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# DIVERSIFICATION AND A MULTIDISCIPLINARY APPROACH FOR RAISING AGRICULTURE PRODUCTION AND ATTAINING FOOD SECURITY IN SMALLHOLDER FARMING SYSTEMS OF SUB-SAHARAN AFRICA

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## Abstract

Agriculture is the primary economic activity for between 50 and 90 percent of the population in Sub-Saharan African countries. Ninety five percent of the food that is produced in Sub-Saharan Africa is grown through rain-fed agriculture. This implies that the region will suffer most from climate change due to its dependence on rain-fed agriculture. Vulnerability to climate change will be especially significant among the resource poor smallholder farmers in African countries whose livelihoods depend on rain-fed agriculture in marginal areas. African agriculture is characterized by variations in farming systems with about 90% of the farming occurring in integrated systems. In these mixed farming systems, the food security challenge may require an integrated approach to match the existing systems. A rainbow evolution which emphasizes the need for diversified systems may be the best practice in raising agricultural productivity. A multidisciplinary approach based on the theory of embededdness whereby farmers, researchers, extension institutions, and political institutions work together can further raise agriculture production and improve food security. Social networks in communities of farmers provide channels for identifying problems and farmers' knowledge integrated with that of research and extension can provide sustainable solutions for food production in smallholder farming systems in Africa.

**Keywords:** Food security, climate change, rainbow evolution concept, theory of embededdness, rain-fed agriculture, extension

## 1. INTRODUCTION

Agriculture is the source of livelihood for many smallholder farming households in Africa. In most Sub-Saharan African countries, agriculture is the primary economic activity for between 50 and 90 percent of the population (Fahsi, 2013). Food security in Africa relies on small-scale localized production on farms that are less than five acres. Further, ninety five percent of the food that is produced in Sub-Saharan Africa is grown through rain-fed agriculture (Mwaniki, 2012). In the respect, it is expected that, among the developing regions in the world, Sub-Saharan Africa will suffer most from climate change due to its dependence on rain-fed agriculture (Ringler *et al.*, 2010). Vulnerability to climate change will be especially significant among the resource poor smallholder farmers in African countries whose livelihoods depend on rain-fed agriculture in

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marginal areas with a poor natural resource base. Change in climate in itself presents heightened and new combinations of risks in Africa attributed to among other things the direct dependence on the natural environment for livelihood. The intricate food situation in Africa is linked to climate change that has brought about unpredictable rainfall patterns, insufficient rainfall and high temperatures. Ziervogel *et al.* (2008) point out that efforts to support African agriculture in the face of climate change must incorporate a multi-disciplinary set of stakeholders. The latter include climate science experts, agricultural practitioners and technicians, local communities and policy makers.

The highlighted concerns in African agriculture could be addressed using two perspectives: the 'theory of embededdness' (Granovetter, 1985) and the 'rainbow evolution concept' (Inter Academy of Sciences, 2009).' The theory of embededdness is based on the need for analysis of all the structures and relationships in an economic activity while the rainbow evolution is suggested from recognition of the integrated nature of African agriculture. Agriculture production can be considered as an action with economic implications whereby the farmer in deciding to engage in farming hopes to gain directly or indirectly. Smallholder farmers also engage in intercropping applying their wealth of traditional knowledge gained and experimented on over time. Most of agriculture that is conducted by smallholder farmers in Africa in addition occurs within a social system where farmers are in a continuous system of interaction sharing ideas and information. Thus if agriculture is regarded as an economic activity that occurs within a social system, then the theory of embededdness and the rainbow evolution concept are appropriate in rationalizing ways in which agricultural production can be improved among smallholder farmers. This paper is a theoretical perspective on proposals to increase agricultural production in the context of climate change in smallholder farming systems in sub-Saharan Africa.

