Adapting to green agricultural economy: experiences from small-scale farmers in Murang’a County in Kenya

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ABSTRACT

Kenya is prone to frequent droughts that are occasionally followed by flash floods. With agriculture being the mainstay of the economy, droughts and floods results in frequent loss of livelihoods and chronic food insecurity forcing farmers to adopt various survival strategies. This study examined the uptake of green agricultural economy strategies in Murang’a County in Kenya. The objectives of the study were (i) to establish the form of green agricultural economy adopted (ii) to examine the socioeconomic and environmental benefits of the adopted strategies. A total of 48 farmers from eight sub-counties of Murang’a and two key informants were interviewed. The study established that all farmers practiced at least one form of green agriculture ranging from conservation agriculture namely mulching, use of zai pits, and minimum tillage to practices that enhanced food production such as use of organic farm manure and value addition. Also some of the practices adopted such as growing of fruit trees and other types of trees mitigated climate change. From the green agricultural practices, farmers achieved socioeconomic benefits which included self-food reliance, enhanced income generation through sale of fruits and fodder and conserved the environment by reducing landslides and increasing the amount of CO₂ sequestered. From the findings the study concluded that the practice of green economy in the County was affordable and enhanced household income and food security in a sustainable way. The study therefore recommends enhancement of the existing practices and development of new strategies that are suitable and affordable to the small-scale farmers. Capacity building towards this end will enhance the adaptation rate.

Keywords: climate variability, adaptation, green agricultural economy, Murang’a County

INTRODUCTION

Agriculture is key to economic development in Africa accounting for 30 – 40% of the Africa’s total Gross Domestic Product (GDP) compared to 3.2% of the global GDP (Wani, et al., 2009). In Africa, agriculture supports the livelihoods of over 80% and provides employment to over 60% of her population. The potential of reducing poverty in Africa through agriculture is twice compared to all other sectors of the economy. Unfortunately, about 66% of the continent has arid and semi-arid climates making the continent prone to vagaries of climate change threatening economic development of the continent. Between 1970 and 2006, for example, droughts accounted for 20% of all the natural disasters in Africa disrupting the livelihood sources of over 80% of the population (Ayoti, 2008). Like in other counties of Africa, agriculture remains the backbone of the economy of Kenya contributing to about 25% of the Gross Domestic Product (GDP), supporting over 80% of the population.
and employing about 70% of the population directly or indirectly. As such agriculture and food security has been one of the key areas that have received a lot of attention with regard to climate change in Kenya by National Climate Change Response Strategy (Government of Kenya (GOK), 2010). With the current population of about 43 million, two in every three rural small-scale farmers observe that the land they own is not sufficient to meet the family needs (Population Reference Bureau, 2011). Coupled with the effects of climate change where frequent drought and flash flood episodes have been experienced, poverty levels have been escalating particularly in the arid and semi-arid areas. The search for alternative source of livelihood has triggered opening of new land for farming in previous vegetated and forested areas. Thus agriculture plays contradicting role where on one hand it propels economic development while on the other hand, it leads to destruction of environment through the emission of greenhouse gases. However, moving towards green economy has been identified as the best strategy for sustainable livelihood sources (Cameron and Stuart, 2012). One way of improving livelihoods is through green agricultural economy. That is, engaging in activities that reduce the environmental impact of agriculture to levels that are sustainable, preserve or restore the quality of the environment while at the same time meet the needs of a society. It is against this background that this study focused on the green agricultural practices adopted by small-scale farmers in Murang’a County in Kenya and the resultant socioeconomic and environmental benefits.

**Objectives**

The main objectives of the study were to:

1. Establish the various forms of green agricultural economy.
2. Analyze the socio-economic and environmental benefits of green agricultural economy in Murang’a County.

