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Africainteract

Enabling research-to-policy dialogue for adaptation to climate change in Africa

Research and Policies for Climate Change Adaptation in Central Africa Agriculture SUMMARY



Jacob Mbua Ngeve,
 Abdulai Jalloh,
 Michel Ndjatsana

Jacob Mbua Ngeve¹, Abdulai Jalloh², Michel Ndjatsana³

¹ **Research Professor**, Institute of Agricultural Research for Development, BP 3134 Yaoundé, Cameroon

² **Programme Manager**, Natural Resources Management Programme, Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles/West and Central African Council for Agricultural Research and Development (CORAF/WECARD), 7 Avenue Bourguiba, BP 48, cp 18523 Dakar, Senegal

³ **Expert en Environnement**, Commission des Forêts d'Afrique Centrale (COMIFAC), Yaoundé, Cameroon

Acronyms and Abbreviations

AAP	African Adaptation Program
AfDB	African Development Bank
APRM	African Peer Review Mechanism
CAADP	Comprehensive Africa Agriculture Development Programme
CAR	Central African Republic
CARPE	Central African Regional Program for the Environment
CCAA	Climate Change Adaptation for Africa
CED	Centre for Environment and Development
CERAD	Central European Weather Radar Network
CIFOR	Center for International Forestry Research
COMIFAC	Commission des Forêts d’Afrique Centrale
CORAF/WECARD	Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles / West and Central African Council for Agricultural Research and Development
CSA	Climate-smart agriculture
DFID	Department for International Development (UK)
DRC	Democratic Republic of the Congo
FAO	United Nations Food and Agriculture Organization
GDP	Gross domestic product
GHG	Greenhouse Gas
GIS	Geographic information system
ICRAF	World Agroforestry Centre
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
IRAD	Institut de Recherche Agricole pour le Développement (Cameroon)
IUCN	International Union for the Conservation of Nature
JICA	Japan International Cooperation Agency
LCBC	Lake Chad Basin Commission
MDG	Millennium Development Goal
MINADER	Ministry of Agriculture and Rural Development (Cameroon)
MINEP	Ministry of Environment and Nature Protection (Cameroon)
MINEPIA	Ministry of Livestock, Fisheries and Animal Industries (Cameroon)

NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Programme of Action
NEPAD	New Partnership for Africa
NGO	Non-governmental organisation
OECD	Organization for Economic Cooperation and Development
ONACC	National Observatory on Climate Change (Cameroon)
UAIC	Unite d’Afforestation Industrielle du Congo
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICONGO	Union patronale et interprofessionnelle du Congo
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

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1. Introduction

Sub-Saharan Africa is considered one of the world's most vulnerable and the most exposed region in the world to the impacts of climate change (World Bank 2009). Climate change is known as a source of risk to Africa's food and water security, livelihoods, shelter and health. Climate change has emerged as a new and unavoidable threat to agriculture in Central Africa. There has been growing research interest in and support for climate change adaptation in agriculture in Africa. Research on climate change adaptation is required to ensure that the findings are appropriately applied to inform policy formulation on climate change adaptation.

It is critical that Governments of Central African countries make policies which are informed by the existing body of knowledge on climate change, climate variability and climate change impacts. Results generated by scientific research should hopefully enable the respective sectors to build resilience against climate change and climate variability through adequate adaptation strategies and contribute to mitigation of climate change impacts through the use of improved and innovative technologies and management practices.

The West and Central African Council for Agricultural Research and Development (CORAF/WECARD) commissioned a detailed critical review of research and policies related to climate change adaptation in the agricultural sector in West, East, Central and Southern Africa. This paper reports on the outcome of the review to enhance the knowledge base and support research-based policy formulation for climate change adaptation in the agricultural sector in the Central African region.

The objectives of this review were outlined as follows:

- (a) To make a synthesis of research related to adaptation to climate change in the agricultural sector in Central Africa;
- (b) Identify research and policy gaps related to climate change adaptation in the agricultural sector in Central Africa;
- (c) Identify the key stakeholders as well as the opportunities for improving the research-policy interaction and collaboration in climate change adaptation in the agricultural sector; and
- (d) Show how research informs policymaking by decision-makers in the countries of the region.

