Economics of climate change adaptation for Kenya
A case study of SCC-Vi Agroforestry project in Kisumu

1. Scope/themes of work

SCC-Vi Agroforestry is a rural development, non-governmental organization that facilitates the development of technical advisory services in agroforestry, sustainable agriculture production, farm enterprise development, rural financial services and climate change adaptation and mitigation.

Kisumu project has one field officer in each sub-location who works with 500 households (organized in groups) in a period of about 3 years (intensive phase). The following 3 years is a more extensive phase where each field officer caters for about 1500 households.

The programme facilitates agroforestry development through participatory methods. The development process starts with a community needs assessment (through Participatory Rural Appraisal, PRA) and strategic planning processes. The project field officers develop capacities of farmers to plan, implement sustainable agroforestry and monitor and evaluate results. Empowered farmer groups can also demand services from service providers like SCC-Vi Agroforestry and others through collaboration, networking and linkages. The project enhances sustainability through mobilization of small groups into umbrella organizations such as Community Based Organizations (CBOs) and Area Marketing Enterprise (AMEs). Such organizations can effectively provide capacity building in rural areas. Training of community facilitators enables farmer groups to provide services to their members.

During the Lake Victoria Development Programme (LVDP) of 2006-2008, implemented by SCC-Vi Agroforestry, the programme focus was mainly on agroforestry production, local business development and financial services. However, a challenge of how to improve farmers' adaptation strategies to climate variability was identified when impacts of land degradation, flooding and drought became more pronounced on agricultural production. Farmers with well developed agroforestry systems, soil conservation structures and croplands with high levels of organic matter have stronger resilience to negative effects of climate change. Therefore a stronger focus on these issues was included in the new Lake Victoria Regional Environmental and Sustainable Agricultural Productivity Programme (RESAPP), 2009-2012, which can be seen in the below five components:

- *Land use, environment and climate change:* Unsustainable farming practices by small-scale farmers has been a contributing factor to land degradation, green house gas emissions and farmers vulnerability to climate change in Lake Victoria basin. The programme focus on interventions that mitigate agriculture greenhouse gases and land degradation by promoting sustainable agriculture land use management (SALM) practices (nutrient management, soil and water management and agroforestry). SALM contributes to build resilient farming systems, disaster risk reduction, developing local capacities and tackling drivers of farmers' vulnerability to climate change effects. About 50 % of targeted households (30,000) have access to carbon finance (from BioCarbon Fund) through the practice of SALM.

- *Farm enterprise development (FED):* Most farmers in the region produce for subsistence and have limited market access. The project develops the capacities of farmers to plan for and select cost-effective, market oriented agroforestry enterprises, keep updated records and market through their groups for improved profitability and market-oriented production.
- *Farmer groups and demand driven advisory services:* The programme strengthen groups and farmer organizations to develop service systems that can give continued support of the development of profitable farm enterprises, SALM and financial services.

- *Capacity building and training:* The programme develops systems for effective capacity building and linking of stakeholders. Methodologies used include Farmer Field Schools (FFSs), study circles, on-farm experiments and other local, farmer-based demonstration sites to enhance learning processes.

- *Lobby and advocacy work:* The programme is influencing policies at local, regional, national and global level through networking and linkages, formal partnerships and strengthening of CBOs. The project influences policies on payment of ecosystem services through linking small-scale farmers to carbon finance, demand driven advisory services and knowledge on sustainable development.

2. Background

SCC-Vi Agroforestry's Kisumu project (one of 7 programme areas in the Lake Victoria basin) started with two divisions in 2003 and has been scaled up with time. Agroforestry and farm enterprise development are the main components from which small-scale farmers have witnessed both economic and environmental benefits. The successful implementation and positive external evaluations lead to continuous donor support leading to expansion to seven divisions in 2004 and ten divisions in 2008. In January 2009 the project expanded to 3 new divisions to cover 13 divisions.

The project has about 70 field officers in 13 divisions in 7 districts and 20 supporting management/technical staffs. Four divisions are currently in intensive phase and three divisions in extensive phase while the other six are partly intensive and partly extensive.

The project has a decentralized, field based organization structure with the following levels:

- Field officers each assisting about 500 - 1500 farm families (depending on intensive or extensive phase)
- Zone coordinators and unit staff supporting the field officers administratively and in technical matters.
- Project manager and administrative unit.