**Study Area and Methodology**

Murang’a County is located in eastern slopes of the Aberdare Ranges in the central parts of Kenya with an average altitude of about 1,255m above sea level and covering an area of 2,558km². The County borders Nyandarua County to the West, Embu to the East, Nyeri to the North, Kiambu to the South, Machakos to the Southeast and Kirinyaga to the Northeast (Figure 1). It has a total population of about 942,581 in about 255,696 households translating into a 524 persons/km². County possess a transition climate which varies from semi-arid in southeastern part to humid in the northern part. Annual rainfall ranges between 1200 and 1600mm which occurs in two seasons, the short rains (between October and December) and the long rains (between March and May). The County has an agro-based economy with over 80% of the households depending on agriculture and the associated activities. With high inter annual and inter seasonal variations in climate, incidents of food insecurity are recurrent particularly in the drier parts of Makuyu, Kambilit, Maragwa ridge, Muthithi, Gaichanjiru, Kakuzi, Ithanga and Githuuri Locations. Most parts of the County have steep slopes hence landslides are experienced in some of the parts during the rainy season. As a result, the County poverty level stands at 28.9%.

Data for the study was obtained in Murang’a County in central parts of Kenya through structured and in-depth
interviews. A total of 50 respondents (48 farmer respondents and 2 Key Informants) were interviewed. From each of the eight sub-counties, six farmer respondents were randomly sampled. The Key Informants were County Executive Commissioner (Minister) for agriculture and County ecosystem conservator. Content analysis was used in analyzing qualitative data while simple summary statistics were used to analyze quantitative data.

RESULTS AND DISCUSSION

The semi-arid to humid climates of Murang’a County result in a mix of extreme climatic events with frequent droughts occurring in the semi-arid regions and occasional floods and landslides in humid areas. Both extremes disrupt the economy of the County particularly through their effects on agriculture. To cope with the harsh climatic conditions, farmers adopted various green agricultural practices. These are the agricultural activities that sought to increase agricultural production while at the same time reducing the negative or elimination of negative externalities caused by the conventional agriculture and preserving the environment.

Green agricultural practices

Zai pits

The zai or planting pits were not widely spread although some few farmers had adopted their use. Typically, zai pits are holes with a diameter of 20-40 cm and a depth of 10-20 cm (dimensions vary according to the type of soil) where seeds are planted. The pit is usually, filled with organic matter. It captures rain and surface runoff, protects seeds and organic matter from being eroded and concentrates nutrients together (Essama, 2005). Due to prolonged period of water retention, more water infiltrates increasing the duration of wet conditions in the pits. In Murang’a County, the pits were commonly used by all farmers in planting of bananas (Figure 2). Whereas the main reason was to preserve moisture for the seedling, the pits were also used to control the gushing runoff through their farmland. In very few instances, some farmers grew arrow roots in zai pits. Roof rainwater was used for growing of arrow roots.

Minimum and zero tillage

Minimum and zero tillage systems involves very little or no soil disturbance during the preparation for suitable seedbed. That is, the soil is worked very little or not at all before sowing is done and thus the soil is not inverted. The aim is to conserve soil moisture, reduce labour costs and minimize erosion. Studies have shown that minimum tillage reduces labour requirements from small-scale farmers by more than 50% for crop production (FAO, 2015). The practice was not very popular in the County but it was practiced by isolated farmers in Kaharati and Makuyu areas. Poor uptake of the practice was due to lack of information and knowledge about it. In most cases minimum or no tillage resulted from late preparation of land for planting making farmers associate it with...
laziness. The uptake of this practice by the few farmers was emanated from farmers training. In Kaharati area for instance, one farmer, who had undergone a capacity building training on conservation agriculture championed the practice in the area by training members in one of the self-help group.

**Mulching**

Mulching involves covering the ground with organic matter such as leaves, straw, or peat to reduce evaporation, maintain even soil temperature, prevent erosion, control weeds, and enrich soil with nutrients. It is very simple and cheap to practice. Mulching was practiced in Makuyu area (Figure 3), one of the driest areas in the County. In this area, farmers were trained on soil water conservation through mulching by Anglican Development Services (ADS) through "Farming God's Way" initiative. However, only few farmers had adopted this strategy.

