Indigenous Efforts by African Farmers in Ensuring Sustainability in Agricultural Productivity in the Face of Changing Climate

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Abstract

The study focused on the impact of climate change on African agriculture and how farmers around Africa have been coping through various indigenous mitigation and adaptation measures they adopt in ensuring sustainability in agricultural productivity. Indigenous methods such as traditional irrigation system, water harvesting and storage methods, soil moisture storage techniques, traditional soil protection techniques such as digging compost-filled planting pits which hold water, helping deep-rooted vegetables grow; building up grass and rock barriers around crops to protect them from soil erosion; and cultivating manure in septic tanks to use as fertilizer, intercropping trees with food crops and so on have responded well in the past to changing climatic conditions. The success of any mitigation cum adaptation strategies would rely not only on the traditional small-scale farming techniques; therefore there is urgent need to revive more traditional farming practices and combine them with modern scientific discoveries to help mitigate and adapt to climate changes.

Keywords: Mitigation, Adaptation, Indigenous, Climate change, Agriculture, Farmers, Africa

Introduction

Climate change is one of the most serious environmental threat to human beings as it adversely affect agricultural productivity (Zlervogel, 2006). The impact of climate change is global but the impact is mainly felt by the developing countries most especially Africa due to their low level of coping capabilities (Nwafor, 2007 and Jagtap, 2007). Jones and Thornton, (2002) projected that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change because African agriculture is predominantly rain-fed and hence depend solely on weather. The elements of climatic change that affects agricultural productivity includes prolonged drought, thunderstorms, flooding of crops fields, erosion of fertile soil, land slides and falling of tender crops by wind (Magadza, 2000). IPCC (2007) reported that there have been noticeable impacts of climate change on plant production, insect, disease and weed dynamics. Moreover, rising atmospheric CO_2 concentration, higher temperatures, changes in annual and seasonal precipitation patterns and the frequency of extreme events are the usual features of climate change phenomenon (Brussel 2009). Mark et al. (2008) observed that seasonal changes in rainfall and temperature, which are features of climate change could impact agro-climatic conditions, altering growing seasons, planting and harvesting calendars, water availability, pest, weed and disease populations; these characteristics will affect the volume, quality, quantity, stability of food production and the natural environment in which agriculture takes place. Khanal (2009) also noted that heat stress might affect the whole physiological development, maturation and finally reduce the yield of cultivated crop.

Studies show that climate change will have positive effects on livestock productivity because Livestock are sensitive to temperature, the combination of high temperature and high humidity cause greater stress and discomfort in livestock, and thus a larger loss in productivity. Changes in climate are expected to have significant impacts on ecosystem function (Backlund et al. 2008). Equally, changes in land use and management associated with agriculture are also likely to affect the ecosystem services associated with agricultural lands, such as the regulation of water quantity and quality and the global carbon cycle and conservation of biodiversity. Warmer climate with elevated CO_2 levels would increase pest and disease pressure and thus result in greater use of pesticides (Hatfield et al. 2008). Increased use of pesticides would be expected to have adverse effects on ecosystem services such as water quality, pollination and biodiversity. This study therefore looked into the various indigenous adaptation efforts by African farmers in ensuring sustainability in agricultural productivity in the face of varying climatic conditions. The various indigenous measures for each of the countries described in this paper is therefore to stimulate farmers to learn from one another's approaches, and to develop further their own adaptation strategies.

Indigenous Adaptation Measures in African Countries

Indigenous knowledge has been defined as institutionalized local knowledge that has been built upon and passed on from one generation to the other by word of mouth (Osunade, 1994; Warren 1992). It is the basis for local-level decision-making in many rural communities. Indigenous knowledge has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities (Mundy and Compton 1991). The knowledge set is influenced by the previous generations' observations and experiment and provides an inherent connection to one's surroundings and environment (Adesina et al, 1999). Therefore Indigenous Knowledge is not transferable but provides relationship that connect people directly to their environments and the changes that occur within it, including climate change (Woodley 1991).

