystems (RWE), and Conservation of Intact Wetlands (CIW))
• Rewetting of Drained Tropical Peatlands (VM0027)
• Rewetting of Drained Temperate Peatlands (VM0036)

American Carbon Registry (ACR)
• Avoided Conversion of Grasslands and Shrublands to Crop Production (ACoGS)
• Compost Additions to Grazed Grasslands
• Restoration of Pocosin Wetlands

Climate Action Reserve (CAR)
• Grassland Project Protocol

Plan Vivo
Accepts existing methodologies from other standards or project-specific methodological approaches.
• Rehabilitation and sustainable management of degraded pastures
• Plan Vivo Climate Benefit Quantification Methodology – Carbon sequestration through improved grassland and natural resources management in extensively managed grasslands

Gold Standard
• Gold Standard Soil Organic Carbon Framework Methodology Version 1.0 (Accepts ICRAF Protocol for Modelling, Measuring and Monitoring Soil Carbon Stocks in Agricultural Landscapes, and VCS VM0021)

Numerous other standards exist which apply to specific countries (i.e. Canada, Australia, and many others) and are therefore not currently relevant for application in developing countries.

2.2.2 Demand (buyers)

Historically, climate finance and policy options for SOC have been low, but the viability of climate financing for soil appears to be improving, although still as a niche market. The Green Climate Fund now targets land use and agriculture under a new funding window. In terms of carbon project development, the World Bank's BioCarbon Fund has supported 20 projects related to habitat restoration and carbon enhancement, but most of these focused on afforestation and reforestation.

Still need to add more here.

Green Climate Fund

Philanthropic sources?

LDN Fund?

2.3 Gaps and challenges of integrating SOC into carbon markets

2.3.1 Efficiency, costs, inclusion of SOC

2.3.2 Pre-financing (blended finance instruments)

In principle, carbon finance is based on an "ex-post" or results-based financing (RBF) modality, meaning that an emission reduction has to be achieved, reported and verified before it can be issues and transferred. This is generally also the norm for voluntary standards currently active in the AFOLU sectors (e.g. Verra, Plan Vivo, and American Carbon Registry), but an increasing number of exceptions are emerging whereby standards issue "ex-ante" credits (e.g. Gold Standard) (DEHSt, 2018). The sale of ex-ante credits enables the covering of project establishment costs using carbon finance (Malin et al., 2013)

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2.3.3 Institutional anchoring, low institutional capacities

2.3.4 Permanence, additionality and leakage

Permanence

Permanence in terms of carbon markets refers to the longevity of a carbon pool, which does not play a role in agricultural projects which reduce GHG emissions other than changes to SOC stocks (e.g. fertilizer use, manure treatment, etc.). Under most carbon standards, increases in SOC stock or avoided SOC loss as a result of a project activity must be maintained for a long period (usually at least for 100 years), and its reversal must be avoided (i.e. by reverting to unsustainable management practices). Permanence is important when emission reductions or removals are used as offsets – if the underlying carbon stock disappears, the offset will also be affected (Unger and Emmer, 2018).

Additionality

Additionality refers to the fact that the project and its emission reduction would not have happened without the intervention of the carbon market, based on an analysis of barriers to implementation of the project activity. Carbon standards provide procedures and rules for testing the additionality of a proposed project which forms part of the baseline and project development steps. These procedures aim to determine whether GHG emissions mitigation was part of the rationale for project design and implementation, and whether the presence of carbon markets provided a clear incentive to project implementation. The burden of proof is on the project developer and often this burden is onerous (Unger and Emmer, 2018).

At the project design level, projects for agricultural carbon finance are required to provide and explicit explanation for land degradation and the subsequent potential for carbon sequestration or emission reducitons as a means to show the additionality of proposed project activities. In order to reach such additionality, relevant management practices need to be implemented at sufficiently "additional" volumes to the baseline To achive this, the scale of adoption of SALM practices, for example, needs to be substantially higher than the baseline context and the proposed business as usual scenario. Effectively showing additionality during project desing may therefore result in high resources costs to robustly document the baseline scenario and convincingly show that the project activities will result in improvements that can be verified (Cavanagh et al., 2020).

Leakage

Leakage occurs when an activity within the project boundary triggers an emission on lands outside of the project boundary and may occur in two forms. Activity-shifting leakage occurs when activities inside the project boundary (e.g. land conversion) relocate outside of the boundary. Market leakage occurs when project activities affect an established market for goods (e.g. farmed products) and causes the substitution or replacement of those goods elsewhere (Unger and Emmer, 2018).