## 2. LITERATURE REVIEW

### 2.1. Agricultural production in Africa and the rainbow evolution concept

African agriculture is characterized by variations in farming systems with about 90% of the farming occurring in integrated systems (Ziervogel *et al.*, 2006). Farming is conducted in small farm holdings mostly of less than 2 hectares and crop production involves a mixture of different crops that are usually intercropped. A concern is that large breakthroughs in agricultural productivity and improvements in food security are yet to occur in Africa. According to Inter Academy of Sciences (IAC) (2009), in these mixed farming systems of Africa, the monoculture and large scale mechanization adopted in Asia may not be effective in raising agriculture production to a level of attaining food security. The food security challenge may require an integrated approach to match the existing systems. Diao *et al*. (2007) are in agreement that, most African countries have not met the requirements for a successful agricultural revolution witnessed in the Green Revolution in Asia. The green revolution which was a high input approach to agriculture involved breeding of early maturing, fertilizer responsive semi-dwarf varieties and innovation diffusion environments that were enhanced by irrigation and agrochemicals. Many smallholder farmers in Africa may not have these resources and as stated by Thomson and Feffer (2007), the integrated farming systems will need several evolutions or multiple initiatives such as intercropping, indigenous technologies and indigenous crops. Problems attributed to poor agriculture production and food insecurity are environmental degradation, declining soil fertility, competition for water and extreme weather changes. These problems are now more evident due to global climate change and resultant weather variability. Vulnerability of Sub-Saharan Africa to climate change is made worse by limited adaptive capacity attributed to poverty, poor infrastructure and high dependence on rain-fed agriculture more so among smallholder farmers (Ringler *et al*., 2010).

The IAC (2009) acknowledged that, science and technology based green revolution used in Asia for raising food production may not be the road for Africa and there is the need to build on the existing African practice as well as use a quadrangle approach that incorporates research and extension, education and farmers participation. Axinn (1997) had a similar opinion that technologies developed for large scale specialized operations often do not fit the needs and interests of small-scale subsistence farmers. When research emphasis is one commodity, agriculture extension systems in such situations become useless to the people in small mixed farming systems. Farrington and Martin (1993) note that resource limited farmers have little to gain from processes of development and transfer of technology characterized by the green revolution. Instead, resource limited farmers need more of evolutionary than revolutionary processes. Evolutionary approaches require understanding of the diverse and complex environment in which farmers operate. The recommendation is that development of technology should be tailored to farmers' circumstances and build on farmers' indigenous technical knowledge. In evolutionary practices, it is not only farmers who gain but the researchers as well because they will be able to understand the role of the technology introduced in the complex farming systems. The researchers can also gain insights on how farmers adopt and adapt technology.

Considering that agriculture practices in among smallholder farmers in Africa are complex and integrated, governments, agricultural extension agencies and agricultural research institutions among other stakeholders can reinforce the rainbow evolution. The latter can inform on strategies for dealing with climate change threats that promote diversification, indigenous knowledge merged with scientific findings to develop practical options for raising agricultural production in smallholder farming systems and subsequently attaining food security. Government agencies need to work closely with farmers and all other stakeholders in defining the way forward in addressing climate change challenges and food insecurity in African countries. This approach would be part of adoption of climate smart agriculture suggested by Alliance for a Green Revolution in Africa (AGRA, 2014) which emphasizes the importance of synergies, tradeoffs, adaptation and mitigation among practices needed to respond to climate change in Africa. These actions can contribute significantly in reducing threats to climate change by increasing resilience and effective use of available resources to raise agricultural production.

### 2.2. Improving agriculture production in Africa through an embededdness approach

The theory of embededdness (Granovetter, 1985) suggests a relational approach in addressing economic activities. The author explains that, economic action is strongly embedded in social structure which leads to trust and points out that extreme good comes from social networks and hence requires social embededdness. The theory links economic actors to economic relationships and structures at both the micro and macro levels and aids in focusing on the inter-linkage and interpretation of these relationships. Agriculture can be viewed from such a relational concept because it involves several stakeholders who include farmers, extension workers and agencies, research and national government. Ochieng' (2009) using the interdisciplinary concept points on the need to link social with natural sciences, sociological with economic and political and natural analyses in seeking strategies to address sustainable agriculture in Africa. The social and natural sciences are also interlinked in meeting the needs of farmers. He uses the theory of embededdness to point out that sustainable agriculture cannot meet the needs of local users in Africa if policymakers and research institutions ignore farmers as the principle actors and researchers.

