

## Indigenous Knowledge for Climate Change Mitigation and Adaptation in Agriculture in sub-Saharan Africa

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**Abstract:** Higher temperatures, more variable precipitation and changes in the frequency and severity of extreme climate events will have significant consequences on food production and food security. The frequency of heat stress, drought, and flooding are also expected to increase, even though they cannot be modeled satisfactorily with current climate models. All of these will undoubtedly have adverse effects on crops and agricultural productivity over and above the effects due to changes in mean variables alone. The impacts of climate change on agriculture are likely to be regionally distinct and highly heterogeneous spatially requiring sophisticated understanding of causes and effects and careful design and dissemination of appropriate responses. Adaptation measures are needed urgently to reduce the adverse impacts of climate change, facilitated by concerted action and strategic planning. As a major source of greenhouse gas emissions, agriculture also has much untapped potential to reduce emissions through reduced deforestation and changes in land use and agricultural practices. This is where indigenous knowledge comes in to play as a key to climate change mitigation and adaptation. African communities and farmers have always coped with changing environments. They have the knowledge and practices to cope with adverse environments and shocks. The enhancement of indigenous capacity is key to the empowerment of local communities and their effective participation in the development process. This paper thus highlights some indigenous mitigation and adaptation strategies that have been practiced in Africa, and the benefits of integrating indigenous knowledge into formal climate change mitigation and adaptation strategies. Incorporating indigenous knowledge into climate change policies can lead to the development of effective adaptation strategies that are cost-effective, participatory and sustainable.

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### Introduction

Up until the late eighties, convincing evidence supporting the theory of global warming (or climate change as it is now more commonly referred to) was lacking and as a result politicians were adopting a wait and see attitude. In 1988, the evidence came in with a bang at a conference in Toronto and was so disturbing that climate change was pushed firmly onto the political. Today, climate change is almost universally accepted as fact, with scientists declaring it to be not just possible but 'inevitable. The world is already experiencing the effects of rising temperatures and, as the Intergovernmental Panel on Climate Change (IPCC) predicts, these effects will intensify over the next few decades (IFRC, 2002; IPCC, 2001).

While climate change has traditionally been perceived as a largely environmental concern, this perception has changed too in recent years with the issue being increasingly taken up by the development community. The IPCC's assessments of the impact that climate change is likely to have on the poor

make disturbing reading. Climate change has been linked to the dramatic increase in extreme weather events witnessed by the developing world in recent years: disasters such as floods and droughts have already killed and affected millions, and these are predicted to escalate in frequency and intensity. Other effects of climate change include food insecurity, ill health, loss of forests and biodiversity, social and political instability and economic decline, all of which will hit the poorest hardest. Climate change, therefore, is one of the greatest threats facing the poor in the 21st century (La Trobe, 2002).

### The evidence for Climate change

Evidence presented by the Intergovernmental Panel on Climate Change (IPCC) reveals that the world's climate is changing. The strength of the evidence presented by the IPCC is such that very few policy makers or academics now deny the realities of global warming. The following global statistics, produced by the IPCC in 2001, reveal how the world's climate has changed over the last 200 years:

- The global average surface temperature has increased since 1861. Over the 20th century, there was an increase in temperature of around 0.6C.
- Since 1950, it is very likely that there have been fewer extreme low temperatures and an increase in the frequency of extreme high temperatures.
- It is very likely that, globally, the 1990s was the warmest decade and 1998 the warmest year since 1861.
- It is very likely that there have been decreases in snow cover by around 10% since the late 1960s. In non-polar regions there has been a widespread retreat of mountain glaciers in the 20 century.
- Global average sea level rose between 0.1 and 0.2 metres during the 20th century, and global ocean heat content has increased since observations began in the late 1950s.
- Warm episodes of the El Nino-Southern Oscillation have been more frequent and intense since third-1970s in comparison with the previous 100 years (IBCC, 1997)

Apart from the scientific evidence, observational evidence indicates that climate change has already had an effect on physical and biological systems throughout the world. Examples of these observed changes include lengthening of mid to high-latitude growing seasons, populations, and altitudinal shifts of plant and animal ranges, declines of some plant and animal populations, and earlier flowering of trees, emergence of insects, and egg-laying in birds. Moreover sea levels have shown signs of rising, and in some regions, including within Africa and Asia, floods and droughts have been observed to increase in recent years. Many rural farmers in developing countries, are already seeing the effects of climate change daily in the reduced availability of water for their agriculture. (La Trober, 2002).

