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Climate Smart Agriculture in Kenya: Challenges and Opportunities

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Summary

Kenya heavily relies on agriculture towards meeting the demands of its population, which in 2011, was 41,609,728 compared to 2009-population census figure of 38,610,097. Agriculture sector contributes about 28.5% of the GDP arising from the 9.7% of total land area that is considered arable. Mixed farming is the most common system applied by farmers due to the small portions of land available for cultivation in regions with reliable rainfall. Recurrent droughts and erratic floods are common with shifts in weather patterns being experienced. Farming practices by many small-scale farmers are unsustainable hence the quest for capacity building on Climate Smart Agriculture (CSA) applications. According to the National Climate Change Response Strategy (NCCRS), poor livestock management practices have caused the sector to contribute to one-third of total national greenhouse gas emissions(GHG). Human power is the most common form of farm power with fossil powered machines in isolated cases. Reforms have been witnessed in the policy framework seeking to improve the sector. This brief will therefore explore the milestones Kenya has undertaken or should undertake towards ensuring agricultural productivity in the midst of climate variability and change.

Introduction

Kenya's economy is highly dependent on climate sensitive sectors including agriculture, tourism, and energy. Agriculture accounts for 65 per cent of the country's total exports and provides more than 70 per cent of informal employment in the rural areas. Approximately 31,629,968 people equivalent to 76% of the total population stay in rural settings responsible for agricultural production (RoK, 2010a). Majority of farmers practice small-scale agriculture that depends on rainfall availability. As such, climate change potentially poses one of the greatest challenges for Kenya to realize its vision of becoming a prosperous country through agricultural production. An estimate of 3.8 million Kenyans required food aid in 2009/2010 increasing from 650,000 in 2007. In order to meet her food demands, investments in climate smart agriculture for significant transformation is necessary. It is from these recent cases of food crisis that the government decided to firm up its strategies towards making Kenya a food secure country.

Given the small share of land available for farming, a number of approaches have to be integrated including, applying appropriate methods of farming, technology application e.g. efficient irrigation methods, and increased access to modern energy among others. Kenya's vision 2030 flagship projects under agriculture are critical due to the overarching nature of the sector that is essential for ensuring stability across the four pillars recognized under the blueprint. It is expected that this will be accomplished through an innovative, commercially oriented, and modern agriculture sector. The vision anticipates realizing these targets through better yields in key crops, increased smallholder specialization in the cash crop sector (2-3 crops per plot), utilization of a million hectares of currently uncultivated land, improved breeding and new cultivation of up to 1.2 million hectares of newly opened lands(RoK, 2007).

In endeavor to reform the sector, several policies are being reviewed and strategies formulated to inform priorities of agriculture within successive medium term plans that are developed after every five years. Among key documents here include Agricultural Sector Development Strategy 2010–2020, National Food and Nutrition Security Policy 2011, National Climate Change Response Strategy 2010, the National Climate Change Action Plan (2013-2017), National livestock policy 2008, National Horticulture Policy, National Agricultural Sector Extension Policy (NASEP) 2012, The Crops Bill 2012, the Agriculture, Livestock, Fisheries and Food Security Bill 2012, National Agricultural Research System Policy, 2012 and the Fisheries bill, 2012. Others are the draft Water Policy, 2012, Draft Forest policy,

2012, Agricultural Insurance Policy and the Draft Climate Change Bill, 2012. It is believed that once the drafts are harmonized and legislated, practices which encourage agriculture that sustainably increases productivity, resilience, reduces GHG emissions, and enhances achievement of national food security and development goals-Climate Smart Agriculture(CSA) -will be promoted across all levels of agri-food chain.

1. Smallholder Climate Smart Agriculture Practices in Kenya

Agricultural production takes the lion's share in GHGs in Kenya. In 2010, the sector was responsible for one-third ($MtCO_2e$) of Kenya's total emissions. Individual sectors such as livestock contributes the largest portion. Given the potential climate smart agriculture practices have, serious sensitization and investment are necessary. Some of these practices are already being implemented by some smallholder farmers in Western and Central Kenya. These cut across technological applications and behavioral shifts seeking minimal use of machinery especially those that contribute to greenhouse gas emissions through integrated agri-food energy systems and appropriate livestock and crop management systems. In 2011, African Ministerial Conference on Climate-Smart Agriculture in Johannesburg pledged for investment in research, technology, and information dissemination to facilitate the adaptation and application of climate-smart agriculture among African countries. These included a plea to development partners to leverage financing for CSA. The following is a detailed discussion of some climate smart agriculture practices in the context of Kenya.

