

1 **Using Indigenous Knowledge as a Strategy for Climate Change Adaptation among**
2 **Farmers in sub-Saharan Africa: Implications for policy**

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8 **Abstract**

9 The study discusses using indigenous knowledge as a strategy for climate change adaptation
10 among farmers in sub-Saharan Africa. The local farmers in this region through the indigenous
11 knowledge systems have developed and implemented extensive adaptation strategies that have
12 enabled them reduce vulnerability to climate variability and change over the years. However, this
13 knowledge is rarely taken into consideration in the design and implementation of modern
14 mitigation and adaptation strategies. This paper highlights some indigenous adaptation strategies
15 that have been practiced in sub-Saharan Africa and the benefits of integrating such indigenous
16 knowledge into formal climate change adaptation strategies. The study recommends the need to
17 incorporate indigenous knowledge into climate change policies that can lead to the development
18 of effective adaptation strategies that are cost-effective, participatory and sustainable.

19 **Key words:** Indigenous, knowledge, adaptation, strategy, climate change, farmers, sub-Saharan
20 Africa

Introduction

The importance of indigenous knowledge has been realized in the design and implementation of sustainable development projects, little has been done to incorporate this into formal climate change adaptation strategies. 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 (Warren, 1992; Osunade, 1994). 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. Therefore indigenous knowledge is not transferable but provides relationships that connect people directly to the environments and the changes that occur within it, including climate change (Woodley, 1991).

Climate change cannot be separated from sustainable development as sustainable development may be the most effective way to frame the mitigation question and a crucial dimension of climate change adaptation and impacts (Cohen et al. 1998; Swart et al. 2003). Integrating indigenous knowledge into climate change policies can lead to the development of effective adaptation strategies that are cost-effective, participatory and sustainable (Hunn, 1993; Robinson and Herbert 2001). Adaptation methods are those strategies that enable the individual or the community to cope with or adjust to the impacts of the climate in the local areas. Such strategies will include the adoption of efficient environmental resources management practices such as the planting of early maturing crops, adoption of hardy varieties of crops and selective keeping of livestock in areas where rainfall declined.

However, incorporating indigenous knowledge into climate change concerns should not be done at the expense of modern/western scientific knowledge. Indigenous knowledge should complement rather than compete with global knowledge systems.

Local farmers in sub-Saharan Africa have been known to conserve carbon (C) 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 C (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. It may be argued that with the growth in population, lengths of fallow have been reduced to the extent that the practice no longer exists in certain areas. However, one must not forget that the importance of forests have been recognized by traditional institutions to the extent that communal forest reserves were very common in traditional societies. Besides the fact that these well managed forests provided food and timber resources to the community, they also served as C sinks. It is recognition of the role of forests in climate change that has influenced participants of the Kyoto Protocol to allow countries to include carbon sequestered in forests in a country's emission requirements.

Agro forestry is another practice that has been very effective in carbon sequestration. Agro forestry is a rational land-use planning system that tries to find some balance in the raising of food crops and forests (Adesina et al. 1999). A practice similar to this has been described in South western part of Nigeria to raise shade tolerant crops such as *Dioscorea* spp and cocoyam in

essentially a permanent forest setting (Adesina, 1988). In addition to the fact that agro forestry 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.

Local knowledge is vital for preserving bio-diversity, which is considered a very successful adaptation strategy. Through the World Bank, gene banks have been established to preserve genetic information of local varieties or indigenous species. Genetic traits of these species and the knowledge of cultivators may prove instrumental in future breeding programs to introduce resistance against pests or diseases or endurance for harsh climatic conditions. A major criticism of this initiative is that preserving genetic traits without preserving the knowledge of the husbandry may prove futile as the seeds and clones stored in seed banks do not carry the instructions on how to grow them (Warren, 1991). Hence, these gene banks should cooperate with farmers and communities who still cultivate local varieties to preserve such essential knowledge and skills in situ.

