Response and intensification of fruit trees in mitigation of degraded farmlands and adaptation to climate change in farming communities

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Abstract

The response for acceptance of fruit trees in farmland was determined in four selected villages in Morogoro region. Farmers realizing the level of farmland degradation were highly motivated to adopt the innovation for incorporation of adapted fruit tree species in their farms and household premises. In order to fast track fruit tree planting activities for the purpose of reducing the impact of climate change in local farming communities, at total 2,600 of different grafted/budded (1,400) and non grafted seedlings from fruit tree species adapted to these areas were distributed and planted to three villages; Msingisi, Masenge (Gairo) and Mlimani ward (Morogoro). Most of transplanted fruit trees (72.6%) survived. Furthermore, for intensified and sustainable planting of fruit trees in the target and nearby villages, one nursery site was established and 50 farmers were trained in plant propagation and nursery establishment. A total of 1,200 Avocado rootstocks were raised and more than 80% (900 seedlings) of them have been successfully grafted. The use of fruit tree species as a strategic intervention for mitigation and adaptation to climate change in the study areas has been received positively with increasing demand for more fruit trees per village.

Key Words: *Strategic interventions, farmland degradation, fruit trees, climate change, forest and agriculture, Environment, ecological intensification*

1.0 Introduction

Over 75% of Tanzanians depends directly on agriculture and natural land resources for livelihood. Much of the agriculture is still rain-fed hence highly vulnerable to climate change, which influence changes in temperature, precipitation, carbon dioxide (CO2) climate variability and surface water runoff. Agriculture is also responsible for significant reductions in carbon sequestration (storage) through forest clearing for farmland, loss of soil organic matter in cropland, and reduced forest conversion to agriculture. Socio-economic factors play a big part in driving deforestation and forest degradation due to unsustainable agricultural production activities. Economic benefits to convert forests into other land uses are often greater than the incentives to conserve or responsibly manage forests.

Agricultural farming involves in most case clearing of land by removing natural forest trees to allow for crop production. In areas where land is a limited resource such as highlands, these farmlands are likely to be bare and prone to soil erosion, loss of ground water and consequent land degradation. In addition lack of tree cover in the farming community has a direct impact to climate change leading to dry conditions, reduced underground water unfavorable for crop production. Agriculture is therefore both a victim and a culprit of climate change impacts resulting into farmland degradation. Special innovations using improved fruit trees and rehabilitation of degraded farmlands are required to as strategy for mitigation and adaptation of climate change in rural farming communities. It is anticipated that as is the case with Shelterbelts, establishment of parallel rows of fruit trees over the farm landscape, is another widely used option to improve microclimates, more specifically to reduce the velocity of the wind by increasing the surface roughness and control wind erosion and evapotranspiration. Fruit trees are thus

important component of the green ecosystem, providing microclimate modulation, protection through permanent cover; providing opportunities for diversification, of agricultural system, efficient use of soil, water and reducing carbon emission and increasing opportunity for carbon sequestration (Rao et al., 2007). Fruit trees are good sinks of carbon dioxide in the same manner as forest trees leading to significant reduction of carbon dioxide (McPherson et al. 2007).

Most climate change adaptation and mitigation efforts to climate are currently focusing on forest trees planting but very little on the use of fruit trees. However, most communities indicate the presence of such trees both indigenous and exotic species - on farms or around the households providing fruits for rural populations (Sauter, 1968, cited in Bagnoud et al, 1995) and as source of income. In this context farmers are more likely to keep fruit trees in their farm lands for the benefits of its fruits and source of income than keeping agroforestry trees. This program is focused on a strategic intervention for promotion, intensification and diversification of fruit trees species in the farmlands for reducing farmland degradation and adaptation to currently experienced extreme local climate variability. The project is distributing and intensifying the cultivation of locally climate-adapted fruit trees as a means to fulfill climate change adaptation strategies under the REDD initiatives with a parallel purpose to increase food security and income generation. This work was aimed at reducing the impact of climate change and land degradation on rural farm lands by intensification of fruit trees for improved income generation and adaptation to climate change under REDD initiatives. This specific emphasis on: Identification of the most vulnerable farmlands and farming community focus groups for implementation of strategic fruit tree establishment, and distribution of different improved fruit tree seedlings for planting during the rainy seasons, establishment of fruit tree nurseries in highlands and low land areas for adaptation to local growing conditions and train farmers groups on nursery management and establishment of fruit tree orchards.