The review on climate change adaptation in the Central African region was carried out with particular focus on Cameroon, Congo Republic and Gabon, where relevant information is available. Additional data for the review was also obtained from Democratic Republic of Congo, Central Africa Republic and Chad and Equatorial Guinea.

Definition of Key Concepts

Climate-smart agriculture (CSA): Agriculture that sustainably increases productivity, builds resilience (adaptation), reduces/removes GHGs (mitigation) and enhances achievement of national food security and development goals. (FAO 2010).

Vulnerability: Vulnerability to climate change refers to the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and adaptive capacity (IPCC 2001).

Adaptation: Adaptation to climate change is defined as a process of adjustments in natural or human systems to a new or changing environment. Adaptation to global warming and climate change is thus a response to climate change that seeks to reduce the vulnerability of biological systems to climate change effects.

Adaptive Capacity: A community's adaptive capacity refers to its ability to adjust to climate change and to moderate or cope with the impacts, including taking advantage of opportunities that may arise with climate change (IPCC 2001).

Exposure: This is the degree of climate stress upon a particular country. It is defined by the magnitude, character and rate of climate change in a given geographical area (IPCC 2001).

Sensitivity: Sensitivity is the degree to which a community or a system will be adversely or beneficially affected by, or be responsive to climate-related stimuli (Smith et al. 2001; IPCC 2001).

2. Overview of the Central Africa Agriculture Sector

Agriculture in the Central Africa is characterised by a predominance of livestock production, grain legumes (groundnut and cowpea) in the north, roots and tubers (cassava, yam and cocoyam) and plantation crops (coffee, cocoa, rubber, banana and tea) in the forested south. Cassava is the main food crop in Congo Republic, Democratic Republic of Congo, Gabon and Equatorial Guinea, while sweet potato is the most important food crop in Rwanda. Cameroon produces a wider diversity of food crops, from cereal-based systems (sorghum, millet and rice) and cattle in the north; Irish potato, grain legumes and vegetables in the western highlands; and starchy staples (cassava, cocoyam, plantain and maize) as well as pigs, goats and poultry in the forest areas of the south. The indigenous people of Central Africa, known as Pygmies, are hunter-foragers, and are quite distinct genetically and culturally from their Bantu neighbours who are mainly farmers.

The agriculture sector, in Central Africa faces tremendous challenges, and is highly sensitive to extreme climatic fluctuations. Agriculture is primarily rain-fed, and the onset of rainfall and precipitation levels have become highly variable, with some parts of the region experiencing decreases in annual rainfall that have made it impossible for farmers to be aware of when to plant or where to graze. Wildlife species migrate southward in search of water. Massive floods resulting in soil erosion in dry areas with fewer months of rainfall have made matters worse.

New diseases have emerged and minor diseases have developed highly virulent strains. Deforestation is being enhanced by extensive agriculture to increase agricultural production, resulting in massive loss of biodiversity, depletion of water resources and extensive environmental degradation.

Agricultural production is characterised by stagnant yields, land degradation and recurrent droughts. Without a sound agricultural sector, the Central African region, already facing food insecurity and poor health, is unlikely to develop diversified economies that can cope with the impact of climate change. Consequently, the impact of climate change on agriculture and food security in the region over the next few decades will depend on progress in applied agricultural research and development (IPCC 2007).

3. Research on Climate Change Adaptation in Central Africa Agriculture

Central Africa's agriculture is seriously affected by the adverse impacts of climate change. However, in the region food security and climate change can be addressed together by transforming agriculture and adopting practices that are climate-smart. Studies have shown that climate change is the result of human activity in the countries of the Congo Basin which rely heavily on agricultural production. (Gockowski and Sonwa 2010; Sonwa et al. 2009; Ickowitz 2006; Nolte et al. 2001; Gockowski et al. 1998; Kotto-Same et al. 1997).