**Intercropping**

Intercropping was the most common form of rain-fed crop farming in the County. Except in tea and coffee plantations, intercropping was practiced in all other cultivated land. Farmers rated intercropping as the most affordable and reliable form of insurance against food insecurity. Except for maize, beans and bananas which were intercropped in all farms, other intercrops varied slightly from one area to the other depending on the climatic conditions. In the wetter areas, farmers mostly intercropped maize, beans, bananas and potatoes, while in the drier areas intercrops of maize, beans, bananas, lablab bean, cassava, sweet potatoes and cow peas were common. Most of the intercrops in the dry areas involved growing of drought resistant crops (Figure 4).

Bananas were grown in the entire County but more...
predominant in wetter areas.

**Growing of cover crops**

Sweet potato vines and leguminous crops were the most common types of cover crops. In promoting the growing of cover crops, the County government had provided farmers with sweet potato vines which acted not only as cover crops but also as drought tolerant crops. A total of 6,000 farmers, particularly in the drier parts of County had been provided with the Orange Fresh sweet potato vines. Other drought tolerant crops provided to farmers were cow peas, and lablab bean, green grams and Katumani beans. This was geared towards cautioning farmers against food insecurity, improving soil fertility being leguminous crops while at the same time acting as cover crops.

Nappier grass was grown by almost all farmers in the County. In addition to farmers individual efforts, the County government had provided 13,000 farmers with top quality high protein Kakamega I and II varieties of nappier grass seedlings. Each farmer that was provided with the nappier grass was to redistribute to three more farmers until all farmers were covered. The purpose of providing farmers with nappier grass was twofold: first to provide adequate fodder for dairy cows and secondly, nappier grass was meant to control soil erosion. High protein variety of desmodium was also given to farmers. In addition to being a fodder crop, desmodium acted as a cover crop reducing the rate of soil erosion. Farmers who didn’t have livestock sold their nappier grass to livestock farmers, particularly from Kiambu County.

**Use of organic manure**

The use of organic manure was largely embraced by farmers in the County (Figure 5). Although artificial fertilizers were also used, the rate at which animal and compost manure was used was comparatively higher. This was attributed to two main reasons, (i) organic manure was readily available at no cost and (ii) it improves soil fertility in an environmental friendly way. It was a common practice especially where farmers practiced mixed farming. The remnants of animal feeds were strewn in animal sheds where they were trampled on by livestock for a period of time forming organic manure. In some instances, farmers made compost manure from the mixture of dry crop matter and animal dung. Farmers indicated that where organic manure was used, very little artificial fertilizers were used.

**Agroforestry**

Farmers in the County had embraced tree planting leading to an estimated forest cover of about 15% in 2015. Every year, farmers planted between 6 and 7 million seedlings most of which were exotic trees. According to the 2008 development plan, out of the 300,000 farmers in Murang’a County, 110,000 (36.7%) were categorized as forestry farmers since their farms had more than 50% tree cover. All other farmers had trees in their farmlands but at lower percentages. Although there were various types of trees grown, four types predominated. These included Silk Oak (*Grevillea Robusta*) (Figure 6), Blue gum (*Eucalyptus grandis* and *E. salgna*), Mango (*Mangifera indica*) and Avocado (*persea Americana*) trees. Silk oak was the most planted type of tree in the County mainly to provide shade for tea and coffee crops and to mark farm boundaries. In addition, silk oak is now used as a source of timber after the ban on forest logging by the Kenya government. Pockets of blue gum trees (*Eucalyptus grandis* and *E. salgna*) were also evident in the County. To a large
extent, the blue gum trees were introduced as a substitute when coffee market deteriorated and prices went down. These trees were largely grown as woodlots providing fuelwood used in tea factories in and outside the County.

Both the Silk oak and Blue gum trees are today grown largely for economic purposes. They are therefore frequently harvested leading to a slow rate of increase in forest cover of less than 1% per year. The rate of deforestation is almost equal to rate of tree planting. This is occasioned by high demand for fuelwood in tea factories, source of energy in 95% of the households and the sale of timber. On average, these trees are harvested at the age of 10-11 years. About 25 trucks (equivalent of 7 tons) of timber and fuelwood are transported from the County every day. The bulk of the timber is transported to Thika Town while fuelwood is sold to the neighbouring tea factories. In addition, several other tons of timber and fuelwood, which do not require government permit to be transported, get extracted from the County every day.