2.0 Methodology

A field survey was conducted on the basis of farmers group discussion in four villages. The major issues were developed in a checklist of the following key questions in relation to climate change: situational analysis of farmlands and levels of degradation as a result of agriculture, relevant environmental conservation measures taken by the community, knowledge and awareness to climate change impacts and mitigation strategies, local fruit trees species and their role in adaptation and mitigation to climate change, knowledge in fruit tree nursery and orchard establishment and constraints associated with fruit tree production.

Grafted fruit trees for mango, orange and avocado were distributed in three villages and farmers were given a choice to select the type of fruit tree species for planting in their farms. Introductory practical training on establishment (fruit tree planting) and management of grafted fruit trees was conducted during the time of distribution of the grafted seedlings. To ensure sustainable implementation of fruit trees as strategic interventions for mitigation and adaptation of climate change, one nursery for fruit trees was established in Msingisi community forest nursery. Avocado and lemon rootstock seeds were collected from local fruit vendors in Morogoro urban areas while scion woods for avocado were collected from Horticulture Unit SUA. Seeds were prepared and planted in plastic pot containers at Msingisi community nursery near Gairo – Kilosa District. Seedlings were maintained to grow and attain a proper stage for grafting.

This nursery was used as a basis for training on nursery management and production of grafted fruit trees for distribution and sharing among farmers for planting in their farmlands. To ensure future availability of scion mother stocks, a plot of mango and avocado trees plants was established at Msingisi Nursery. To ensure full transfer of the technology as part of the component in strategic intervention, farmers groups selected by the Village Agricultural Extension Officers and local village government leaders to participate in the training. Farmers were trained in seed preparation, sowing rootstock seeds in pots for avocado, grafting of avocado seedlings and management of freshly grafted seedling at nursery level.

3.0 Results

3.1 Baseline and situational analysis

In the four villages that were targeted for initiation of the fruit tree strategic intervention, a total of 90 farmers having an average of 30 farmers per village provided response in several issues in the checklist of questions.

The situational analysis of farmlands and levels of degradation as a result of agriculture was witnessed to be depreciating across the four villages where group discussion was conducted. Most farmers in the target farming communities reported a decrease in soil fertility of their farms incidences of soil erosion and low crop yield associated with unreliable rainfalls and other variables as cues for land degradation (Table 1). Farmers reported that most of the surrounding farmlands were becoming bare land loosing land cover as a result of lack of vegetation especially during dry season.

Table 1: Various indicators of farmland degradation reported by farmers as a result of agricultural activities

Reasons or Cues given for land degradation	Villages				Ranking
	Tchenzema	Masenge	Msingisi	Kilimani	
Declining forest cover					1
Reduced crop yields					4
Low soil fertility					5
Lack/reduced domestic water availability					6
Reduced water natural bodies					2
Drying of streams					3
Competitive pasture reduced grassland					7
Ranking impacted villages	3	2	1	3	

With respect to farmers' knowledge and awareness to climate change impacts and possible mitigation strategies, most farmers in the focus group discussion understand there were issues related to climate change (Table 2). The major incidences of temperature increase/rise during the dry season, reduced and unpredictable rainfalls were flagged out as a regular scenario related to climate change by majority of farmers in the study area (Table 2). Farmers reported that the rains are not enough, they come in a very short time in the season, and the distribution can be very scant some areas receive high intensity and others none. Farmers are not certainly sure when the correct time to plant or not to plant is. This imposed a problem in establishing the correct time to deliver fruit tree seedlings for planting as well. Also farmers reported that there are high incidences of insect pests and diseases in their crops than it was in the past 10 years. The change in

cropping season was also highlighted by farmers in Tchenzema that the cropping seasons have changed and that maize used to take longer time to harvest (8 -9 months) in their local area but currently maize can be harvest in 6 months time. This implies that the level of awareness to climate change is high among the farming community leading to prerequisite for intervention measures.