Effects of climate change on the agriculture sector in Central Africa: The unpredictable and erratic climatic patterns resulting from climate change pose a serious threat to the agricultural sector, affecting crop production and impacting on farmer livelihoods and food availability. These climatic effects on the agricultural sector in the region are related to variability in local climates rather than in regional climate patterns.

Farmers of the sub-region agree that among the roots and tubers, cassava (the basis of the diets of most populations) is the hardest hit, and its field yields and disease resistance have been most affected by climate change. High yielding cassava varieties which were yielding upwards of 35t/ha under on-farm conditions have seen their yields reduced to a bare 15t/ha. New diseases like the cassava root rot have developed in synergy with root insects such as the African root and tuber scale (*Stictococcus vayssierei*). African cassava mosaic disease, endemic in the region, has developed more virulent strains such as the Ugandan variant. At the same time, a minor cocoyam leaf spot (caused by *Phytophthora colocasiae*) has turned into a yield devastating blight for the crop. The severity of maize and sorghum *Striga* has made these crops less productive in the north, leading scientists to produce extra-early maize and sorghum varieties to curb hunger in that agro-ecological zone. In the forest region, plantain fungal diseases have increased in severity because of increasingly heavy precipitation in that ecozone. Maize has been seen to be the most vulnerable cereal, followed by rain-fed rice. Groundnut and common bean are the grain legumes most affected by a changing climate in the sub-region. All these have seen substantial losses to

agricultural production. There is need to support research in the region to enable farmers to adopt measures and strategies for adaptation of their agriculture to these climate-induced changes.

Two major hazards for agriculture are temperature and precipitation which invariably affect livestock, fisheries and crop performance. The effect of temperature on crop performance varies with the species concerned. An assessment of adaptation of bambara groundnut, peanut, maize, sorghum and soybean in eight agricultural regions of Cameroon showed that for the future, substantial yield increases are estimated for bambara groundnut, soybean and peanut, while little or no change or even decreases are estimated for maize and sorghum yields, varying according to the climate scenario and the agricultural region investigated (Tingem et al. 2009). They found that for maize, sorghum and bambara groundnut, changing sowing dates as an adaptation strategy may be ineffective in counteracting adverse climatic effects because of the narrow rainfall band that strictly determines the timing of farm operations in Cameroon. In contrast, the possibility of developing later maturing new cultivars proved to be very effective in offsetting adverse climate impacts, giving the highest increases in productivity under different scenario projections without management changes (Tingem et al. 2009).

It has been found that lake fisheries (such as in Lake Chad) have already begun to feel the impact of climate variability, affecting fish production. Climate change is also affecting fish and their habitats in the region. Warmer temperatures are influencing the abundance, migratory patterns and mortality rates of wild fish stocks and determining what species can be farmed in certain parts of the region. These climatic effects on fish are already having social and economic consequences for people dependent on fisheries and aquaculture – workers, coastal communities and fish consumers.

The impacts of climate change on aquaculture are more complex than those on terrestrial agriculture owing to the much wider variety of species produced (Brander 2007), and because we are in an era of finite resources (Naylor et al. 2009), but more immediate progress can be made in aquaculture than in wild fisheries because of the greater level of control possible over the production environment (WorldFish Center 2007). Despite the advantages, the aquaculture industry has experienced very limited expansion in the Central African region because of the cost involved, and climate change adaptation strategies are not yet properly understood by farmers. Climate-smart fisheries and aquaculture will require: improving efficiency in the use of natural resources to produce fish and aquatic foods; maintaining the resilience of aquatic systems and the communities that rely on them to allow the sector to continue contributing to sustainable development; and gaining an understanding of the ways to reduce effectively the vulnerability of those most likely to be negatively impacted by climate change.

The challenge in the Central African region is how to strike a balance between increasing food production to ensure food security and alleviate poverty, and at the same time reduce GHG emissions and the resulting climate change. To adapt to climate change, choices will have to be made on intensifying agriculture on already exploited land (to avoid further deforestation) and rational use of fertilisers (mainly organic) to maintain productivity on existing exploited lands.