As reported by Anselm (2011), adaptation helps farmers achieve their food, income and livelihood security objectives in the face of changing climatic and socio-economic conditions including climatic variability, extreme weather conditions such as droughts and floods and volatile short term changes in local and large-scale markets (Kandlinkar and Risbey, 2000). Farmers can reduce the potential damage by making tactical response to these changes. According to Brussel (2009) adaptive measures to climatic change in agriculture range from technological solutions to adjustments in farm management or structures and to political changes such as adaptation plans.

Adaptation and Coping Strategies in Tanzania

Nsema et al, (2009) in their research on strengthening local agricultural innovation systems to adapt to climate change in Tanzania found out that negative impacts of climate change in Tanzania include decreasing crop production, increasing pests and diseases and abandoning of certain crops, in particular maize. Other factors which are not climate related have been mentioned to be introduction of new plant seeds which carry pests and diseases. Livestock production has also been adversely affected because of diminishing water and pasture and increasing pests and diseases particularly tick borne diseases. This is also attributed by lack of proper livestock diseases control such as dips. The production of both crops and livestock are more severely impacted.

In response to the reported changes in Climate Change in Tanzania, Nsema et al, (2009) reported that there has been a change in planting dates, change in crop varieties: Introduction of improved varieties e.g. maize hybrids. Cultivation on valley bottoms for production of vegetables. It was predicted that harvests will be less due to further decline in soil fertility. Hence the farmers resorted to plan ahead by expanding crop production, increasing livestock, improved access to subsidized fertilizer, having improved access and terms for credit, increasing business activities. Strategies for improving agricultural production included increase area of cultivation; buy more fertile for their children; increase number of livestock; diversify the crops and try to have own source of water for irrigation. In some areas the strategies for the future included early field preparation, zero grazing of cattle, Non-farm activities making of clay pots, planting milulu for basket weaving, planting trees (Pines for timber, mivengi for water sources conservation) and besides restrict river banks/valley bottom cultivation, prohibition of wildfires/bushfires and introduce tower gardening and water harvesting (Nsema et al, 2009).

Nsema et al, (2009) further reported that in adapting to drought, local communities have responded in different ways by planting drought tolerant crops such as millet and sorghum, timing of farm operations, early planting and harvest of rain water, growing drought tolerant crops, planting high yielding varieties etc. Farmers have reverted to growing traditional crops varieties that are considered to be both drought and disease resistant, for example, millet and sorghum. In addition, some farmers are increasingly being engaged in the cultivation of other pests/diseases resistant crops such as pigeon peas as an alternative to growing beans. Small-scale irrigation is practiced in narrow river valleys, and can be seen as a potential coping strategy to climate change.

Migration is among the local adaptation strategies, The study by Yanda and Mung'ong'o, (1999) indicated that migration is an important adaptation strategy in times of climate change or environmental degradation in some parts of Tanzania. People are migrating to cultivate in some places considered to be relatively more fertile.

Adaptation to Climate Change in Malawi

The SOER (1998) report indicates that in the last three decades, Malawi has experienced significant variability and unpredictability in seasonal rainfall. The agriculture, water, forestry, fisheries and wildlife sectors are greatly affected by these drought events. The SOER (1998) further reported that agriculture and livestock sectors are directly affected by drought, water shortages, resulting from drought or inter seasonal rainfall shortages, and have significant impact on other sectors as well. However, temperature was very high implying that evaporation rate was high too. For this reason it is suggested that farmers in this area should practice agroforestry in which annual crops grow together on the same piece of land with trees, thereby reducing evapo-transpiration and improving infiltration.