According to IPCC Report, 30% of animal and plant species will be vulnerable to extinction if global temperature rose by 1.5 to 2.5 degrees Celsius. It says the world's have-nots would be worst hit by climate change, predicting greenhouse gases would change rainfall patterns, intensity tropical storms, accelerate the melting of Arctic ice and mountain glaciers and amplify the risk of drought, flooding and water stress. As with disaster risk management, policies and measures concerned with climate change represent a risk management approach. Both disaster prevention measures and climate adaptation measures aim to address underlying vulnerabilities, which would otherwise put the natural and human systems at risk. Indigenous knowledge is knowledge unique

to a given culture or society, acquired through accumulation of years of experiences of local people passed on from generation to generation (Mukhopadhyay, 2009). Any adjustment (economic, ecological or social), whether passive, reactive or anticipatory is used as a means to ameliorate the anticipated adverse consequences associated with climate change. Indigenous knowledge is a precious national resource that can facilitate the process of disaster prevention, preparedness and response in cost-effective participatory and sustainable ways. Hence a blend of approaches and methods from science and technology and from traditional knowledge opens avenues towards better disaster prevention, preparedness, response and mitigation. As for coping with changes in the weather, traditional indigenous knowledge of storm routes and wind patterns enables people to design their disaster management long in advance by constructing types of shelter, wind break structures, walls and homestead fences appropriately. Similarly, knowledge of local rain corridors enables them to prepare for storms. Knowing the colour of clouds that may carry hailstones enables people to run for cover. Knowing that prolonged drought is followed by storm, thunder and lightning during the first few rains enables people to prepare or expect a disaster (Mukhopadhyay, 2009). Floods can be predicted from the height of birds nests near rivers. Moth numbers can predict drought. The position of the sun and the cry of a specific bird on trees near rivers may predict onset of the rainy season. Traditional African rain-makers are slowly gaining recognition. The scientific world has begun embracing them as partners in unraveling the never-ending mysteries of Mother Nature. In fact, climate experts are looking up to indigenous African knowledge as a probable salvation to the devastating effects of climate change.

Indigenous peoples around the world may suffer most from climate change due to a combination of their high dependence on ecosystems, occupation of marginal lands, social pressure and lack of political representation. 'Because of their long dependence on nature they have developed strategies to cope with climate change and extreme natural events which still have as much relevance today as they did hundreds of years ago. People here built houses of bamboo on stilts, so that floodwater passes underneath the floor of the house without damaging it. During earthquake, the bamboo houses away back and forth but no damage is done. Many dry land areas face severe degradation, in which marginal areas are turned into wastelands and natural ecosystem are altered through destruction of surface vegetation. (Mukhopadhyay, 2009).

There is plenty of water, green forestry and wildlife in this area which is possible by the use of their socio-religious knowledge, values and tradition. Examples of such traditional and innovative adaptation practices include: shoreline reinforcement, improved building technologies, increased water quality testing, rainwater harvesting, supplementary irrigation, traditional farming techniques to protect watersheds, changing hunting and gathering periods and habits, crop and livelihood diversification, use of new materials, seasonal climate forecasting, community-based disaster risk reduction and so on. These methods of coping with extreme weather - and in the longer term, climate change - are effective and relatively cheap. What's more, they preserve cultures and local people's dignity. The main problem is that they're not given much weight at national and international level.

### What is Indigenous Knowledge?

Indigenous knowledge is local knowledge that is unique to a given culture or society (Warren, 1987). Indigenous knowledge is the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments, and intimate understanding of the environment in a given culture (Rajasekaran, 1993). According to Haverkort (1991), indigenous knowledge is the actual knowledge of a given population that reflects the experiences based on traditions and includes more recent experiences with modern technologies. Local people, including farmers, landless laborers, women, rural artisans, and cattle rearers, are the custodians of indigenous knowledge systems. Moreover, these people are well informed about their own situations, their resources, what works and doesn't work, and how one change impacts other parts of their system (Butler and Wand, 1990).