1.1 Location

The project area cover lands of medium to high agricultural potential. In the Lake Victoria basin, the programme covers parts of Nyando River, Sondu Miriu River, and Yala river basins. The mean annual rainfall ranges between 600mm–1,600mm in the low lands and high land potential areas respectively with a reliability of 60%. In highland areas a diversity of crops performs better (though soil erosion is high) than in lowlands (areas dominated by droughts and flooding). The annual temperatures are high and ranges between 20ºC to 35ºC with April – June and December - February experiencing lower and highest temperatures respectively. This area is dominated by the Luo community with few Luhyas and Kalenjins.

1.2 Participating population

The project reaches more than 60,000 smallholder farmer households who owns between 0.5 to 5 hectares (target group) of farmland and depend on their farms to derive their livelihood using own labour. The major resources of this group of farmers are labour and land. The farmer groups have limited access to knowledge of modern and appropriate farming technologies. Women and youth constitute the main labour force in agricultural production, and the project encourages them to participate fully in project activities at all levels. School children are involved in agroforestry activities through 4k-clubs ("Kuungana Kufanya Kusaidia Kenya" meaning "Join together to assist Kenya"). With a team of more than 70 field officers the project has progressively reached over 60,000 households during the last 3 years. The main socio-economic activities in this area include; small-scale farming, processing of agricultural products, extraction and processing of natural resources, fishing, small-scale commodity trade and livestock rearing.

1.3 Partners

The project acknowledges the fact that SCC-Vi Agroforestry is not the only actor in the area of agroforestry development and therefore project activities are jointly implemented with technical, policy, administrative and legal support from relevant organizations. In the case of creating a change in the society, the organization technologies have influenced Kenya national policy on privatization of advisory services in agricultural sector. National farmers associations like Kenya National Federation of Agricultural Producers (KENFAP) participate in project activities through informing about agricultural policy,

lobbying and advocating work in the area. SCC-Vi Agroforestry has started collaboration and partnership work with the following institutions:

Research Institutions
World Agroforestry Centre (ICRAF), Kenya agricultural Research Institute (KARI) and Kenya Forestry Research Institute (KEFRI) are stakeholders for sharing research findings in areas of appropriate technologies related to sustainable land use management, agroforestry, agriculture and forestry. The project has been jointly disseminating research findings among smallholder farmers in the area of operation. SCC-Vi Agroforestry has the ability to upscale and disseminate the knowledge through trainings, and on farm trials for testing developed technologies in farmer field schools, demonstration plots and farmer field days.

SCC-Vi Agroforestry has established close links to government ministries such as the ministry of Agriculture, Livestock, Fisheries and Forestry and are collaborating in advisory work in their relevant fields to supplement the government efforts. As a result, farmer capacity building has been enhanced. Planning of advisory work to avoid duplication, field days and advisory support in implementation has been synchronized.

Community development institution
The project has focused on strengthening farmer organizations and Community Based Organisations towards collective ventures. As a result, the SCC-Vi Agroforestry has strong collaborations in areas of production, marketing and other service delivery. For the purpose of marketing, information, policy and other services, the project link groups to apex organizations. In turn, groups transfer knowledge and skills to other community members.

Capacity building agencies
Through networking with universities such as Moi, Maseno, Egerton and Nairobi universities in Kenya, SCC-Vi Agroforestry receives students on attachment. This very often provides the first hands-on practical experience to students. The organization in turn benefits from their services and recommendations given in their reports. The programme also receives research students from within and outside Kenya who carry out their research projects. Their reports add value to the SCC-Vi Agroforestry and assist in understanding the impacts on the target group.

Consultants
SCC-Vi Agroforestry has been assisted by several consulting firms in for example developing the methodologies for the carbon finance project in western Kenya. The consultants are assisting in areas where SCC-Vi Agroforestry lacks expertise from within or from other collaborators.

1.4 Timeframe

The project has gradually expanded its area of coverage since its onset from two divisions from 2003 to the current 13 divisions in 2009. The project implements activities in a period of six years starting with an intensive phase of approximately 3 years and

continues for an additional 3 years extensive phase. The intensive phase involves group formation, training & capacity building in agroforestry, SALM, farm enterprise development, financial services, leadership and democracy development, facilitation of formation of umbrella farmer organizations and capacity. The extensive phase includes more consolidations of knowledge and groups. In the extensive phase, most of community groups are able to develop their own plans, monitor and evaluate their implementation and approach staff and other service providers when they need technical support. After the extensive phase SCC-Vi Agroforestry initiates a community dialogue to phase out completely.