The assumption that traditional knowledge of farmers is inefficient, unproductive and backward and that the donor, government and the scientist know what is best is unacceptable. The emphasis is that all those with interest in agriculture production must meet on the same platform and work out practical solutions for improving productivity. Ochieng' concludes that, sustainable agriculture should be understood as a systemic process that is embedded in historical, biophysical, socio-economic, and political institutions and relationships that are found in specific localities. Agriculture as an economic activity should be conducted in ways that are specific and dependent on social relations and structures. In order to raise agricultural production in Africa which has a rich social history, it would require an understanding of how social structures in communities can be adapted to address the problems of climate change.

The Inter Academy of Sciences (IAC) report on ways of harnessing the best science and technology to increase agricultural productivity in Africa observes that science and technology alone will not raise agricultural productivity in Africa without the existence of an enabling environment (Loffler, 2009). Some of the factors that affect agriculture production and food security are inadequate support institutions and poor policies reflected in low government investment in Agriculture. For instance, Mungai (2012) observes that in Kenya, the agricultural sector comes a poor second to industrialization and urbanization that are soaking up development resources. The political environment determines to a great extent the goodwill needed for realization of agricultural productivity and food security in Africa. The level of resource allocation in the agricultural sector by governments will influence the focus and comprehensiveness of activities in agricultural research and extension activities. Boosting productivity of smallholder farms, wider participation, and empowerment of the rural poor and helping families to cope with external shocks like climate change that affect their access to food production resources will ultimately assist in attainment of food security. The multidisciplinary concept is also emphasized by Ziervogel *et al*. (2008) and Diao *et al.* (2007) who indicate that to support African Agriculture in the face of climate change, science experts, agricultural practitioners and technicians, local communities, donors and policy makers must all work together.

Agricultural production in Africa which has a rich social history would require further an understanding of how social structures in communities are used to address the problems of climate change. The process of social learning thus becomes socially embedded and jointly utilized leading to change in behaviour that can lead to adoption of new agricultural production technologies and eventually improve productivity (Pretty, 2008; Axinn, 1997). Adaptation to climate can be viewed as a social learning process in which farmers need to be equipped with skills and knowledge on how to respond to difficult circumstances brought about by variable and unpredictable weather. For instance, threats from climate change means farmers must find coping mechanisms to ensure continued agricultural productivity. Extension service should be a social exchange process between farmers, families, and extension agents where information is shared and discussed on how the farmers and families can adopt new technologies to improve agriculture production and their livelihoods.

As Axinn (1997) observes, agriculture extension systems should be careful not to drift away from multiple roles that require organizing farmers, empowering, ensuring equity, and sustainability. Empowering farmers will lead to a process whereby the farmers can exert influence and power over research systems so that they generate useful and practical information that meets their needs and interests. Extension workers and research personnel should work with farmers and communities to build capacity towards understanding the complex nature in the farmers' fields and to act on the information in making decisions.