The state of research on challenges, options and barriers to adaptation. Currently, research on climate change adaptation is scanty in the region, but hopefully many on-going regional projects, some of which include agricultural adaptation, will generate some information on climate change as it affects agriculture and hopefully contribute towards adaptation to climate change in the region. Furthermore, the present state of research in the region does not give us enough information on how to address the many challenges posed to agriculture by climate change. In this regard, acid-tolerant genotypes now being developed in the region to address soil acidity may result in limited success when transferred to growers.

A recent study (see Tingem et al. 2008), showed substantial yield increases for bambara groundnut, soybean and groundnut, and little or no change and even decreases of maize and sorghum yields, varying according to the climate scenario and the agricultural region in Cameroon. The yields of maize and sorghum are expected to decrease by 14.6 and 39.9 percent, respectively, across the whole country. The results also show that the effect of temperature patterns on climate change is much more important than that of precipitation. Findings call for monitoring of climate change/variability and dissemination of information to farmers, to encourage adaptation to climate change

In the 12,000 years since livestock were first domesticated more than 7,000 breeds have been developed, all of which adapted to a specific habitat and were shaped, often over centuries, by the cultural preferences of a particular community (FAO 2007). Examples of local adaptation are the N'Dama cattle in Central Africa, the West African dwarf goats and the Djallonke sheep and goats of Central Africa, which were bred in the tsetse-infested humid and sub humid zones of West and Central Africa. These breeds have demonstrated resistance in the tsetse infested zones of West and Central Africa where trypanosomiasis is prevalent (Bosso 2006). These breeds have a proven ability to survive, reproduce and remain productive without recourse to drugs. The raising of these indigenous, trypanotolerant livestock is one approach to control disease, reducing the risk of inducing drug resistance in trypanosome strains.

During drought, pastoral women also harvest wild food and other products that have market value such as honey, thereby playing a particularly important role in natural resource management. Barriers and constraints to adaptation such as lack of information about short-term climatic variation, lack of knowledge of appropriate adaptation measures and lack of credit or savings to effect adaptation measures have been identified which hinder the adoption of adaptation strategies in the region.

International research support to climate change adaptation:

The International Livestock Research Institute (ILRI) intervenes in this domain by providing a framework for climate change adaptation work. Scientists at ILRI do so by conducting analytical and diagnostic studies; identifying hotspots of climate change and vulnerability; conducting vulnerability assessment to identify intervention options; exploiting climate change scenarios; and assessing ex-ante adaptive responses and impacts on livestock communities and ecosystems. They also test the feasibility of promising adaptation options; support the design and formulation of adaptation strategies; assess feasibility of index-based livestock insurance for large populations facing covariate risks linked to climate change; and identify institutional arrangements to deliver livestock insurance products to the poor, particularly women

(Ayantunde et al. 2008). ILRI also intervenes in building the capacity of research and non-research actors; supports implementation of adaptation projects; pilot tests adaptation interventions; and does results-based monitoring and evaluation, focusing on what works, what does not work, and why, lessons learned and issues for scaling up.

There is also indispensable support and partnership provided by other actors such as the IPCC (involved in the making of inventories of GHGs), UN Food and Agriculture Organization (FAO), the CGIAR Centres, NGOs, industry and the private sector. These organisations provide adaptation options, while advanced research centres and universities carry out climate prediction and modelling. Unfortunately, livestock adaptation issues in developing countries are not well articulated or well studied, resulting in a dearth of information in this domain in the Central African region.

4. Sector Policies for Climate Change Adaptation in Central Africa Agriculture

Institutional support for adaptation policy in the region

At the G8 summit in Gleneagles, Scotland in 2005 decisions were made to support the reduction of vulnerability of African countries' to climate change by strengthening the existing climate institutions and centres in Africa through the Global Climate Observing System (Niang 2007). Consequently, the World Bank committed to incorporate climate risk into its investment portfolio. African Union African Heads of states are being urged to integrate climate change issues into their national development policy agendas. Generally, interest in climate change is increasing, especially at the Economic Community of Central African States (ECCAS) (Niang 2007). At a meeting of the Assembly of the African Union in Addis Ababa (Ethiopia) (29-30 January 2007), all the governments in Central Africa were urged to integrate climate change considerations into development strategies and programmes at national and regional levels and to implement the Plan of Action on Climate Change and Development in Africa.