3. Implementation costs

The implementation costs are estimated at sub location level, working with 500 households. The budget of the project is formed on the basis of the number of household a field officer works with. It requires an estimated of 17 USD to reach and implement interventions with one farmer household in terms of administration, capacity building, logistical and provision of tree seeds. From 2006 to 2008 the project has spent a total of 3,100,000 USD. During this time, 62,000 farmer households have been involved in programme activities. This gives a total cost per farm household of 50 USD for 3 years (17 USD/hh/year).

1.1 Capital costs

Investment

SCC-Vi Agroforestry employs field officers who give advisory services to farmer households in the rural areas. The field officer is living in his/her area of operation. Field officers earn a salary ranging from 450USD per month to 570USD (including a medical package and house allowance). There are several other costs which cover staff capacity building, administration and management while part of it is to subsidize service delivery costs to the households.

The specific costs attached to various components are as below:

	Item	Annual cost (USD)	Remarks
1	Staff salary	6000	
2	Capacity building	120	
3	Motorbike	1,000	Purchase cost 4,000 USD
4	Fuel	790	
5	Maintenance	395	
6	Stationary	700	
7	Demonstration equipments	250	Including VS&LA
8	Field offices	100	Divisional level covering 6-10 FO, 700 USD
9	Seeds	240	
	TOTAL	9,595	

1.2 Institutional costs

Training and community empowerment services

SCC-Vi Agroforestry has put in place a system of field officers who sensitize, facilitate and train the community and individual households. SCC-Vi Agroforestry provides capacity building services through trainings, exposure/exchange visits, and participation

in exhibitions, agricultural shows, farmer learning centres and farmer field schools. Farmer field schools and agroforestry training centres have had a great impact on acquisition of appropriate sustainable land use technologies in the community. Farmers have become more aware of environmental issues and effects of climate change. Also covered in up scaling of capacity building are institutions such as churches, schools, urban councils and health centres. SCC-Vi Agroforestry has three Agroforestry Training Centres (ATCs) in the Lake Victoria basin (Kitale in Kenya; Masaka in Uganda and Musoma in Tanzania).

Table 1. Economical overview (USD) and number of enterprises and visitors for 2007 in Kitale Agroforestry Training Centre.

	Kitale
Visitors	2697
Enterprises (with Projected Income Statement)	15
Budget expenditures for 2007 in USD	
Farm inputs	2,500
Salaries	26,000
Casual labour	1,200
Other (water, electricity, seeds, etc)	3,000
TOTAL COST	32,700

Monitoring and evaluation

Monitoring and Evaluation (M&E) is crucial in SCC-Vi Agroforestry to provide feedback to management on progress of implementation, achievement of targets and impact of the programme. M&E is conducted at project, divisional, location and farmer household levels by using participatory monitoring tools. The exercise is conducted mainly through self monitoring by the farmer themselves but also by group trainers, field officers, monitoring and evaluation officers with back stopping from consultants. The cost of monitoring and evaluation stands at 24,000 USD (two staff including administrative cost) or 2-3 % of the budget and has been included in the up scaling costs.

Administration

Administrative costs for the Kisumu project is about 10% of total budget and has been included in the up scaling costs. Administrative cost includes: computers, security, stationeries, electricity, rent of office etc.

4. Scaling up, feasibility and costs

SCC-Vi Agroforestry provides a case which demonstrates richness in approaches and potential to scale up but scaling up of agroforestry and sustainable agriculture land use management (SALM) innovations is far more complex than simply transferring information and planting material; it often entails building institutional capacities in the community for promoting and sustaining the innovation and adoption process. Careful assessments of the relative costs and benefits and the advantages and disadvantages of different strategies can greatly strengthen the

In his budget speech to Parliament on Thursday, Finance minister Amos Kimunya set aside three billion shillings (42,857,142 USD) to finance food imports and an additional two billion shillings to subsidise agricultural inputs.

Farmers' knowledge on sustainable agricultural land use management practices is relatively low. And the level of advisory services to farmers from government extension is still low in local communities in Kenya, therefore financial resources are required for advisory services.

Business Daily, Kenya, 16 June 2008

effectiveness of scale up efforts. Kisumu project has been working with communities in the area since 2003. Some sustainable structures are already in place and advisory services are being delivered through the same. Due to visible impacts of the interventions, quite a number of community services providers have approached the SCC-Vi Agroforestry for partnership and collaboration arrangements across the country. The level of demand for services provided by the organization therefore requires a strategy for scaling up to other parts of the country. Agroforestry technologies are applicable in agro-ecological zones from humid and sub-humid to semi humid and semi arid.