A. Conservation Agriculture (CA)

Conservation agriculture refers to farming practices that depict minimal mechanical soil disturbance, maintenance of a mulch of carbon-rich organic matter covering and feeding the soil rotations or sequences and associations of crops including trees, which could include nitrogen-fixing legumes. It provides a myriad of climate change adaptation and mitigation solutions by offering sustainable production intensification and enhanced productivity of resource use. According to (FAO, 2011), conservation agriculture reduces water needs of crops by 30%, lowers energy needs by 70%, and sequesters significant amounts of carbon. It also helps farmers adapt to climate change as the perennial cover of organic matter protects the soil from high temperatures, desiccation, and erosion. The National Climate Change Response Strategy developed in 2010 aimed at guiding climate adaptation and mitigation activities. The strategy clearly highlights improvement of farmers' livelihoods through application of integrated adaptation systems that spell out conservation agriculture to be of ultimate

significance in achievement of food security (RoK, 2010b).

The principal of minimum tillage curtails occurrence of net losses of carbon dioxide by microbial respiration and oxidation of soil organic matter, building soil structure and aeration spaces through soil biota and roots. Farm clearance using alternative means to burning reduces emissions while the cleared residues are used as mulch or mixed with other residues for compost manure. Mulching provides a substrate for soil-inhabiting microorganisms which helps to improve and maintain water and nutrients in the soil. Rotational and diversified agriculture can be effectively used to minimize spread of pests. Furthermore, this assists in nutrient regeneration as different crops have specific nutrient elements with the ability of fixing some elements lacking in the soil such as nitrogen in the case of legumes. Thus, farmers who carry out crop rotation between cereals and legumes enhance sufficient nitrogen availability in the soil for cereal growth without necessary applying synthetic fertilizers. Some of these methods are being employed by selected farmers especially mulching when dry spell approaches. However, this is common among olericulture farmers.

B. Reducing emissions from livestock sector

Livestock rearing in Kenya is carried out by both small and large scale farmers. Most small-scale farmers are located in areas with high to moderate rainfall. Ranches can be found in selected regions mainly in the Rift valley region where large tracts of land exist as well as isolated highlands. In the dryer areas, pastoralism is the main economic activity characterized by large stocks grazed communally. This overstocking coupled by movement from place to place leads to unsustainable land use practices. Of importance to climate are the high levels of emissions as a result of overstocking and deforestation. Besides, livestock sector is responsible for methane and nitrous oxide emissions from ruminant digestion in addition to poor manure management (FAO, 2010a). Treatment of manure is necessary for reducing emissions and raising productivity. For example, the anaerobic digestion of manure stored as a liquid or slurry can lower methane emissions and produce useful energy, while composting solid manures can lower emissions and produce useful organic material for soil structure improvement. There is a need for farmers to substitute manure for inorganic fertilizers that have potential of lowering emissions simultaneously enhancing soil conditions. Emphasis on rotational grazing and use of fodder banks and strategic reservations has the capability of minimizing land degradation through overgrazing which exposes soil. Improved breeding enhances quality of offspring that can better withstand a changing climate. Livestock health should be supplemented through high standard mineral forages missing in fibrous forages. As part of

interventions, the government through ministries of agriculture, livestock and fisheries and devolution and planning are encouraging pastoralists to destock and instead consider zero grazing or rear a manageable size of stock.

C. Integrated soil fertility and water management

Integrated soil fertility management (ISFM) is necessary for realizing maximum output per acreage in the light of striving to achieve food security. ISFM refers to a set of soil fertility management practices that includes the use of fertilizer, organic inputs, and improved germplasm, combined with the knowledge of how to adapt these practices to local conditions. Different crops have unique nutrient requirements. Thus, it is important to emphasize on planting crops suitable to local soil conditions. In the event that the necessary nutrients are missing, appropriate measures should be taken without compromising climate impacts. Management of soil fertility and organic matter together with improvement of the efficiency of nutrient inputs, increases production while minimizing application of inorganic fertilizers. Effective water harvesting and storage is very useful in meeting crop soil water demand.

This is necessary for supporting physiological processes as well as enhancing the fleshiness of fruits and leafy vegetables among other common farm crops. Making use of surface run off becomes handy during dry season for farmers who harvest the water and store in earth dams, ponds or tanks. However, this practice is limited in terms of application by small scale farmers especially in arid and semi arid areas due to high poverty indices. Enabling actions that are required to promote the adoption, diffusion and transfer of technology are financial incentives, availability of affordable credit, improvement of appropriate land tenure system, and capacity building. Further there is need to emphasize smart irrigation technologies such as drip where by water only reaches the intended portion of plant ground cover, in this case, the root zone. Controlled irrigation is very important in paddy rice fields where methane emissions are also high. This is important in schemes such as Mwea, Ahero and Bura where irrigation activities for rice are quite intensive. Currently, sprinkler and canal methods dominate.