When asked on relevant environmental conservation measures taken by the community, majority of farmers reported some of the previous projects in their areas that addressed environment conservation through measures for reduction of soil erosion planting of forest trees and terracing but not any farmer mentioned the role of fruit trees in environmental conservation. However, farmers reported little success on the existing environmental conservation due to termination of such interventions and some did not successfully work.

Farmers in villages especially in Tchenzema Kilimani and Masenge realized that agriculture has greatly contributed to land degradation through clearing of natural vegetation (local trees) in expansion of their farm to match the growing family demand for agricultural land (Plate 1 and 2). However, reforestation intervention strategies through planting of forest trees have been advocated by various programs in these areas with little success. It was also realized that little is known on the importance of local fruit trees species in environmental conservation and their role in mitigation and adaptation to climate change. These information provide enough evidence of the possible integration of intensified fruit tree planting innovation as a measure towards addressing issues of farmland degradation adaptation to resilient climate change. Baseline survey also indicated that there is very little knowledge in fruit tree nursery and orchard establishment though farmers reported constraints associated with fruit tree production such as emerging fruit flies problems in mango and avocado more seriously in Mango, completion of land for forage animals during dry season a case more prominent at Msingisi where goats and cattle forages on farm lands after crop harvest. This impose a great challenge for establishment of fruit trees in the village farm land.

3.2 Distribution of fruit tree species in selected villages

Four different fruit tree species (Avocado, Mango, oranges, and Jackfruit) were distributed during the rainy season to the selected villages on the basis of their adaptation to local climatic conditions. The two sites (Masenge and Mlimani are located mostly in the high lands while Msingisi is in the moderate lowland altitude area supporting these fruit trees species depending on the location of the farm. A total of 2,600 of both grafted /budded (1,400) and non grafted seedlings were distributed to farmers willing to incorporate fruit trees into their farms (Table 1).

Table 2: Indicators of climate change flagged by famers' focus groups

Village	Tchenzema	Masenge	Msingisi	Kilimani	Ranking order of importance
Quantity of rainfalls not enough					1
Change in length of dry and rainy season					3
Temperatures are now Hot					2
Rainfall Distribution not certain					6
Frequent incidences of crop failure					6
Changes in cropping calendar or season					4
immergence of new plant disease and insect pests					5
Impact per village	2	2	1	3	

Plate 1 Situational analysis of the farms in one of the villages demonstrating bareness of the land due to agricultural activities

Plate 2: Encroachment of the forest reserve due to expansion of crop farming among community members in Masenge villages threatening forest vegetation cover and increased vulnerability to impacts of climate change.

Table 3. Distribution and planting of grafted fruit trees species by farmers and schools in target villages

Name of village	Number of farmers	Types of Fruit tree species collected by farmers in each village				
		Mango	Avocado	Orange	Jack fruit	Totals plants/ village
MSINGISI	49	260	1,200	20	0	1,480
MASENGE	16 + P/school	0	200	130	0	330
MLIMANI	29	370	250	170	5	795
CHENZEMA	30	0	0	0	0	0
Total	90	630	1650	320	5	2,605

The number of seedlings in Msingisi includes the nursery seedlings and grafted seedlings for scion wood orchard were delivered at the community forest nursery in Msingisi for use in grafting in the coming years. More fruit tree species especially temperate fruits (apple, peach, plums and pears) are still to be acquired and distributed in Masenge and Tchenzema where they more adapted cooler climate

Plate 3: Collection and selection of grafted fruit tree species for on farm planting among farmers in the community

Table 4: Survival and distribution of different fruit trees planted in selected village for integration into farm lands

Location	No. of households with fruit trees	Surviving fruit trees/village				Percent survival
		Orange	Avocado	Mango	Total	
Msingisi (Gairo)	27 (out of 49)	5	900	60	965	65.2
Mlimani (Morogoro)	29	160	175	310	645	81.1
Rubeho - Masenge	16 and Primary School	86	121	0	216	84.8
Total/specie		275	1245	370	1,890	72.6

Plate 4: Introducing fruit tree nurseries in farmers community for strategic integration of fruit trees in their farmlands for adaptation to climate change and conservation of farm landscapes.

Plate 5: Horticulturist demonstrating to farmers on procedures involved in grafting a fruit tree (Avocado) seedling.