The agricultural sector is critical in jumpstarting the rural economy as it employs 80% of the population and accounts for 65% of Kenya's foreign exchange, according to the Kenya Revenue Authority. Even far from rural areas, successive trends have showed that Kenya's inflation movement is closely tied to agriculture and any distortion on it has a direct consequence on the overall inflation.

Scaling in hot-spot water towers, reaching all households in 6 years

One strategy when scaling up to other parts of the country is to give preference to the five water towers (catchments) of Ken
Aberdare mountains and Mount Ke
over 80 percent of households in
expensive since evaluation of ea
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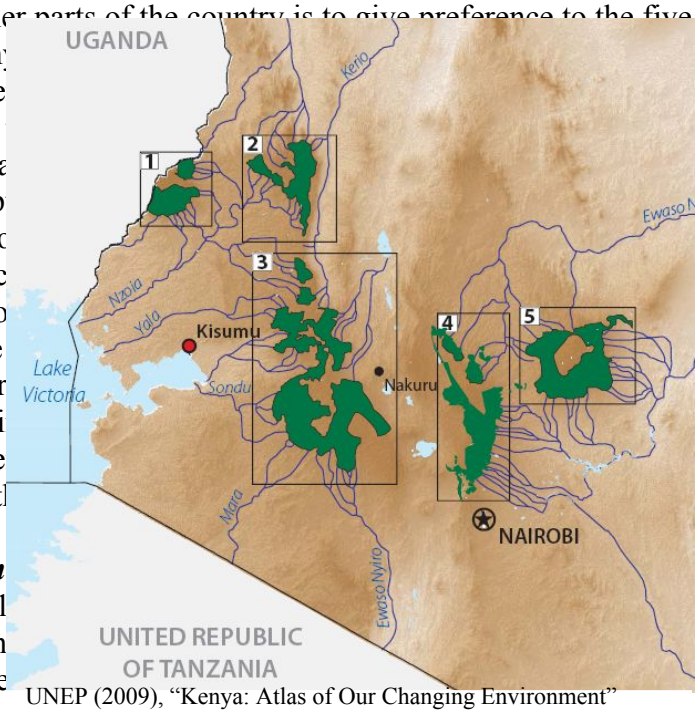

UNEP (2009), "Kenya: Atlas of Our Changing Environment"

Scaling to the entire country, reach

Kenya has 2,427 locations and 6,61
each sub location for 3 years (inten
(extensive phase) in the whole of Ke

Table 2. Costs for up scaling of interventions to the whole of the country (USD)

Year	No of sub-locations intensive (extensive)	No of locations (extensive)	Cost/location+ sub-location (USD)	Total cost (USD)
2010	1,323	0	1,323*9,595	12,694,185
2011	2,646	0	2,646*9,595	25,388,370
2012	3,969	0	3,969*9,595	38,082,555
2013	3,969 (1,323)	486	4,455*9,595	42,745,725
2014	3,966 (2,646)	972	4,938*9,595	47,380,110
2015	2,643 (3,969)	1,458	4,101*9,595	39,349,095
2016	1,320 (3,969)	1,458	2,778*9,595	26,654,910
2017	0 (3,966)	1,457	1,457*9,595	13,979,915

2018	0 (2,643)	972	972*9,595	9,326,340
2019	0 (1,320)	485	485*9,595	4,653,575
TOTAL				**260,254,780**

The total budget needed to reach all sub-locations, 260 million USD divided in 10 years, should be put in relation to the annual budget for Kenya's national climate change response strategy (see box below) of more than 1 billion USD. It should be noted that in 6 years an approximate number of 33% of households are reached in the respective sub-locations, which explains why the cost increases if trying to reach all farming households as in the water tower example above.