Local farmers in sub-Saharan Africa have developed several adaptation measures that have enabled them to reduce 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). There is a wealth of local knowledge based on predicting weather and climate. A study of weather knowledge in various parts of the sub-Saharan Africa reveals the wealth of knowledge that farmers possess. These farmers have developed intricate systems of gathering, prediction, interpretation and decision-making in relation to weather. These systems of climate forecasts have been very helpful to the

farmers in managing their vulnerability to a very great extent. Farmers are known to make decisions on cropping patterns based on local predictions of climate and decisions on planting dates based on complex cultural models of weather.

According to Follett et al. (2001), it is anticipated that climate variability and change in sub-Saharan Africa will have overwhelming impacts on agriculture and land use, ecosystem and biodiversity, human settlements, diseases and health and water resources. With respect to agriculture and land use, climate change will likely elicit a significant change in agricultural production both in terms of the quantum of products as well as the location or area of production. For example, the change is expected to lead, among other things to a shift in rainfall belts. Since agriculture is largely rain-fed in the sub-Saharan Africa, this will be accompanied by a shift in the traditional areas of production of certain crops with all the possible negative consequences that this may bring to the local people.

Temperature increases and decline in rainfall for example, will cause ecological stresses that could impair the functioning of ecological systems particularly in terms of plant growth and development. Settlements will similarly be affected as difficult conditions force people to move to marginal lands. The impacts of such diseases that luxuriate under high temperatures may in all probability be amplified under a changing climate driven by increased temperature. For example, it is anticipated that there will be a marked increase in the scourge of malaria across the sub-Saharan Africa. Water resources will be similarly affected as surface and ground water depend on moisture from precipitation hence, reduced precipitation will lead to decline in local water supply in many areas. The magnitude of these impacts in the various human systems will be influenced by the level of their vulnerability to climate change (Lal and Bruce, 1999).

Sustainable land and water management combined with innovative agricultural technologies could help poor farmers adapt to climate change impacts (Dar, 2009). New knowledge, technology and policy for agriculture have never been more critical and adaptation strategies must urgently be applied to national and regional development programmes.

The paper therefore reviews using indigenous knowledge as a strategy for climate change adaptation among farmers in sub-Saharan Africa under the following sub-headings, which also forms the specific objectives of the study:

1. Water and land resources usage as indigenous adaptation measures;
2. Land tenure issues and adaptation in sub-Saharan Africa;
3. Use of climate-proof crops and pests control methods;
4. Climate change, land and indigenous people; and
5. Benefits of indigenous knowledge in climate change adaptation.

Methodology

The paper is an opinion paper and it relied heavily on secondary data from current literature and observations on climate change in the study area.

Water and land resources usage as indigenous adaptation measures

Water is critical for agriculture across the semi-arid tropics. Although rainfall predictions remain uncertain, scientists agree that climate change will reduce water availability and storage, and warmer temperatures will increase the amount of water needed by crops. Improving crop production in these regions largely depends on better capture and storage of rainwater. But rainwater harvesting and storage technologies remain underdeveloped. And we know little about the economic viability of such systems-implementing them may well require financial investment beyond the capacity of most rural communities (William and Dar, 2009).

Most agriculture adaptation options have a positive impact on water resources and management. Improved cropland and grazing management can increase water storage and infiltration, reducing loss through runoff and leading to greater water availability in the soil (Mooney, Gerow, Antle, Capalbo, Paustian, 2007) and enhancing ecosystem water balance (West and Post, 2002). This is true also for manure application and, in general for other approaches that maintains or increase soil organic matter (Stern, 2006). Additionally, conservation agriculture often reduces evaporation from the soil, especially in drier environments. Since the combined water loss through runoff and evaporation often leaves less than half of the rainfall (or irrigated water) available for crops, the adoption of these technologies can increase crop yields and food production. Other technologies are more explicitly related to water management: e.g. water conservation and harvesting and efficient irrigation can effectively increase the soil carbon pool (FAO, 2008). Terraces and contour farming also have big impacts on water, providing for storage of rainfall and discharging excess runoff through a drainage system (WOCAT, 2007). Nevertheless, in areas where water management focuses on drainage to lower water tables for crop and forage production, such as organic soils that tend to be highly fertile, there is the risk of exposing soil organic matter to aerobic decomposition, promoting substantial losses of soil carbon (Conant, 2009). Other practices increase or maintain water quality: technologies that sequester carbon in grassland soils tend to maximize vegetative cover and reduce water induced erosion and sediment load (Conant, 2009). Enhanced soil moisture should also reduce vulnerability to low rainfall and drought conditions, thus increasing the capacity of farming systems to adapt to climate change. Much of the concern over water resources in agriculture stems from a lack of moisture to maintain crop or forage production at optimal levels. This issue is particularly acute in dry land agricultural systems.