### 2.3. Sustainability in agricultural production and climate change

Climate change adaptation may not be based on a single technological solution that research and extension pass to farmers. The latter implies that any recommendations to address climate change must be based on specific local circumstances. Leaders in agriculture extension systems need to bear in mind that research based technologies with large scale farming systems bias do not fit the needs of smallholder subsistence farmers. Increase in agricultural productivity is often linked with the question of sustainability as changes in agricultural practices automatically bring changes in demands on resources. Climate change can affect attainment of sustainability because of unpredictable rainfall patterns and temperatures. Sustainable agriculture practices should be economically viable, socially acceptable, environmentally friendly, and technically appropriate (Pretty, 2008; Ochieng', 2009). This means that as various regions implement measures to increase the productivity of their farm land, they must also find ways to ensure that future generations will also have the resources they will need to live and thrive. Overcoming the challenges of climate change is also accompanied by the issue of sustainability which is especially a concern in increasing agricultural productivity in marginal lands and fragile ecosystems where poverty is prevalent and which are occupied by smallholder farming systems.

Farmer participation in agricultural research is recommended due to recognition of the need to have technologies and practices that meet the needs of farmers. Participation ensures relevance and success because programmes become farmer centred with the farmers actively involved in determining the agenda, communication and channels of communication. Participation should not be mistaken with research done in farmers' field initiated and completely controlled by scientists. As pointed out by Farrington and Martin (1993), participation in agricultural research should be informed by the concern that, conventional quantitative research methods tend to preserve social inequality. It is thus necessary for those leading in research in agriculture to realize that research is an educational process not only for the researcher but for the community as well. Problem oriented research, respect for peoples' capability to produce and analyze knowledge and researcher's commitment to and involvement with the community should be the priority. Research should be seen to take into account the purposes of participation which are community involvement in social research; action for development and education as part of the mobilization process for development. This view is also emphasized by APRODEV (2012) that long term sustainable agricultural solutions are more likely to be realized from participatory research approaches that are community based and responsive to farmers' needs. In particular, focus on knowledge intensive techniques as observed in integrated African agriculture is sure to give more benefits in the context of climate change compared to high external inputs recommendations.

Agricultural production is often based on the premise that there are technologies that farmers need to adopt and these technologies should be generated by research (Ministry of Agriculture and Rural Development, 2001). The information from research is expected to reach the farmers for adoption that will transform agriculture production. This model of change, however, overlooks the fact that the use of agricultural technologies is a process of social learning. In his theory of social learning, Bandura (1971) points out the need to consider social variables learning approaches. The implication is that people learn from others with similar characteristics through interaction, observation and imitation. Thus, as Pretty (2008) points out, finding solutions for sustainable agriculture should include farmer participation, group action, and promotion of local institutions, culture, and farming communities. An important consideration is appreciation that as farmers seek for appropriate means of raising productivity, there are likely to emerge new configurations of social capital reflected in social organizations, horizontal and vertical partnerships between institutions, and human capital oriented towards leadership, management skills and ability to be innovative.

Pretty also notes that agriculture systems that have high levels of social and human assets are more likely to innovate in the face of uncertainty and variability in weather presents such an opportunity for creativity among smallholder farmers. People make decisions that are closely tied to ongoing economic relationships and social structures. The decisions are further affected by choices of other individual actors and groups and hence the need to identify actors, factors and structures in addressing the problem of sustainable agriculture. Indigenous technical knowledge should be viewed as an important complement to scientific knowledge because it is location-specific and can supplement science in explanation and prediction. The implication is that science should provide technology options to problems and constraints identified by farmers and relevant to their conditions.

## 3. CONCLUSION

The reality of climate change and the resultant threat to agricultural production and food security are of great significance in African countries. Considering the diversity in African agriculture especially smallholder farming systems, a rainbow evolution may be the best practice in raising agricultural productivity. Improving agricultural production may further require using integrated approaches that go along with integrated farming systems characteristic of smallholder rain-fed agriculture in Africa. The rainbow evolution fits adequately with the social culture in Africa. Merging well tested indigenous knowledge with science can thus lead to sustainable solutions for addressing climate change. The practice would fit well with the integrated and diverse production systems where adaptations are tailored to the needs of the farmers and local communities. Agriculture production cannot be improved by single effort of the farmers and all stakeholders must work together in reciprocal relationships tapping into strengths of each institution. A multidisciplinary approach is also needed and the theory of embededdness can be a useful guide in that farmers, researchers, extension institutions, and political institutions need to work together to develop and support interventions that will raise agriculture production and ensure food security in Africa. This implies that farmers' knowledge can be integrated with that of research and extension. Social networks in communities of farmers are in addition crucial because they provide channels of identifying problems and sharing information. The political will of the government cannot be overlooked because agriculture production cannot occur in politically unstable localities lacking the needed infrastructure that will enhance productivity.