Using carbon finance project to scale up agricultural production

SCC-Vi Agroforestry are currently piloting the Western Kenya Smallholder Agriculture Carbon Finance project under BioCarbon Fund mechanism by the World Bank (a carbon project sequestering 490,500 tonnes CO_2eq under voluntary certification standard process targeting 40,000 small scale farmers in 6 divisions to access global carbon payments). The interventions paid for, are based on sustainable agricultural land use management practices that mitigate atmospheric carbon and reduce vulnerability of farmers through enhancing their adaptive and resilience capacities to cope with impacts of climate change. SCC-Vi Agroforestry has been able to upscale the activities that manage land in western Kenya through carbon funds which eventually mitigate greenhouse gases and enable farmers adapt to effects of climate change. The carbon funds target establishment of soil, tree and agriculture biomass carbon pools for direct and indirect climate change mitigation as well as livelihood values (improved agricultural productivity) or benefits reducing communities' vulnerability to climate variability risks such as drought, diseases and floods. This project has synergetic linkage of mitigation and adaptation to climate change as some adaptation-driven agricultural technologies favour mitigation e.g. return of residues to fields to improve water-holding capacity will sequester carbon into the soil as well. Strategies that simultaneously increase adaptive capacity and reduce vulnerability and mitigate climate change are envisaged in SALM project activities. For example increasing soil organic matter content can both improve soil fertility and reduce impact of drought, improving adaptive capacity, making agriculture less vulnerable to climate change, while also sequestering carbon.

> The Environment and Wildlife ministries are working on the finer details of a national climate change response strategy and investment framework programme that will see government spend at least Sh80 billion (1,066,666,666 USD) every year over the next twenty years.
>
> *Business Daily, Kenya, 16 September 2009*

Within a period of 9 years of Emission Reduction Purchase Agreement (ERPA) the project will enable small-scale farmers to receive carbon payments (estimated to 1,962,000 USD) for advisory services as well as an economic carbon revenue distribution scheme for livelihood development.

Table 3. Project cost of Western Kenya Smallholder Agriculture Carbon Finance Project Source: Project Carbon Finance Document

Activity	**Details**	**Year/period**	**Cost (USD)**
Preparation costs	*Feasibility studies, monitoring plan, PDD, etc.)*	2009-2011	50,000

Establishment costs	*Site and soil preparation, seedlings, planting, weeding until planting is completed*	2009-2011	50,000
Operating costs (*from planting onwards and for the duration of the project*)	**Breakdown of approximate costs:** 1. *Salaries for Vi Agroforestry staff, 60 %* *2. Logistics/transport, 15 %* *3. Training/capacity building of staff, 10 %* *4. Seeds and seedlings, 5 %* *5. Other (insurance, office rent, electricity), 10 %* *Inflationary annual increment of cost is 10 %*	2009-2011	
	Phase 1: • The total cost for extension in twenty seven (27) locational extension areas of concentration (paid 6000/yr*27) • One supervisor per 14 projects areas of extension *Total cost phase 1: 1,026,000 USD*	2009 2010 2011	310,000 341,000 375,000
	Phase 2: One extension adviser per division (6 divisions). Paid 300USD*12*6=21,600 USD per year for 6 consecutive years. (including 10% inflationary increment annually). *Total cost phase 2: 162,000 USD*	2012 2013 2014 2015 2016 2017	21,000 23,000 25,000 28,000 31,000 34,000
	Other costs *(explain)* carbon validation, 3 times	2011, 2014, 2017	172,000
	Total project costs US$		1,460,000

The above project investment will be almost equivalent to carbon revenues paid to the farmers in 9 years time, but with other direct and indirect values which makes it even more worthwhile to invest in. The fact that smallholder farmers access carbon payments, become aware of climate change, receives advisory services, transform their agricultural practices, improve wealth status, develop their capacities, improve biodiversity among others are the co-benefits of this project. In the up scaling example below, an assumption of including all agro-ecological zones covered, for carbon finance has been calculated to see the potential of the revenues.

1.1 Costs by agro ecological zones

Agro-ecological zones, market access, and socioeconomic characteristics are dominant factors that influence agroforestry land use intensity. From lowlands to highlands, the agroforestry land use intensity tends to increase as resilience index is higher due to favourable climatic conditions and soil type. For instance dairy farming with exotic livestock with high productivity is more commonly practiced in the highland areas while in lowlands indigenous livestock keeping is dominant. Pasture and fodder management practices will therefore greatly vary in terms of adoption rate and adaptability.

In highland areas crop management costs are lower than in lowlands in terms of water availability from

According to the estimates released on Wednesday the budget for the Ministry of Agriculture has been drastically reduced to Sh11.7 billion (156,000,000 USD), compared to Sh29 billion allocated in 2007, raising questions of how the Government intends to fund interventions meant to spur production.