Adaptation in Kenya

In Kibera, Nairobi, the largest slum in Kenya, more than 1,000 women farmers are growing "vertical" gardens in sacks full of dirt poked with holes, feeding their families and communities. These sacks have the potential to feed thousands of city dwellers while also providing a sustainable and easy-to-maintain source of income for urban farmers. Pastoralists in South Africa and Kenya are preserving indigenous varieties of livestock that are adapted to the heat and drought of local conditions.

As reported by Isaiah (2011), that the Use of Agro-biodiversity by Indigenous and Traditional Agricultural Communities in Adapting to Climate Change in eastern Kenya which is mostly semi-arid, receiving only erratic rainfall with long spells of drought that can last as long as three years, involve employing permaculture, a traditional farming method where different types of crops ranging from vines to fruits trees are grown together as a strategy to cope with erratic weather. Also from his findings to survive this long-standing dryness which could potentially be aggravated by climate change, the farmers resulted to grow here include perennials such as indigenous fruits which cope well in erratic weather; important legumes such as pigeon pea, lablab, climbing bean (ngelenge) and creeping forms of cowpeas (ndamba) which have been successfully cultivated in these tough conditions for generations.

Burkina Faso

In Burkina Faso, farmers have resisted desertification and rehabilitated degraded land through planting trees in the fields and around villages. They also use traditional water harvesting and storage methods, and soil moisture storage techniques such as zai-pits (Aly and Hamado 2005). A zai-pit is a square hole 60 centimetres deep and 60 by 60 cm wide, sunk into dry, sandy soil. It is filled with compost manure mixed with topsoil. When, the mixture of compost and topsoil is saturated say with rain water (or by irrigation), it is able to retain moisture for several days - whereas the sandy soil that surrounds it dries out again almost immediately.

The people have resulted to some agricultural activities to extend traditional soil protection techniques, Methods such as digging "Zai" pits – compost-filled planting pits which hold water, helping deep-rooted vegetables grow; building up grass and rock barriers around crops to protect them from soil erosion; and cultivating manure in septic tanks to use as fertilizer. But to enable crops to survive erratic rains, many more farmers need access to high-yield, quick-growing seeds (Aly and Hamado, 2005).

Sahel Region of Africa

Allowing trees to grow and shade fields has helped boost yields for farmers across the Sahel. Farmers in the western Sahel have resorted to growing trees. They mix trees and crops, a practice they have named "farmer-managed natural regeneration," or FMNR, and that is known generally as agro-forestry, this brings a range of benefits. The trees' shade and bulk offer crops relief from the overwhelming heat and gusting winds. Indigenous knowledge has been directly applied in the Sahel in climate change mitigation through emission reduction, Carbon sequestration and carbon substitution. In the area of adaptation, indigenous knowledge systems have been applied in weather forecasting, vulnerability assessment and implementation of adaptation strategies. Local farmers in the Sahel have been known to conserve Carbon in soils through the use of zero tilling practices in cultivation, mulching and other soil management techniques (Schafer 1989; Osunade 1994). Natural mulches moderate soil temperatures and extremes, suppress diseases and harmful pests, and conserve soil moisture. Before the advent of chemical fertilizers, local farmers largely depended on organic farming, which also is capable of reducing GHG emissions. It is widely recognized that forests play an important role in the global carbon cycle by sequestering and storing Carbon (Karjalainen et al. 1994; Stainback and Alavalapati 2002).

Local farmers are known to have practiced the fallow system of cultivation, which encouraged the development of forests. Agroforestry is another practice that has been very effective in carbon sequestration. It is a system that tries to find some balance in the raising of food crops and forests (Adesina et al. 1999; Floyd 1969). Agroforestry techniques can be perfected to cope with the new conditions that are anticipated under a drier condition and a higher population density, they lead to an increase in the amount of organic matter in the soil thereby improving agricultural productivity and reducing the pressure exerted on forests.