Irrigation is the most common and direct way for producers to reduce water stress to crops and forage grasses, but improved cropland and grazing management have also been viable alternative strategies to improve soil water regimes. Also, in much of the world maintaining adequate moisture during extreme events is perhaps the most important aspect of adapting to future, warmer climates. About 95 per cent of water in developing countries is used to irrigate farmlands, policies to improve irrigation efficiency are also critical. Research is needed on water flows and water quality and infrastructure needs to be improved (William and Dar, 2009).

Stern (2006) noted that better land and crop management are equally important. There are already some promising and economically viable technologies to reduce risk of crop failure, improve soil fertility and increase productivity under variable climatic conditions. These include methods to reduce agricultural inputs, such as fertilizer micro dosing and smarter application of pesticides, as well as technologies for minimizing soil disturbance such as reduced tillage, conservation agriculture and crop rotation. Revising planting dates, plant densities and crop sequences can help cope with delayed rainy seasons, longer dry spells and earlier plant maturity that are already being observed across parts of Africa including Malawi, Mozambique, Zambia and Zimbabwe.

The major sources of land based adaptation from agriculture according to IPCC (2007) are described below.

- Improved agronomic practices generate higher inputs of carbon (C) residue, leading to increased soil C storage (Follett et al. 2001). Such practices include using improved crop varieties, extending crop rotations, avoiding use of bare fallow and using cover crops.
- Integrated nutrient management can reduce emissions on-site by reducing leaching and volatile

losses, improving nitrogen (N) use efficiency through precision farming and improving fertilizer application timing (Lal and Bruce, 1999).

- Increasing available water in the root zone through water management can enhance biomass production, increase the amount of above-ground and the root biomass returned to the soil, and improve soil organic C concentration. Soil and water conservation measures such as the construction of soil or stone bunds, drainage measures and irrigation constitute important aspects of water management.

- Tillage management practices with minimal soil disturbance and incorporation of crop residue decrease soil C losses through enhanced decomposition and reduced erosion. Systems that retain crop residues tend to increase soil C because these residues are the precursors of soil organic matter.

Land tenure issues and adaptation in sub-Saharan Africa

Some of the recent climate change literature examines issues of vulnerability and adaptation (Eriksen, et al, 2001) including the challenges and opportunities for support to collective action to improve land use systems and livelihoods resilience (IUCN et al, 2003). Current assessments of the challenges of adaptation however focus on the scope for substitution of existing crops with more drought tolerant species and varieties, adaptive research for dryland crops to develop more suitable varieties, land use management and agro forestry to improve water retention and promote crop diversification, wider development of s and the scope to improve credit availability, crop insurance, improved weather forecasting and introducing payments for avoided deforestation / reforestation by small farmers to substitute for loss of farm income (IFPRI 2007). Secure land rights for dryland farmers provided either on a farm household or community basis,

are likely to increase the incentives for investment and people to invest in and take advantage of these types of adaptation.