Daily Nation, Kenya, 12 June 2008

rains, where irrigation is required for same performance and productivity of crops in dry lowlands. For instance establishing costs of a tree is higher in lowland as in uplands. Soils are well drained, less saline and acidic in highland areas than lowlands where black cotton soils exist and during dry spell they crack and cannot support crop production or grass vegetation. Such factors determine extension training, packaging, materials, strategies and logistics a project has to budget for in more detailed up scaling examples.

Adoption rate of agroforestry technologies also vary with agro-ecological zones due to rainfall patterns and soil characteristics. The cost of training farmers until an activity is well established in lowlands is higher than in highland areas and the market price for farm produce in lowlands is higher than in uplands. The lowland area requires more capacity development in agroforestry than uplands since drought and flooding or water logging are severe in this area.

Scaling to AEZ where agroforestry is viable, reaching 33% of households in 6 years

The Kisumu project covers three river basins i.e. Yala, Nyando, and Sondu Miriu which are important catchments for management of Lake Victoria and its ecosystem. The agro-ecological zones (AEZ) covered are sub humid and semi humid. These zones are characterized by different climatic conditions favouring different agricultural activities and cover 9% of Kenya's total land. However, in the example below, agro-ecological zones ranging from humid to semi arid are included as well, since agroforestry interventions are suitable in all those areas.

The budget needed to cover those AEZ is 58.8 million USD annually during the intensive period (3 years) and 21.6 million USD annually during the extensive period (3 years) giving a total of 241 million USD. This can be compared to the annual budget for Ministry of Agriculture of 156 million USD (see box above). The figures below have been calculated through geographical information systems overlay of population data and agro-ecological zones.

Table 4. Annual costs for advisory services in different agro-ecological zones and the potential annual values of carbon revenues

Agro-ecological zone	**Area (hectare)**	**Population**	**Sub locations**	**Cost (USD)**	**Carbon finance revenues (4 USD/ha) on 50% of land area (potential of 1.5 tonne CO_2 /ha)**
Humid	2,529,900	8,669,882	1,791	17,184,645	15,179,400
Sub humid	2,681,600	5,720,462	1,182	11,341,290	16,089,600
Semi humid	2,594,700	7,217,188	1,491	14,306,145	15,568,200
Semi humid to semi arid	3,376,600	4,829,858	998	9,575,810	20,259,600
Semi arid	8,230,200	3,243,250	670	6,428,650	49,381,200
Arid	12,642,600	919,991	190	0	0 (agroforestry not viable)
Very arid	25,755,700	1,399,369	290	0	0 (agroforestry not viable)
TOTAL	**57,811,200**	**32,000,000**	**6,612**	**58,836,540**	**116,478,000**

Note: average population in a sub-location is 4840 persons and total population is from 1999 census.

5. Livelihood benefits

The benefits created by agroforestry and other SALM practices are both economic and environmental. Agroforestry increases farm profitability in several ways: (1) nutrients are well kept and are continuously being recycled in the system, (2) total output per unit area of tree/crop/livestock combinations is greater than any single component alone, (3) water management is an integrated part of the system, (4) crops and livestock protected from wind are more productive, and (5) new products add to the financial diversity and flexibility of the farming enterprises and makes the household less vulnerable. All benefits are explained more in detail below:

1.1 Income generating activities

The focus on farm enterprise development has lead to farmers planning for their enterprises and choosing the most suitable ones that can give them high profits. A diversification of enterprises is also encouraged for reduced vulnerability to extreme weather and market fluctuations. The local groups and organizations play important roles in bulking of produce, value addition and transportation of products to better markets. Financial services have added on to the income generation and a saving and loaning culture has started where productive investments are increasingly common. The ability to take loans has lead to a felt increase in productive investments directly leading to higher incomes.

1.2 Health

The contribution of agroforestry to human health is important since many diseases in the communities are related to poor nutrition such as lack of proteins or vitamins. Most households with agroforestry systems have witnessed increased and diversified food production where fruits, vegetables and animal protein often are the difference between a balanced diets and deficiency diseases. The promotion of medicinal tree species and trainings in their uses has further contributed to improving the health of target communities. Besides the above direct contribution to health the increased income has enabled community members to afford medical services which they could not afford before.

1.3 Food, water, energy security

Food security: Increased diversification of food production and increased productivity together with increased income, fruits, vegetables and honey production assists household in meeting their nutritional needs. In case of failure of one crop they have others to ensure that they are food secure. The improved soil fertility and water management give

higher yields and with drought resistant varieties the vulnerability to climate hazards is reduced.