In the Sahel, local farmers have developed several adaptation measures that have enabled them to reduce their vulnerability to climate variability and extremes. One important step in reducing the vulnerability of a climatic hazard is the development of an early warning system for the prediction or forecast of the event (Ajibade and Shokemi 2003). These farmers have developed intricate systems of gathering, prediction, interpretation and decision-making in relation to weather. Adaptation strategies that are applied among the pastoralists include the use of emergency fodder in times of droughts, multi-species composition of herds to survive climate extremes, and culling of weak livestock for food during periods of drought. During drought periods, pastoralists and agro-pastoralists change from cattle (Bos) to sheep (Capra) and goat (Capra) husbandry as the feed requirements of the later is less than the former (Oba, 1997). Pastoralists' nomadic mobility reduces the pressure on low carrying capacity grazing areas /through the circular movement from the dry northern areas to the wetter southern areas of the Sahel.

Uganda

Uganda's Developing Innovations in School Cultivation (DISC) program is integrating indigenous vegetable gardens, nutrition information, and food preparation into school curriculum to teach children how to grow local crop varieties that will help combat food shortages and revitalize the country's culinary traditions. An estimated 33 percent of African children currently face hunger and malnutrition, which could affect some 42 million children by 2025. School nutrition programs that don't simply feed children, but also inspire and teach them to become the farmers of the future, are a huge step toward improving food security.

Madagascar

In Madagascar, the agricultural sector employs over 70% of the population, low productivity coupled with land tenure insecurity and strong demographic growth have led to over exploitation of lands, decline soil quality and desertification; thereby making food security on the Island be under threat. Agro-ecological techniques which involves protecting soil with a perennial green cover which restores soil fertility,increase yield and reduces irrigation has been put to practice. The method requires no labour, no fertilizer and helps reduce Co_2 emissions by fixing Co_2 in the soil.

South Africa

In a survey by Archer et al, (2008) on Farming on the edge' in arid western South Africa the impacts described by the farmers includes severe drought, observed drought stress in their tea crops, mostly in the form of diminished yield. In addition, weather conditions contributed to increased frequency of potholes in roads, complicating transport, tick infestation that affected livestock and their poor conditions due to direct result of the pattern of weather events. Farmers were able to respond by stock reduction and dipping. Insufficient rain period adversely affected off-farm work opportunities. Farmers have been coping by providing supplemental feed to the livestocks. All farms surveyed reported climate-related heat stress to livestock, livestock water shortages (related to rainfall, without supplemental irrigation), and climate-related increases in pests and pathogens (affecting rooibos and stock) (Archer, 2008). uncertainty in the timing of agricultural activities as a direct result of late starts to the winter rainfall season and increased frequency of dry spells during the season. With regard to rooibos, adaptation strategies undertaken by all farms included: changes in ground preparation and tea harvesting times; wind erosion prevention measures (retaining bushed strips in lands, or planting of wind breaks, which reduced loss of tea due to wind); and water conservation measures.

Furthermore Archer et al, (2008) reported that the farmers resorted to using as a basis their local knowledge about managing climate risk, conserving biodiversity and conserving soil and water. These were not new activities; they comprised existing activities and strategies. Windbreaks continued to be planted because wind increases tea loss, using indigenous vegetation planted in rows angled (to prevent soil build-up against the barrier) to the direction of the dominant drying wind, Vegetation was removed, to aid water conservation. Lastly, alternative income sources continued to be developed, including eco-tourism initiatives, and the collection of indigenous medicinal plants and seeds.

Nigeria

Enete and Amusa (2010) reported that unusual early rains that are not sustained, erratic rainfall, delay in the onset of rain, long period of dry season, less rainfall, long period of harmattan and higher temperature, heavy winds, drought and decreasing soil moisture have been on the increase. thunderstorm, heat waves, desertification and loss of forest resources have shown no change, while floods, heavy rainfall and soil erosion have been decreasing and early rains that are not sustained, erratic rainfall, delay in the onset of rain, long period of dry season, thunderstorms, heavy winds, intense heat wave and so on. This was also the same trend for pests, diseases, weeds and signals of land degradation such as declining soil fertility and drying up of streams/rivers such are the case with southeastern Nigeria in the face of varying climate. Science in Africa (2007) observed that the effects of these extreme weather events and uncertainties in the onset of rainy season on agriculture are particularly more pronounced in the developing world.