Growing of Fruit Trees

Mango (M. indica) and avocado (p. Americana) were the most common fruit trees grown in the County. Whereas avocado trees were spread across the entire County and were largely grown for domestic consumption, mangos were largely found in the drier parts and to a large extent for commercial purposes. Kandara and Gatanga areas had the highest concentration of avocado trees while Makuyu area had the highest concentration of mango trees. Fruit trees were rarely cut growing to very huge sizes (Figure 7 above) and were thus considered the best with regard to increasing forest cover. Other fruit trees that were grown but on a very small-scale included Macadamia tree which was purely planted for commercial purposes. Except for mangoes and macadamia fruit trees that all farmers deliberately planted, over 70% of farmers had avocado fruit trees growing “wildly” in their farms, i.e. they grew without being planted by farmers. Nearly all farms had at least 5 avocado trees. The types of avocado trees grown were low yielding varieties largely for family
consumption but the surplus production was sold to middlemen at very low prices. As a result, some farmers would cut the trees to provide fuelwood.

Between 2006 and 2013, the Kenya Forest Service (KFS) department, in the County through an agroforestry funded project provided farmers with grafted Hass avocado seedlings leading to some deliberate efforts by farmers in growing of avocado trees. The focus of the County government was to shift from growing of fruits for domestic consumption to commercial purpose. As a result, the County government provided 130,000 high yielding Hass avocado seedlings to farmers. In the areas where mangoes do well, 6000 farmers were each provided with 5 high yielding varieties of mango trees. A total of 30,000 trees had been distributed in different agro-ecological zones by the time of the survey.

Value addition on agricultural produce

Value addition in agriculture involves the process of changing agricultural products from its original state to a more valuable state preferred in the market. The most common form of value addition was ripening of fruits particularly avocados, mangoes and bananas. Where ripening was done, the price of fruits rose by over 100% compared to the cost of unripe fruits. For instance before ripening, a bunch of bananas (30-40 kilograms) had a market value of Kenya Shillings (KShs) 100 but after ripening, the same bunch was sold at an average of KShs 400. The price of ripe avocado fruits rose by about 233%. The retail price for unripe avocado fruits during the survey was KShs 1.50 while a ripe fruits retailed at KShs 5. Value addition, through ripening, was largely practiced in Saba Saba and Kaharati areas. In Saba Saba, farmers had a common ripening place in Marikiti market at Saba Saba shopping centre while in Kaharati, ripening was done at the farm level. Unfortunately, very few farmers added value through this process due to the perishable nature of the ripened fruits. The need for immediate disposal (sale) of the ripe fruits deterred most farmers because of the unpredictable nature of the market. As a result, farmers preferred selling unripe fruits to middlemen at lower prices. Just like in other parts of the country, the County is dominated by primary production with very little efforts to improve the quality of agricultural produce.

Benefits of green agricultural economy

Social benefits

It was evident from the farmers’ assertions that intercropping enhanced food security at household level. Different crops were affected by drought and high intensity rainfall differently. Crops that withstood harsh climatic conditions acted as insurance against food insecurity. Sweet potatoes, lablab bean, pigeon peas and cassava were the major crops that provided food during dry spells. In addition, avocado, mangoes and bananas were sometimes eaten substituting the normal meals. Fruits were given out as gifts to visitors and offerings in church. That is, in social setups fruits were given as appreciation to friends and relative who visited and probably came from regions where fruits were never grown. Some fruits, particularly bananas, were given as appreciation to invited guests in social functions such as fundraising. In cultural ceremonies such as weddings some types of fruits were symbolically used. In church, some farmers gave fruits as offerings.