The land tenure implications of climate change impacts on agriculture are also difficult to predict. Although not a simple consequence of climate change, but of development and population pressures and political economy, increasing scarcity of good quality agricultural land will increase land pressure and competition, further weakening the asset base of the poor in the absence of guarantees of tenure security. Combined with decreases in crop productivity this would hasten the exit of the poor from agriculture. Thus in addition to facilitating adaptations to changing rainfall conditions, another set of challenges for land policy is to facilitate migration, diversification and exits from agriculture, and how best to secure the tenure rights, or provide alternative settlement and compensation for those affected. Here we concentrate on how to strengthen resilience on situ, building on existing adaptations, including established strategies involving seasonal mobility (Adesina, 1988).

Problems of increasing climate variability are already currently experienced by Africa's farmers, The IPCC Working Group (2007) found that in the Sudano-Sahel region of Africa, persistent below-average rainfall and recurrent droughts in the late 20th century have constricted physical and ecological limits by contributing to land degradation, diminished livelihood opportunities, food insecurity, internal displacement of people, cross-border migrations and civil strife. Some impacts of climate change may already be visible. Precipitation has fallen by 50-150mm per season from 1996 to 2003 in East Africa, which has brought on a subsequent fall off of long-cycle crops.

Africa's dryland farmers and pastoralists face serious implications including the decreased viability of rainfed dryland farming, changes in the geographical ranges within which arable

farming and cattle raising are feasible (including possible increased opportunities as well as constraints for pastoralists in some regions), and overall increased land and water competition in drylands. These are all issues for which Africa's dryland farmers have already been adapting to some degree to current and recent patterns of climate variability, which under climate change, are likely to be exacerbated. However the adaptive responses required to future climate change should not in principle be very different from existing adaptations to climate variability except in scale and pace at least in the medium term and excepting extreme climate change impact scenarios. In view of this much can be learnt from understanding how farming populations and the formal and informal institutions which shape and regulate land and resource use have responded and adapted to these changes – and in practice the changes have surely gone wider than the agricultural systems (Lal, 1997).

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252 **Climate-proof crops**

253 West and Post (2002) stated that changes in growing seasons in the tropics can also to a large
254 degree be adapted by redeploying existing improved crop varieties that can cope with a wide
255 range of climatic conditions. The International Crops Research Institute for the Semi-Arid
256 Tropics (ICRISAT) has developed pearl millet hybrids that can cope with temperatures of 40
257 degrees celsius and deliver normal yields with limited water. Short duration varieties of chickpea
258 and pigeon pea mature in 65–75 days and so can escape terminal drought at later stages of
259 growth. What is needed now is a better understanding of the physiological mechanisms
260 underlying heat tolerance so that we can develop more effective screening techniques for desired
261 traits, and identify wider gene pools to develop climate-proof crops

262 **Pest control**

263 Developing technologies to help farmers control pests is just as important. Climate change could
264 have positive, negative or no impact on each pest. But we need better models to assess their
265 global impact as most pest population prediction models have different spatial and temporal
266 scales than global climate models (Woodley, 1991).

267 Pests are usually controlled by cultural practices, natural enemies, host plant resistance,
268 biopesticides and synthetic pesticides. But many of these control tactics are highly sensitive to
269 the environment and climate change may render them less effective.

270 It may alter the interactions between pests and their host plants, directly affecting resistance to
271 pest control. For example, there are indications that stem rot (*Sclerotium rolfsii*) resistance in

groundnut is temperature dependent, while in Kenya resistance to sorghum midge (*Stenodiplosis sorghicola*) breaks down under high humidity and moderate temperatures.

We must urgently identify and develop crops that can resist pests under variable climates. ICRISAT has started work in this area, developing mildew-resistant pearl millet in India, wilt-resistant high-yielding pigeon pea in Malawi, Mozambique and Tanzania, and rosette-resistant groundnuts in Uganda.

Climate change, land and indigenous people

Climate change will have a substantial impact on the lifestyles and livelihoods of indigenous peoples because of the effects on the variety of wild and remote areas where they live and the natural ecosystems. These include: polar areas, where melting ice sheets affect fish and wildlife populations; mountain environments, where glacial melt creates particular hazards such as glacial lake outbursts, and affects alpine ecosystems and water supply; remaining tropical forests, threatened with long term drying trends causing changes in natural resource availability and utilization; dryland environments, where pastoralist groups are reliant on mobile access to fragile grazing and water resources spread over wide distances and highly dependent on rainfall availability; and coastal wetlands and low lying island threatened by sea level rise (Davies and Ebbe,1995).