2.3.5 Carbon Land tenure

2.3.6 Benefits for farmers

The ultimate benefit derived by farmers from carbon finance projects may depend on a number of factors. In the case of the KACP (Vi Agroforestry, 2012), for example, analysts have raised concerns regarding the low returns from emissions reductions sales to farmers and the high transaction costs of the implementing agency and sub-contracted firms (Cavanagh et al., 2020). Based on a random sample of 16 KACP farmers' groups representing 279 households, it was estimated that in the KACP the average carbon revenue received per farmer group (15 or more households per group,) was about USD 40.14. This amount translated into an average of USD 0.33 per household per year from 2009-2016 which are considered unlikely to provide sufficient incentive for the adoption of SALM practices (Cavanagh et al., 2020).

3 Case studies and future development

3.1 Monitoring and carbon accounting

3.1.1 Kenya Agriculture Carbon Project (KACP)

The KACP (Vi Agroforestry, 2020, 2019) is a climate compensation project located in western Kenya which promotes sustainable agricultural land management (SALM) practices for implementation on smallholder farms (average size of <1 ha) to improve livelihoods and generate GHG removals through soil and tree carbon sequestration. The 20-year project (2009-2030) set a total emission reduction target of 1,980,088 tCO_2e by 2030 using the Verified Carbon Standard (VCS) carbon offset standard. The project formed the basis for the development of a new carbon methodology, VCS methodology Vm0017 (VCS, 2011b), based on an approach of accounting for carbon sequestration in the soil from the adoption of SALM practices (Wekesa and Jönsson, 2014).

The project was implemented by Vi Agroforestry, in partnership with the World Bank's BioCarbon Fund and UNIQUE forestry and land use, involving 29,497 smallholder farmers participating through 1,730 farmer groups, covering 21,966 ha of land under SALM. SALM practices included:

- Mulching and composting for nutrient management
- Soil and water conservation such as retention ditches
- Crop rotation and intercropping
- Agroforestry
- Tillage and residue management
- Land restoration and rehabilitation through natural regeneration
- Integrated Livestock Management
- Integrated Pest Management
- Sustainable energy (i.e. biogas and efficient stoves)

The KACP is the first soil and agricultural carbon project in Africa through which the carbon revenues result in direct additional income for farmers as a reward for environmental services. The SALM practices sequestered an estimated average of 1.68 tCO_2e/ha/year, resulting in a total of 184,447 tCO_2e sequestered and verified of which 24,788 tCO2e was sold to the BioCarbon Fund for the period of 2010 to 2015. These carbon revenues were shared between farmers (60%) and to cover costs for the administrative work and advisory services (40%). In addition, SALM practices increased maize yields by 90% in all agro-ecological zones in five years and improved the income of households from increased crop yields and the sale of carbon credits.

The KACP project crediting periods runds from July 2009 to June 2030 for a total of 20 years based on a number of monitoring periods. The first three monitoring periods occurred as follows:

1st monitoring period: 1 Jul 2009 to 31 Mar 2012

2nd monitoring period: 1 Apr 2012 to Mar 2015

3rd monitoring period: 1 Apr 2015 to Mar 2017

The monitoring system started by establishing the baseline through Permanent Farm Monitoring (PFM) using the Activity Baseline Monitoring Survey (ABMS). The baseline survey was conducted in 2009 using a sample of 100 farmers from Kisumu and 100 from Kitale based on maize production. The necessary surveys were conducted by a field-officer to ensure high levels of precision in measurements and georeferencing of assessment locations. Progressive PFM surveys were conducted every year from 2010 to 2014 with data collect seasonally and entered annually into the database.

Subsequent monitoring is based on Farmer Group Monitoring (FGM) as a tool to monitor project implementation annually, providing the basis for Vi Agroforestry to identify farmers or farmer group-specific training needs. The system provides a sustainable farm self-learning and planning tool for farmers. Through a FGM sub-system, farmers record their data at individual farm level (self-monitoring and evaluation), building group capacity to monitor implementation by all the group's members. The individual data collected is aggregated at group level involving an intensive recording and verification process involving farmers, contracted farmer groups, project field coordinators and a project M&E officer (Figure 1).