Plate 6: Farmers participation, A farmer demonstrating a grafting technique in avocado tree seedling during training session

Plate 7: Farmers participation, a group of farmers in a village actively involved in grafting of avocado tree seedlings in the nursery.

4.0 Discussion

The baseline study have clearly indicated the levels of understand by farmers on issues related to climate change and it has been pointed clearly by the farming community in the study area that agriculture in part has contributed to current scenarios of climate change. Farmers realize land degradation caused by agricultural activities though expansion of farm lands and search for daily need for forest products has led to a decline in natural vegetation and land cover. They have also significantly ranked decline in rainfall intensity and season duration, increase in temperature and changes in production seasons as key indicators related to climate change. Previous strategies advocating forest trees planting were very famous to farmers' community but little integration of forest trees into agricultural lands was effected in the study area. Fruit tree planting in farm lands as an intervention towards mitigation and adaptation to climate change was positively appreciated by the farming community in the sampled villages. As most farmers demonstrated the levels of awareness to issues of climate change and have indicated linkage to forest cover degradation. This fruit trees intervention is one of the strategies that links ecological intensification of agricultural system and farming community (Berkes and Folke, 1998), but more important will be the impact to reducing solar temperature (Beer et al, 1998; Ong et al., 1996). Fruit trees are important component in microclimate modification in the farms as compared to open farmlands without shade trees or fruit trees. Fruit trees once well established will play a key role as windbreaks in the farms thus slowing the wind speed and giving more time for clouds accumulation in a

given area. Cloudy conditions are common in tree densely populated areas than in a bare land leading to microclimate modification through reduced atmospheric and soil temperature (Steffan-Dewenter et al., 2007) Fruit trees need therefore to be promoted in other villages in the country and further impact to the community in term of increased carbon sequestration, change in microclimates, and reduced vulnerability of the community to climate change.

Furthermore, it is indeed expected that properly established fruit trees in the farmland for will greatly contribute as a source for income through sale of fruits to local markets and distant markets for processing and fresh consumption (Dixon et al., 2001). Previous reviews (Mendez et al., 2001; Vogl et al., 2002; Wezel and Bender, 2003) have demonstrated that across Africa, home gardens with a diverse range fruit yielding trees are quite popular and contribute significantly to food security by providing fruits throughout the year. In this concept therefore the current strategic intervention is not only addressing conservation of farmlands but also enhancing household food security and diversity of food types in farming community. The possibilities for integrating farms with traditional fruit trees and non-traditional fruit trees will be accelerated in the presence of good collaboration between village governments, agricultural extension agents and farmers in the target area.

Challenges and Opportunities

This work has presented clear progress in the response of farmers in utilization of fruit trees in mitigating land degradation and adaption to climate change. Beside these short term progress it has been realized that there are challenges and potential lessons that can be learned in the course of the study.

Rainfalls reliability and duration is the principal requirement for initial establishment of fruit tree seedlings and therefore timely planting and clear knowledge of weather information is essential. This therefore requires a timely delivery of seedlings in the rainfall season. In most part of the target areas specifically in Msingisi, the pressure for pasture resource required for animals like goats was the main challenge that endangers initial establishment and growth of fruit trees. Water availability is a limitation in some areas for nursery establishment in that a need for establishment and building water reservoirs for the site that need nursery for propagation of fruit trees. Acclimatization of some fruit tree species especially avocado proved difficulties where drought conditions prevailed.

The trend for demand of fruit tree seedlings in this strategic intervention requires therefore and attention to increase in number of participating farmers to provide good coverage of the area and thus turning into greener landscape. In highlands areas with cooler temperatures, more temperate species apple, pears, peaches and plums will be added to the farming systems. The use of fruit trees species is a sound strategy for mitigation and adaptation of climate changes should be extended to other villages in the country that are be threatened or vulnerable to impacts of climate change. The fruit tree propagation techniques initiated to groups of farmers requires out-scaling in order to bring large scale benefits to different communities in the farming system. Adoption of propagation methods in fruit trees will greatly contribute to as possible sources of income generation through sale of fruit tree seedlings. However, further detailed analysis of the changes in household income and health improvement as a result of sale of fruits will be required.

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