New Partnership for Africa's Development (NEPAD): Many countries in the region are lagging behind in official climate change policies. The Conference of African Ministers of the Environment (ACMEN), in the second Assembly of the African Union at Maputo in July 2003, prepared and adopted a plan of action for the NEPAD environment initiative which included early warning systems for natural disasters, identification of climate-vulnerable ecosystems and regions and regional and sectoral development of adaptation strategies.

IDRC/DFID: The Climate Change Adaptation in Africa (CCAA) programme, financed by DFID and IDRC, is a product of the G8's commitment to support Africa, to reduce vulnerability to climate change (Lafontaine et al. 2012; IDRC/DFID 2007). Launched in 2006 and completed in 2012, the CCAA contributed to building organisational capacity and improving the adaptation capacities

of African researchers and local communities and organisations; helped increase to some extent the adaptation capacities of decision-makers; raised awareness among targeted local communities and local and national decision-makers with respect to climate change issues, vulnerability assessment and adaptation strategies; and also significantly contributed to the knowledge base and the development of knowledge-sharing mechanisms at various levels, providing some benefits at the local level for at-risk communities and the most vulnerable.

Lake Chad Basin Commission (LCBC): This consortium is made up of Cameroon, CAR, Chad, Niger and Nigeria, and its main mission is to provide policy in the management and exploitation of the Lake Chad Basin. It has developed strong policies to support better understanding of the contribution of fisheries to local, national and regional economies, including the sector's contributions to food, nutrition and livelihood security.

National Policies on climate change

Cameroon: *National agriculture sector policies and strategic documents:*

Agriculture sector policies which are formulated by MINADER aim at enhancing agricultural productivity by increasing cultivable areas, irrespective of whether or not these affect climate change. Climate change adaptation and mitigation considerations have been integrated into the country's National Environmental Management Plan which aims at drastically reducing GHG emissions, and which has identified coastal zone management for fisheries, mangrove and coral reef protection as a major component. The Government of Cameroon has also established a regional Climate Change Observatory (ONACC), an institutional home for climate change-related research and information for the sub-region (CMEF 2005), and has plans to establish a country-wide multi-sectorial approach to adaptation, including agricultural adaptation, in the different agro-ecological zones, taking a poverty reduction focus and integrating gender-sensitive approaches.

The Government of Cameroon has been active in integrating climate change into national environmental strategies (such as the National Plan for Environmental Management) and formulating a country-wide approach to adaptation (Crawford et al. 2011). It has also submitted its Initial National Communication to the United Nations Framework Convention on Climate Change (UNFCCC).

Gabon: *Agriculture policies and climate change:* Gabon's agriculture and food security policies are geared toward enhancing food security and protecting coastal areas for increased fish production, and the country is well aware of the implications of climate change. However, there appears to be no specific climate change policies related to agriculture, nor agricultural sector policies with anything to say about climate change. Climate change projects in Gabon include the Institutional Reinforcement Project for Institutional Capacity for a Better Adaptation to Climate Change in the Coastal Zone of G Climate.

The Republic of Congo: No specific policies are available on agriculture and adaptation in the Republic of Congo. As a member of COMIFAC, Congo Republic will also benefit from the current project on Climate Change Scenarios for the Congo Basin. Policy issues on climate

change adaptation are currently lacking in the Republic of Congo. Existing policy texts are weakly applied and agricultural university institutions did not take into account issues of climate change. Human capacity building in research teams and basic infrastructure development (for climate forecasting and drought research) are weak and their improvement is urgently needed to foster work on agro-climatic data collection on climate change, as well as plant resistance to climate-induced drought in some areas of the country.

5. Research Gaps in Climate Change Adaptation and Sector Policies in Central Africa Agriculture

In the Central African region there are several areas of concern with regards to gaps in climate change adaptation research.