Water security: Communities are trained on ways of harvesting rain water for domestic, livestock as well as for agricultural use. Some households are thereby able to grow vegetables during dry spells and get good market prices for their products. Through water harvesting and drainage systems on the farms, the farmers are able to mitigate the effects of drought as well as floods. Water collection from roofs enables farmers to have safe drinking water curbing cases of water borne disease outbreak such as cholera.

Energy security: The project provides seeds for fast growing, high calorific tree species which the farmers grow alongside crops enabling them to attain fuel wood security (a main energy source in rural areas) at the same time as the trees fix nitrogen for the crops. Farmers are also trained on how to make wood saving stoves, which ensures economical utilization of the available energy stocks (can reduce firewood demand by 50%). The fact that farmers meet their firewood needs from their own farms relieves the forests from deforestation thus recharging the rivers avoiding incidences of drought. When communities no longer rely on forests for their firewood needs, environmental conservation can be achieved.

Community empowerment: The project empowers the community through capacity building, study tours and provision of starter tree seeds. Farmer groups demand capacity building that can lead to an optimum production. Community resource persons are trained as trainer of trainers so that the knowledge can spread further and stay within the community after project has phased out. Some capacity gaps that existed and have been addressed include; beneficial linkages between trees, crops and animal components in production, market access and market information, records and book keeping, microfinance services and leadership skills among others. Through trainings, smaller farmer groups have merged and now belong to stronger farmer organizations which are able to plan, implement and monitor their activities on their own. Empowerment of pupils and students is also important for sustainability purposes. Farmer groups have been trained on value addition and are able to make herbal drugs and soaps, juices and other products that contribute to their income. Further, the use of agroforestry and sustainable land use management practices (as mentioned above) directly assist households in adapting to climate variability.

Gender issues: Women form about half of the target group that SCC-Vi Agroforestry works with. Training attendance, group leadership and actual work force on farms are emphasized to be shared equally between men and women. The improvement of on farm energy and water sources has relieved women and girls from the laborious task of

collecting firewood and water, giving them time to participate in education, group meetings and trainings.

Education: Through income generating activities farmers' income improve and one of the first priorities for them is education of their children. On farm firewood availability has relieved young girls the burden of long distance walking and time consuming tasks of collecting firewood and it is not so common any more that girls are denied school because they are needed for domestic work. The field officers are working with schools in their areas of operation and train pupils in agroforestry, nutritional gardens and nursery establishment and management.

6. Environmental benefits

All agroforestry practices promoted are aiming at conservation, protection and restoration of degraded environments. Agroforestry is an integrated system where the components depend on each other for their existence i.e. livestock feed on tree leaves and crop residues to produce manure which is used by the crops and the trees to provide farm products for the farmer. In detail, the different environmental benefits are explained below.

1.1 Soil

To make possible improved soil fertility, the first aspect is to reduce soil erosion to a minimum. Agroforestry practices such as tree and contour planting; cover cropping and mulching works to hold soil and reduce the exposure to wind and water. The use of terraces, grass strips, micro catchments and trash lines further enhances drainage and small scale irrigation, which together with conservation agriculture interventions such as reduced tillage and residue management increases soil and water productivity in croplands. The incorporation of plant residues and animal waste improves the soil texture and nutrient availability which consequently improves the water holding capacity, water infiltration, soil aeration and soil structure. All the above mentioned aspects have a positive impact on soil productivity. Agroforestry also ensures an active soil fauna assisting the physical soil properties and decomposition.

Fertility benefits: Many of the tree species that SCC-Vi Agroforestry promotes are nitrogen fixing which improves the soil fertility. The use of organic manure, mulch and compost also play important roles in maintaining or improving soil fertility. These organic amendments should be combined with appropriate rates of inorganic fertilizers to increase yields further if the farmers can afford. Practices of improved fallows, intercropping and crop rotation assist both in maintaining the fertility as well as reducing the pests and diseases in soil.

1.2 Ground/surface water storage, water productivity

Water: With improved soil fertility, the water infiltration and water absorption increase which leads to an improved

water utilization on farm. Drainage channels and water harvesting ponds gives possibilities to off season production and reduced water stress. Roof catchments with water tanks can provide safe water for the household all year around. This minimizes risks related to unsafe water handling, e.g. cholera epidemics. The increased use of organic fertilizers and judicious use of inorganic fertilizer avoids water pollution from agrochemicals. The indirect protection of forests and woodlands in the catchment areas increases or maintains the river flows and improves the water eco-system.