Economic benefits

Farmers sold fruits either to the middlemen or directly to the consumers but with the largest percentage being sold to middlemen. On average, farmers in Makuyu area earned between KShs 10,000 and 15,000 from the sales of mangoes every year. Avocado fruits retailed at KShs 1.50 each while bananas retailed at about KShs 100 for most farmers. Farmers earned between KShs 1,500 and KShs 2,000 from avocado sales and between KShs 3,000 and KShs 4,000 from the sale of bananas every year. In addition to sale of fruits, farmers without livestock generated income from the sale of high quality high protein Kakamega I and II varieties of nappier grass. The economic benefits of using organic farm manure were twofold. First, improved soil fertility led to increase in crop production. Surplus produce was sold at local markets. Secondly, it saved on farm input costs. By the time of the survey, the price of fertilizer was KShs 80/= per kilogram and was deemed very high by the farmers. Although farmers did not fully substitute the use of chemical fertilizers with farm organic manure, about 90% of small-scale farmers relied on farm organic manure for it was free to farmers with livestock and was also available at any time of the year.

Environmental benefits

Environmental benefits of green agricultural practices ranged from simple benefits such as soil moisture conservation to more complicated mitigation of climate change through the process of carbon sequestration. Reduction of landslides in the humid steep areas was one of the most notable environmental benefits. The intermeshing of tree roots holds soil particles together increasing slope stability preventing potential landslides (Figure 8 below). In 2015 in Mathioya area, for instance, one of the farmland with three sections, one with woodlots, another with five rows of trees and the other one without trees, experienced mudslides in the section.
The heavily forested County sequestered thousands of tons of carbon dioxide (CO$_2$) every year. According to GreenFacts (2015) carbon sequestration refers to the removal carbon from the atmosphere and storage of it in carbon sinks such as oceans, forests or soils through physical or biological processes. Although little efforts had been made to establish the amount of CO$_2$ sequestered in the County, the study estimated approximately 440,956.19 tons (Table 1) were sequestered every year based on the following information.

Table 1. Estimated annual carbon dioxide sequestered in Murang’a County

<table>
<thead>
<tr>
<th>A. Species characteristics</th>
<th>B. Tree Type</th>
<th>C. Number of Surviving Trees</th>
<th>D. Sequestration Rate (lbs/tree)</th>
<th>E. Annual Carbon Sequestered C*D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grevillea (Silk oak) H</td>
<td>10</td>
<td>5,113,920</td>
<td>19.3</td>
<td>98,698,656</td>
</tr>
<tr>
<td>Eucalyptus (Blue gum) H</td>
<td>8</td>
<td>3,068,352</td>
<td>15.5</td>
<td>47,559,456</td>
</tr>
<tr>
<td>Persea Americana H (Avocado)</td>
<td>15</td>
<td>2,556,960</td>
<td>29.7</td>
<td>75,941,712</td>
</tr>
<tr>
<td>Mangifera indica H (mango)</td>
<td>10</td>
<td>1,534,176</td>
<td>11.8</td>
<td>18,103,276.8</td>
</tr>
<tr>
<td>Total pounds of carbon sequestered</td>
<td></td>
<td>240,303,101</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total pounds of equivalent CO$_2$ sequestered X 3.67</td>
<td></td>
<td>881,912,379.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent CO$_2$ sequestered in tons /2000</td>
<td></td>
<td>440,956.19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key: H = Hard, C = Coniferous, S = Slow, M = Medium, F= Fast

CONCLUSION AND RECOMMENDATIONS

Murang’a County experiences climatic extremes leading to severe droughts and occasional floods and landslides. Episodes of food insecurity are experienced in the drier areas while in landslide make regular news in humid and
steep areas during high intensity rainfall. To cushion themselves against the challenges occasioned by high variations in rainfall amount, intensity, patterns and distribution, farmers adopted various green agricultural economy strategies that reduced environmental impact of agriculture while at the same time met the needs of the society. Through intercropping, farmers were insured against total crop failure while through tree planting, farmers generated income while at the same time mitigated climate change. Through green agricultural economy, a myriad of socioeconomic and environmental benefits which included among others reduction in the rate of landslides were achieved. However, despite the significance, the adoption of these strategies remained relative low. The study therefore recommends enhancement of the existing practices and development of new strategies that are suitable and affordable to the small-scale farmers. Capacity building towards this end will enhance the adaptation rate.

ACKNOWLEDGEMENT

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REFERENCE