Crop yields in the Sudan-Sahel zone of northern Nigeria are strongly and positively influenced by rainfall and evaporation as major climatic parameters affecting crop yields. This is so because soil moisture, which is often regarded as the single most important parameter in determining crop yields in semi-arid environments, can be coarsely derived from a relationship between rainfall and evaporation (Baier, 1977; Kowal and Kassam, 1978). However, According to Enete and Amusan, (2010) the main cause of poor yields is attributed to drought, poor soils, pest and diseases. The declining yields were blamed on the uncertain rainfall pattern since the Sahelian drought of the 1970s. Loss of seeds due to droughts and migration were some of the factors mentioned for the overall decrease in levels of production in spite of moderate rainfalls in some years. In adjusting to drought, the farmers employed cropping mixtures during drought, for example, they usually substitute early millet for sorghum, they also plant cassava and quick-maturing cowpea in the FADAMAs (wetlands) with no normal cropping mixtures during drought.

Areas cultivated during drought reduced often due to lack of seeds and labour - the young and able men migrate to cities in drought years leaving farm work to aged ones. Their livestock also suffer as a result of drought since the growing season could not receive adequate rainfall and could not get water from nearby wells and earth-dams to water their crops. However, availability of water in the earth-dams depended on sufficient rain falling at the beginning of the season, otherwise the little water collected may be lost completely through seepage and intense evaporation.

Other places like Bangladesh as reported by Isaiah, (2011) that in drought prone regions of Bangladesh, the resilience of traditional homestead gardens is strengthened through inter-cropping of fruit trees with vegetables, small scale irrigation and organic fertilizers. In the flood-affected regions, floating gardens have been created for cultivation of mixed traditional crops, red amaranth and kohlrabi. Therefore he concluded that local agrobiodiversity could be the basis for integration of adaptation and protection of indigenous peoples' rights .

Conclusion

The foregoing has highlighted the various indigenous measures adopted by some African countries in combating the menace of climate change on their agricultural systems. Effective adaptation strategies will require reliable scientific data on the nature of climate change and on its potential impact, though some of the indigenous ways in which the farmers have been adapting have been highlighted but the success of any adaptation strategies would not rely only on the traditional small-scale farming techniques but also in conjunction with modern knowledge on climate change adaptation such as climate forecasting and long-term climate change projection. The various indigenous measures for each of the countries described in this write up is therefore to stimulate farmers to learn from one another's approaches, and to develop further their own adaptation strategies.

Recommendation

1. It is recommended that for low potential areas that are highly vulnerable to climate change, significant investments will be needed to maintain agricultural production and the general community livelihoods. Achieving the above would need increased understanding of climate change and socio-economic dynamics of particular locations which will aid in the pursuit of longer term policies on adaptation.
2. Improving the knowledge and skills of extension service personnel about climate change and adapted management strategies, increasing extension-farmer ratio, and making the extension services more accessible to farmers.
3. Government policies should therefore ensure that terms for credit in the banks are flexible to enhance farmers' access to affordable credit, which will increase their ability and flexibility to change crop and soil management strategies in response to climate change
4. Provision of incentives for farmers by the African government and Stakeholders to avoid deforestation through intensified production on existing land.
5. There is need for crop and livelihood diversification in addition to the adoption of high yielding crop varieties and intensive agricultural production.
6. Formulation of strategies by institutions and organizations that will enhance the capacity to adapt to climate change within natural and agricultural systems.
7. Indigenous knowledge and practices should be integrated into formal climate change mitigation and adaptation strategies for continuous process of innovation.

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