Indigenous groups can be particularly vulnerable to climate change hazards because they face widespread discrimination and exclusion from and degradation of land and natural resources on which they depend, often as a result of government failures to recognize the legitimacy of their land and territorial rights. In this context in which indigenous people's livelihoods and cultural survival are already under threat, they also face the direct and indirect impacts of climate change on the ecosystems which have formed the traditional basis of their livelihoods.

Benefits of indigenous knowledge in climate change adaptation

Developmental projects are known to have been created, funded and managed by outside resources and introduced into rural communities with the hopes and promises of impacting their lives. These projects did not take into consideration the culture of the people and resulted in low participation and success rates (Howes, 1980; Woodley, 1991; Nyong and Kanaroglou, 1999). As a result of these failures, there was a growing interest in the incorporation of local knowledge and traditions to increase project participation rate and provide environmentally sound approaches to development. Although research is gradually recognizing the importance of indigenous knowledge systems in developmental studies, the value of indigenous knowledge in climate change studies has received little attention.

Climate change adaptation projects can learn from the experiences of other developmental projects by recognizing the value of indigenous knowledge systems. Two major problems that can be identified as obstacles to integrating indigenous knowledge into formal climate change mitigation and adaptation strategies are: recognizing the need to, and how to actually integrate indigenous knowledge into formal western science.

Indigenous knowledge adds value to climate change studies in the following ways. First, indigenous knowledge systems create a moral economy. It identifies a person within a cultural context, therefore providing decision-making processes or rules of thumb to be followed based on observed indicators or relationships within events (Woodley, 1991; Adugna, 1996;). Members of communities act within these rules of thumb to maintain security and assurance, or risk isolation from their community. In an uncertain and biased world these rules of thumb provide people with a sense of community, belonging and stability. Second, indigenous knowledge is increasingly exhibiting a resemblance with scientific methods as many ideas in indigenous

knowledge that were once regarded as primitive and misguided, are now seen as appropriate and sophisticated. Third, indigenous knowledge systems provide mechanisms for participatory approaches. A major requirement for the sustainability of any project is that the local population must be seen as partners in the project, with joint ownership. This is best achieved when the communities effectively participate in the design and implementation of such projects. Fourth, indigenous knowledge systems share the same guiding principles with sustainable development framework with 3E concerns-Economy, Equity, and Environment (Davies and Ebbe,1995). The essence of most climate change projects is to reduce poverty and ensure sustainable development. This can be facilitated by the integration of indigenous knowledge into climate change policy. Fifth, indigenous knowledge systems can facilitate understanding and effective communication and increase the rate of dissemination and utilization of climate change adaptation options.

Conclusion and Recommendations

Indigenous knowledge practices have been employed successfully in adapting to climate change impacts among farmers in sub-Saharan Africa. However, it is important to note that not all indigenous practices are beneficial to the sustainable development of a local community; and not all indigenous knowledge can a priori provide the right solution for a given problem. Therefore, before adopting indigenous knowledge, integrating it into development programs, or even disseminating it, practices need to be scrutinized for their appropriateness just as any other technology. In addition to scientific proof, local evidence and the socio-cultural background in which the practices are embedded also need to be considered in the process of implementation and evaluation.

There is need to adopt the bottom–up participatory approach that encourages the highest level of local participation in climate change programmes designed for the rural communities as this provides valuable insight into how communities and households interact and share ideas and allows the intended beneficiaries to develop the skills and practices necessary to forge their own path and sustain the projects. Incorporating indigenous knowledge into climate change policies can lead to the development of effective adaptation strategies that are cost-effective, participatory and sustainable. There is the need therefore to integrate this local knowledge into formal adaptation policies.

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