D. Capacity development

Climate smart agriculture engulfs a number of practices some of which are complex to local farmers while others do not have any idea of what the cultivation system entails. As such, it is important that a non-linear, flexible approach be used when disseminating CSA technologies, with emphasis on capacity building amid room for adaptations to local conditions. Failure of extension services to necessitate this can be linked to a combination of a lack of relevant technology ie that fits local needs, failure by research and extension to understand and involve farmers in problem definition and solving, and weak linkages between extension, research, and farmers (Davis, 2008). Further, strengthening early warning institutions is pragmatic with sensitization measures on the need to integrate warning advisories into planning. According to AGRA (2013), the lack of capacity in agricultural sciences in Africa hampers development of relevant technologies that could lift smallholder farmers out of poverty. The report reiterates that there are also extension workers whose capacity is inadequately mobilized because they do not have the right working environment or tools (hard and soft) to fully mobilize their knowledge and skills. Enhancing farmers' access to CSA information with equal march in training for capacity development is vital.

E. Climate friendly Energy applications in Agriculture

Separating energy from agriculture is almost impossible. Energy is an essential input across entire value chain. The use of appropriate forms of energy in meeting daily farm operations is important. The choice of conventional energy resources in generating power on the farm has the potential to reduce GHGs. For instance, use of solar photovoltaic (PV) in pumping water for irrigation in a number of farms has ensured clean energy utility with no emissions compared to diesel water pump. Another area that has potential of substituting fossil fuel operated engines is the ability to manufacture local biodiesel powered engines. This technology has already been tested by Policy Innovation Systems for Clean Energy Security (PISCES) research team at African Centre for Technology Studies (ACTS) in collaboration with University of Dare salaam in Tanzania. Promoting establishment of solar centres for instance along beaches of Lake Victoria has a direct impact of improving livelihoods of fisher fork in the area through provision of power for refrigeration and drying of dagaa.

According to a survey carried out by Environment Liaison Centre International (ELCI) and ACTS in 2013 a long seven beaches of the lake (Nambo, Dunga, Uyoma, Paga, K'Oginga, Tilapia and Honge beaches) only two had refrigeration facilities . That is, at Usenge cooling facilities were powered by electricity from the grid while at Paga, power supply was by solar PV systems. Hence, fishmongers have to smoke the fish for longer shelf life a practice which consumes large volumes of woodfuel depending on quantity of fish caught on a particular day. Low carbon energy techniques have the benefit of promoting sustainable development, reducing disaster risks, empowering communities through improved livelihoods, and leveraging investments if they are adopted by farmers.

2. Opportunities

As prior mentioned, agriculture contributes 28.5% of the country's gross domestic product and offers over 70% of the employment force. At a glance, introducing measures that will enhance sustainability of the sector including increase in food security unarguably presents several opportunities. Some of these have been discussed below;

A. Cautioning food security

Practices implemented to enhance conversion of idle land in arid and semi arid regions into food productive plots have a direct impact of increasing food productivity in the country. Furthermore, irrigation systems ensure all year-round farming since its independent of rainfall implying increase in annual yield per hectare in comparison to rain fed agriculture. With respect to climatic conditions, storage and processing of the produce in these areas which have poor road networks could be met through renewable energy such as solar photovoltaic and biofuels for provision of energy for use in post harvest handling which is responsible for loss of one-third of food produced globally (FAO, 2010b). In medium and highly productive areas, practices such as mulching, diversification, and livestock breeding have potential of increasing productivity.

B. Increased income from agriculture

Conservation agriculture reduces the cost of land preparation for planting and weeding through the reduced tillage practice. This enhances energy efficiency on the farm coupled with ability to save money that is used to purchase other inputs. Increasing energy efficiency across the agri-food chain also increases profits, which cumulatively reserve the potential for agricultural expansion. On farm, co-generation can lead to sell of surplus energy to the grid leading to income generation.

C. Improved soil structure

By improving soil structure through integrated soil and water management systems, soil erosion is controlled paving way for diversification as very limited types of crops if not trees can survive on degraded soils. Water harvesting for example can help support other chores besides facilitating agricultural practices. Roof top-harnessed water can be used for domestic activities like house cleaning and cooking reducing time used spent in fetching water several kilometers away from home. Furthermore, soil and water management increases resilience to drought and extreme weather events.

D. Investment in Green Energy

With the rising volatility in fossil fuel prices, integration of energy smart technologies considered renewable gives dealers in the non-conventional energy value chain opportunity to benefit from the investment. For instance, the decision to run stationary farm engines using biofuels such as biodiesel, generates two-fold benefits in that the feedstalks can be used for improving soil fertility after squeezing out the raw material for the fuel. Biogas energy production on the farm for example necessitates clean energy for cooking and lighting while the slurry is used to improve soil fertility.