### Value of Indigenous Knowledge

Indigenous knowledge is dynamic, changing through indigenous mechanisms of creativity and innovativeness as well as through contact with other local and international knowledge systems (Warren, 1991). These knowledge systems may appear simple to outsiders but they represent mechanisms to ensure minimal livelihoods for local people. Indigenous knowledge systems often are elaborate, mid they are adapted to local cultural and environmental conditions.

Indigenous knowledge systems are tuned to the needs of local people and the quality and quantity of available resources (Prètty and Sandbrook, 1991). They pertain to various cultural norms, social roles, or physical conditions. Their efficiency lies in the capacity to adapt to changing circumstances.

According to Norgaard (1984) Traditional knowledge has been viewed as part of a romantic past, as the major obstacle to development, as a necessary starting point, and as a critical component of a cultural alternative to modernization. Only very rarely, however, is traditional knowledge treated as knowledge perse in the mainstream of the agricultural and development and environmental management literature, as knowledge that contributes to our understanding of agricultural production and the maintenance and use of environmental systems.

### Diversity of Indigenous Knowledge

Indigenous knowledge systems are:

- Adaptive skills of local people usually derived from many years of experience, that have often been communicated through "oral traditions" and learned through family members over generations (Thrupp, 1989).
- Time-tested agricultural and natural resource management practices, which pave the way for sustainable agriculture (Venkatratnam, 1990).
- Strategies and techniques developed by local people to cope with the changes in the socio-cultural and environmental conditions.
- Practices that are accumulated by farmers due to constant experimentation and innovation.
- Trial-and-error problem-solving approaches by groups of people with an objective to meet the challenges they face in their local environments (Roling and Engel, 1988).
- Decision-making skills of local people that draw upon the resources they have at hand.

Indigenous knowledge provides the basis for problem-solving strategies for local communities especially the poor. It represents an important component of global knowledge on development issues. IK is an underutilized resource in the development process. Learning from IK, by investigating first what local communities know and have, can improve understanding of local conditions and provide a productive context for activities designed to help the communities. Understanding IK can increase responsiveness to clients. Adapting international practices to the local setting can help improve the impact and sustainability of development assistance. Sharing IK within and across communities can help enhance cross-cultural understanding and promote the cultural dimension of development. Most importantly, investing in the exchange of IK and its integration into the assistance programs of the World

Bank and its development partners can help to reduce poverty.

### **Mitigation and Adaptation and the Role of Indigenous Knowledge**

#### **Mitigation and adaptation**

It is generally known that Africa is a minor contributor of global GHG emissions. Its share of carbon emissions, which is by far the most important GHG, is only 3.2% of the world's total in 1992. Its share of methane emission is also small, only 7.7% of the world's total in 1991 (Davidson 1998). Agriculture, and land use sectors dominate GHG emissions in Africa, accounting for 57%, with the energy sector accounting for 32%. Emission from gas flaring is increasing but still accounts for a very small share.

Two lines of actions are articulated in the literature for dealing with the adverse conditions that are expected to attend climate change. These are mitigation and adaptation strategies. Mitigation strategies are procedures or activities that help prevent or minimize the process of climate change. According to Swart *et al.*, (2003), mitigation strategies can be grouped into two categories: some represent mainly technological solutions; others involve changes in economic structure, societal organization, or individual behavior. In the African Sahel, mitigation activities are traditionally employed as natural resources conservation measures, but they generally serve the dual purposes of reducing the emission of GHG from anthropogenic sources, and enhancing carbon sink". Strategies aimed at reducing GHG emission emphasize cutbacks in the burning of fossil fuel through improved energy-efficiency, use of clean energy sources particularly solar and discontinuation of gas flaring. Carbon sink enhancement generally involves forestry programmes that protect the forest and 'encourage afforestation in marginal areas including range lands (Adesina *et al.*, 1999).

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. They also include the use of technological products that enable the individual to function in the "new" condition. Obviously adaptation strategies are expected to be many, and their combinations in various will be required in any given location.

Until recently, mitigation and adaptation were seen as two mutually exclusive strategies.