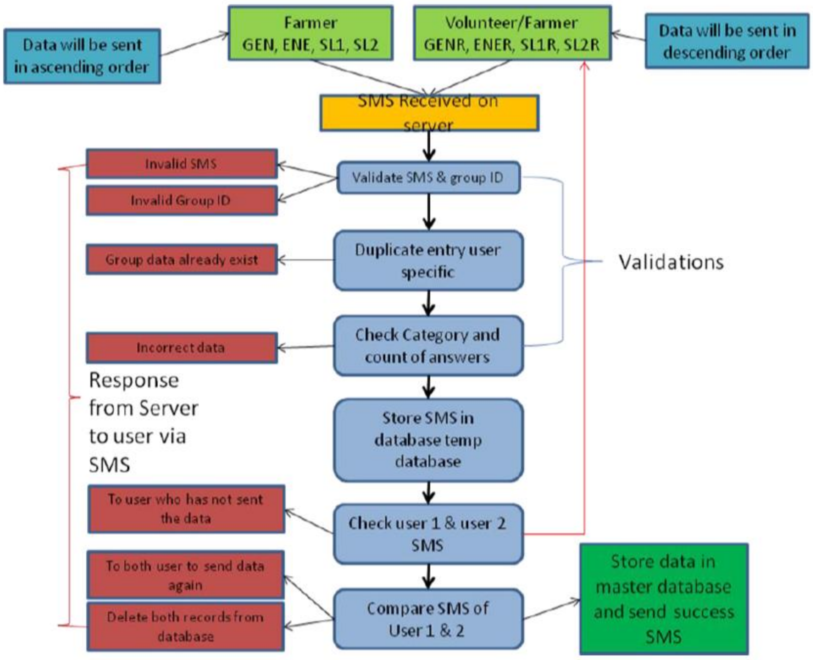

Figure 2. Data transmission and quality control procedures in the KACP.

3.2 Standard development

Soil Carbon Initiative

The Soil Carbon Initiative (SCI) has designed an outcome-based, scientific verifiable agricultural standard with input from over 150 stakeholders to improve soil health and build soil carbon by encouraging a shift to regenerative agricultural practices (Soil Carbon Initiative, 2020). The Version 1.0 methodology was out for comment until 5 May 2020 (The Soil Carbon Initiative, 2019). The standard was designed to help farmers and supply chains to measure improvements in soil health and soil carbon sequestration to address the change in climate. The SCI measures soil health and soil carbon without dictating which management practices should be applied. The points-based standard is applies in three stages through enrolment, demonstration of commitment (annual evidence of plans and activities), and outcomes based testing of performance areas (within a year of enrolment and every three years thereafter. Farmers can earn SCI verification by enrolling agricultural systems that are already at a high level of soil health, or by demonstrating improvements in performance areas during the next testing cycle (every three years). Farmers are required to continue demonstrating improvement until a high level of soil health performance is reached relative to their region.

The standard tests four performance areas of:

1. SOC
2. Soil water dynamics (water infiltration or water holding capacity)
3. Aggregate stability
4. Microbial biomass.

Each performance area is suggested to include in field, in-lab, and proxy tests which are flexible and may incorporate test that farmers are already doing. Acquiring “SCI-Verified” status requires lab tests for performance area as much as possible based on review of results by certified SCI “Verifiers”.

Although the ultimate aim is to drive SOC sequestration in soil, SCI does not require producers to measure changes in SOC stocks to be SCI verified due to the long time (5+ years) required to demonstrate such improvements. Instead, SCI offers significant points for using a validated program to demonstrate improvements in SOC stocks.

3.3 Digital solutions

UNIQE

Nori

3.4 Transfer learning from other sectors

REDD+

4 Actor and processes mapping

Organization	Activities	More information/ Contact
Verra		https://verra.org/
Gold Standard		https://www.goldstandard.org/
Vi-Agroforestry		https://viagroforestry.org/
Danone Livelihood Funds?		
WBG – BioCarbon Fund		
Allianz für Klima und Entwicklung		
Unique		https://digital.unique-landuse.de/
MyClimate		
South Pole		https://www.southpole.com/
Atmosfair		
RecSOIL		
Indigo?		
Nori?		
Dagan?		
Carbon Farming Initiative		
Soil Carbon Initiative		https://www.soilcarboninitiative.org/
Livelihoods Carbon Fund ?		

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