## References

Alliance for a Green Revolution in Agriculture (AGRA) (2014). *Africa agriculture status report 2014:.Climate change and smallholder agriculture in Sub-Saharan Africa*. Retrieved 7th September 2015 from www.agra.org.

APRODEV (2012). *Agricultural research for sustainable agriculture and global food security*. APRODEV Policy brief 2020. Retrieved 20th March 2015 from www.aprodev.eu.

Axinn, G. H. (1997). *Challenges to agriculture extension in the twenty-first century.* In Scarborough, V., Killough, S., Johnson, D. A., and Farrington, J. (Eds.) *Farmer-Led Extension*. London: Overseas Development Institute.

Bandura, A. (1971). *Social learning theory*. Retrieved June 2015 from http://www.esludwig.com/uploads/2/6/1/0/26105457/bandura_sociallearningtheory.pdf.

Diao, X., Hazell, P., Resnick, D., & Thurlow, J. (2007). *The role of agriculture in development in Africa: Implications for Sub-Saharan Africa*. Research Report 153. Washington D.C.: International Food Policy Research Institute (IFPRI).

Fahsi, M. (2013). *Obama's plan to end hunger in Africa is really a plan to industrialize agriculture.* Retrieved 18th March 2015 from www.mintpressnews.com.

Farrington, J., & Martin, A. (1993). *Farmer participation in agricultural research: A review of concepts and practices*. London: Overseas Development Institute.

Granovetter, M. (1985). *Economic action and social structure*: *The problem of embededdness.* Retrieved 28 April 2014 from www.faculty.babson.edu.

Inter Academy of Sciences (IAC) (2009). *IAC report on realizing the promise and potential of African agriculture.* Retrieved from http://www.cgiar.org/www-archive/www.cgiar.org/pdf/.

Loffler, H. (2009). *Realizing the promise and potential of African agriculture*. Retrieved from www.interacademycouncil.net/.

Ministry of Agriculture and Rural Development (2001). *National Agricultural Extension Policy*. Nairobi: Agricultural Information Centre.

Mungai, C. (2012). Families feeling the pinch of rising food prices. *Sunday Nation*, May 13, 2012. p. 11.

Mwaniki, A. (2012). *Achieving food security in Africa; Challenges and issues*. Retrieved from www.un.org/africa/.

Ochieng, C. M. O. (2009). *Sustainable agriculture in Africa: Towards a new paradigm - The Embeddedness Approach.* Retrieved from www.codesria.org/IMG/pdf/obote.pdf.

Pretty, J. (2008). *Sustainable Agriculture and Food*. Volume 1. London: UK. Earthscan.

Ringler, C. Zhu, T., Cai, X., Koo, J., & Wang, D., (2010). Climate change impacts on food security in Sub-Saharan Africa. IFPRI Discussion paper 01042.

Thomson, C., & Feffer, J. (2007). Africa: Green revolution or rainbow evolution? Retrieved from http://fpif.org/africa_green_revolution_or_rainbow_evolution/.

Ziervogel, G., Cartwright, A., Tas, A., Adejuwon, J., Zermoglio, F., Shale, M., & Smith, B. (2008). Climate Change adaptation in African Agriculture. Stockholm. Rockefeller Foundation.

Ziervogel, G., Nyong, A., Osman, B., Conde, C., & Downing, C. (2006). Climate variability and change: Implications for household food security. *AIACC (Assessments of Impacts and Adaptations to climate Change)* working paper No. 20, 1-32.