E. Reduced GHGs

Approaches that promote conservation agriculture and application of modern forms of energy provide possible alternatives to mitigating climate change through reduction of emissions. According to FAO (2011), there exists a correlation between nitrous oxide (N_2O) emissions from fertilizer application and energy use (and hence carbon dioxide emissions) in the production of fertilizer. It is estimated that farmers in Kenya lose up to 30% of harvest outside the farm gate due to lack of modern storage facilities and poor practices. As a result, the dumped food releases GHGs in the process of rotting thus contributing to their concentration in the atmosphere. In the uptake of CSA, practices such as precision agriculture, including a more efficient use of fertilizer, lowers CO_2 and N_2O emissions and reduces the consumption of fossil fuels. For example, the use of manure for biogas generation considerably cuts down methane emissions while sustainable agro forestry sequesters carbon and displaces fossil fuels for energy provision.

3. Challenges

A. Financing mechanisms

Lack of efficient rural finance and credit supply system for small holders and rural primary agro processors is a common problem undermining farm productivity. At the national level funding for climate-smart agriculture, and the closely related goals of food security and sustainable land management come from different sources. As a result, there is a tendency towards inefficiency, or worse, policies that work at cross-purposes (Seth, 2012).

B. Enabling environment

Depending on local demands, climate smart agriculture may be resource intensive. As such, there is need for the government to input economic instruments that support private sector investment and provision of incentives to lure farmers and encourage value addition. For example, having policies and regulations that support access to loans through financial institutions will enhance capital and operational investment requirements

C. Lack of awareness

There is need for linkage between staff from the ministry of agriculture and related agencies with farmers at the community level. Many research outputs are not translated into forms useful to grass-root farmers. This could include multi-dimensional awareness creation strategies such as use of county governments' staff through devolution of climate change coordination unit services, translation of outputs into local languages and strengthening capacity of agricultural extension officers on aspects of adaptation to climate change.

D. Lack of inclusive planning

In consistent to the new constitution of Kenya promulgated in 2010, inclusive planning by all stakeholders is pragmatic. Farmers should be incorporated within sector development planning from inception. According to Seth 2012, Farmers' input should be used to ensure development projects target what is most relevant to local communities and be designed to accomplish agreed goals in the most effective way within the local context. Grass-root representation at national level could include public benefit organizations and community leaders.

E. Land tenure

Secured land tenure systems have demonstrated improved productivity compared to unsecured. Review of policies related to land tenure should be put into consideration incorporating consistency and clear administrative directions. Procedures should be re-evaluated and apply current technologies for service efficiency. This will reduce time taken for adjudication and issuance of title deeds and facilitate acquisition of credit as they serve as securities.

F. Institutional coordination and stability

There is need for close coordination among CSA related departments and ministries in the government for smooth implementation of the national climate change action plan. Creation of climate change unit (CCU) in the Ministry of Environment, Water and Natural Resources seem to shed some light for future linkage. Ministry of Agriculture has also created climate change coordination unit o mainstream climate change in agricultural operations. These together with other government authorities should work closely for concerted deliverables. Frequent re-structuring of state departments destabilizes consortia operations.

G. Incoherent policies

Harmonization of inter-ministerial policies in light of climate smart agriculture needs to be given priority by relevant ministries. These should adapt to mitigation and adaptation goals outlined within the National Climate Change Action Plan. Nevertheless, despite the slow amalgamation of these policies Kenya is at an advanced level in Africa as regards integration of climate and agriculture.

4. Conclusion

This brief comes timely when Kenya and other Sub-Saharan countries aim at mechanizing farm operations for which the application of climate smart technologies offers a myriad of benefits. If well implemented, green energy technologies such as biofuel engines can operate agro-processing machines while solar photovoltaic can go a long way in supplying energy for value addition and storage of produce to minimize post harvest loses. Harmonization of policies in the Ministries of Environment, Water and Natural Resources and Ministry of Agriculture, Livestock and Fisheries is necessary for a coherent policy atmosphere. Efficient utilization of the devolved system of governance has potential of effectively decentralizing climate smart agriculture services under the ministry of agriculture through the recently created Climate Change Coordination Unit by the national government. The unit should workout ways of building capacity of farmers in line with CSA practices and explore ways of enhancing access to financing for the purposes of modernizing agriculture, increasing productivity and ensuring food security. Prerequisites to promoting uptake, diffusion, and transfer of best practices include but not limited to fiscal incentives for private sector attraction to enhance affordability of inputs to farmers, availability of affordable credit, improvement of land tenure system, and capacity building.

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