1.3 Ecosystem benefits

Agroforestry indirectly provides a number of ecosystem services and benefits which include biodiversity conservation both in terms of flora and fauna, soil enrichment and stabilization, reduced pressure on natural resources such as woodlands and forests which in turn improves air and water quality. Pollination is enhanced in agroforestry system as trees provides good habitat for pollinators. Tree species that SCC-Vi Agroforestry promotes are either of indigenous origin or local naturalized species. Several species, especially among the indigenous are red-listed and are hard to access as wildlings. The project plays an important role in seed distribution of these species to build up a planted seed stand. Tree planting and the use of sustainable land management practices are increasing the carbon storage and thereby assisting in mitigating the climate change effects.

1.4 Shade and reduced heat stress

The planted trees provide shade to livestock in pasture land and to human beings within the homestead, along roads and in the fields. The use of crop residues for mulching protects the soil from direct sunlight which otherwise could lead to heat stress and high evapotranspiration losses. The growing of trees together with crops and other vegetation results in the creation of a more favourable micro-climate and reduces heat stress of crops.

7. Barriers to existing projects and scaled programmes

Technological barriers: Most agroforestry technologies can be transferred and adopted by farmers. Depending on local climatic conditions and soils, the technologies are adapted and chosen to suit the context. Agro-ecological zones from humid and sub-humid to semi-humid and semi-arid are suitable for agroforestry interventions.

Financial: The investment cost for up scaling programmes like SCC-Vi Agroforestry would be in the range of 59-73 million USD in Kenya per year. Mobilizing funds especially from government and donors often have attached special conditions sometimes not developmental, but political and bureaucratic. But when comparing with the amounts of money that is already in the sectors of agriculture and climate change for Kenya, it should be fully possible to up scale the programme. The carbon finance mechanism is another possible money source for up scaling of the kind of work SCC-Vi Agroforestry is doing.

Institutional (national, sub-national): Empowered farmer groups and networks at community level can provide effective support to their members and be a strong voice of the community. By large scale, farming communities are in informal groups or organizations which lack legal entity but with strengthening of these groups into democratic member based farmer organizations farmer can be empowered and strengthen farmers voice. The focus of intervention is to strengthen the groups or networks to provide demand driven services to their members or target groups so that they can influence and plan their own development while democratic values are being strengthened in the group and the wider society. These groups and networks are according to SCC-Vi Agroforestry the most efficient in reaching out to the community in order to reduce poverty, creating sustainable local resource centres and to ensure ownership of the development process.

Policy (national, sub-national): The national policy do not support subsidy of effective cost farm inputs (e.g. livestock breeding) or making agroforestry integration adopted by farmers. Despite that agriculture accounts for 65% of Kenya's foreign exchange according to the Kenya Revenue Authority, small scale agriculture is not given desired attention especially in the rural areas of Kenya.

Logistical: Administration of integrated agroforestry project has shown difficult in covering extensive area with heterogeneous farming communities. In some places roads do not exist or are in poor conditions especially in rainy seasons.

8. Conclusions

The Kisumu project demonstrates the potential of smallholder farmers to develop, manage environment and mitigate/adapt to climate change through adoption of agroforestry and related sustainable land management technologies. The implementation of such community projects can be done together with groups, farmer organizations and local institutions to bring about community empowerment and climate resilient livelihood development. The project works with small scale, resource poor farmers who only require assistance in terms of local capacity building.

Between the different examples of up-scaling, the last one covering agro-ecological zones from humid to semi arid is the most realistic. However, to some extent, work can be carried out in the two driest AEZ as well, but then the cost will increase quite a lot. 40 USD is believed to be a threshold expenditure to enable a household develop through agroforestry and sustainable land use management technologies in Kenya in any given

agro-ecological zone if infrastructure (roads, markets etc) and policy assistance is in place. The budget in this case was 58.8 million USD annually during the intensive period (3 years) and 21.6 million USD annually during the extensive period (3 years) giving a total of 241 million USD during a six year period. This could easily be covered by the budget for Ministry of Agriculture of 156 million USD annually.

The first example of up scaling to reach all households in the hot-spot water towers during six years is more of a dream scenario as households are participating voluntary. Even in a six year period, it is impossible to be able to attract all households to take part of the interventions. As the approaches used are participatory, it will not assist anyone to force households to join. The use of participatory approaches enables farmers to take initiatives, make decisions and choose among different service providers, based on their own needs and values.