Nevertheless, there are strong linkages between the two and it is increasingly recognized that integration of both strategies may not only provide new opportunities, but may even be a prerequisite for successfully addressing both issues. According to Klein *et al.*, (2003), integration connects mitigation and adaptation with natural resource management, biodiversity conservation and measures to combat desertification. While the intellectual argument for integration has been strongly made, its realization in the policy realm has been less successful. Mitigation and adaptation should not all be about the implementation of options; successful implementation depends on the availability of various types of resources to create an enabling environment for mitigation and adaptation, including the capacity to adapt and mitigate (Klein and Smith, 2003). Poverty and limited technical capacity have been identified as the major impediments to integrating mitigation and adaptation in developing countries, particularly in Africa (Michaelowa, 2001; Yohe 2001). Because the poor are considered the most vulnerable to climate change impacts, it is often believed that financial capital is the most important indicator of adaptive capacity. According to the 1998/1999 World Development Report, knowledge, not financial capital, is the key to sustainable social and economic development. Building on local knowledge, the basic component of any region's knowledge system, is the first step to mobilize such capital (Phillips and Titilola, 1995).

#### **Indigenous knowledge in climate change mitigation and adaptation**

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. Therefore Indigenous Knowledge is not transferable but provides relationships that connect people directly to their environments and the changes that occur within it, including climate change (Woodley, 1991).

Indigenous knowledge has been directly applied in the Sahel in climate change mitigation through emission reduction, C 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. Considering that agriculture and land use changes are identified as the two main sources of GHG in Africa, we will review indigenous knowledge systems that have been applied in mitigation and adaptation within these two sectors.

Local farmers in the have been known to conserve 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.

Agroforestry is another practice that has been very effective in carbon sequestration. Agroforestry 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; Floyd, 1969). A practice similar to this has been described in a part of 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.

Traditional knowledge of plants is very useful in agro-forestry projects. Scientists have tended to limit plants' trials for forestry and agro-

forestry to known species that have performed well in other parts of the world. In the drier parts of the Sahel, the significance of the baobab (*Adansonia dig irate*) and acacia (*Acacia*) trees is just being realized by researchers as a valuable tree especially during the hot and dry parts of the year. Local people certainly know other trees that perform well under different ecological conditions. The integration of such candidates into the pool of suitable agro-forestry trees will provide opportunities for the farmers to make choices.

Local knowledge is vital for preserving biodiversity, which is considered a very successful mitigation 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 their 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.,

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). There is a wealth of local knowledge based on predicting weather and climate. A study of weather knowledge in various parts of the Sahel 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. To a very great extent, these systems of climate forecasts have been very helpful to the farmers in managing their vulnerability. 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.

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. 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. This system of seasonal movement represents a local type of traditional ranching management system of range resources.

### **Benefits of indigenous knowledge in climate change mitigation and 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 mitigation and 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 (Adugna, 1996; Woodley, 1991). 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 mitigation and adaptation options.

### **Steps to integrate indigenous knowledge into mitigation and adaptation strategies**

In order to integrate indigenous knowledge into formal climate change mitigation and adaptation studies, certain steps must be taken. The first step is to acknowledge that indigenous knowledge has provided communities with the capability of dealing with past and present vulnerabilities to climatic extremes and other stresses. Second, one must adopt the bottom-up participatory approach that encourages the highest level of local participation. The benefits of this are that (i) Provides valuable insight into how communities and households interact and share ideas, and (ii) It allows the intended beneficiaries to develop the skills and practices necessary to forge their own path and sustain the projects. (iii) The local communities should be seen as equal partners in the development process. It is basically an internal process, which only may be enhanced by outside assistance. Local actors should progressively take the lead while external partners back their efforts to assume greater responsibility for their development. Reducing vulnerability entails the strengthening of adaptive capacities of vulnerable individuals and groups. Capacity building should emphasize the need to build on what exists, to utilize and strengthen existing capacities. Indigenous knowledge plays a significant role in the sum total of what exists in a local community. Fourth, inasmuch as we acknowledge the importance of indigenous practices in climate change mitigation and adaptation, they should not be developed as substitutes of modern techniques. It is important that the two are complements and learn from each other in order to produce "best practices" for mitigation and adaptation (Adugna, 1996). A Best Practice is the result of articulating indigenous knowledge with modern techniques-a mix that proves more valuable

than either one on its own. The interaction between the two different systems of knowledge can also create a mechanism of dialogue between local populations and climate change professionals, which can be meaningful for the design of projects that reflect people's real aspirations and actively involve communities.

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 consideration in the process of validation and evaluation.

### Conclusion

While 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 mitigation and adaptation strategies. Climate change cannot be divorced 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. Incorporating indigenous knowledge will prove it be among the cost affective, users-friendly and participating approval.

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