Gaps in agricultural research and policy

In agricultural research, the main gaps relate to identifying how to tackle climate change scenarios (precipitation, floods, temperature and drought) on crop farming and making the necessary government policies to implement adaptation. Major gaps in agricultural research are: (a) the adaptation of annual crop (maize, sorghum, millet and wheat) cultivar responses to drought in drier zones given the shortened water regimes in the Sahel, and the need for new crop varieties to bring resilience in the agricultural community in dry zones, (b) tackling emergent crop diseases in the context of changing climate; (c) countering increases in small animal diseases and pests in the forest-savannah transition areas in response to global warming and regional climate change; and (d) addressing fragile, highly depleted soils which are highly vulnerable to climate change (Knox et al. 2012).

Gaps in Fisheries adaptation research and policy

Major gaps in fisheries research and policy include: (a) research to support data collection of fishery and climate information for a regional data bank, and collating information and data already existing in the region; (b) climate change risk assessments adaptation plans, with special consideration to the most vulnerable populations; (c) documentation on the status and strength of disaster risk management and early warning systems in the region; (d) integrating research into climate change effects on the region-owned systems such as the Lake Chad Basin; (e) conducting research on prevention strategies for further reduction of water in the major lakes (such as Lake Chad, (f) field research and effective policies to restore fish biodiversity with rising sea levels and increasing pollution in the coastal maritime ecosystems, including production of fingerlings, phytoplankton and zooplankton; and (g) investigating measures to protect mangroves and coral reefs, important ecosystems which are currently in danger of pollution and destruction.

Gaps in livestock research and policy

Gaps in research and policy in the livestock sector include: (a) formulating effective policies on communal rangeland management systems to reduce conflict among livestock keepers; (b) enhancing studies and policies on crop-livestock integration to extend the lives of and enrich pasture lands and enable livestock rearers to adapt easily to climate change; (c) addressing emergent livestock diseases and pests in a changing climate; (d) adopting policies to enhance and protect wildlife through domestication of livestock species (a notable example worthy of emulation is the domestication of the cane rat which is now a popular sub-industry in some countries like Cameroon); (e) treating adaptation in the livestock sector as a generic capacity rather than specific only to climate change; (f) developing adaptive capacity in making informed assessment of threats, making informed choices about response measures from a range of options, deploying the preferred response measures and creating an enabling environment to implement these measures; (g) building capacities for improved climate forecasting and warning and increasing awareness of climate change and its consequences; and (h) strengthening human capital through basic education and public awareness and making information on livestock adaptation options widely available to all stakeholders.

Gaps in Pastoralism Research and Policy

Research and policy should focus on: (a) enhancing research and communication to improve understanding of the complex relationship between pastoralism and climate change; (b) promoting understanding of the importance of the pastoralism sector to the adaptation strategies of rural poor people of the Central Africa; (c) developing adaptive capacities among stakeholders in the pastoralism sector; (d) building capacities for improved climate forecasting and early warning systems, (e) increasing awareness of climate change and its consequences on pastoralism; and (f) improving pastoralist education and public awareness.

6. Stakeholders and Opportunities for Collaboration in Research on Climate Change in Central Africa Agriculture

The major stakeholders in Central Africa on climate change issues are governments, civil society, NGOs, research organisations, the donor community and farming communities. The diversity of stakeholders is useful in providing opportunities for effective collaboration in climate change adaptation matters.

COMIFAC is the regional body set up by the Heads of State of the Central African region to regulate forest development policy as well as issues relating to climate change in the forest zone. CIFOR and ICRAF are the international agricultural research centres which have active programmes on climate change in the region. CIFOR carries out work mainly on climate change policy on forest management, whereas ICRAF is more involved in climate change mitigation efforts. As regional actors, they are involved in internationally funded research projects involving many countries in the region.

There are a range of opportunities for collaboration between stakeholders and partners in climate change adaptation in Central Africa.

(a) Tapping of stakeholder expertise: Collaboration is effectively fostered through mutual consideration and respect among stakeholders. The governments of the region play a key role in forging collaboration of stakeholders to work together on climate change adaptation matters.

(b) Benefit sharing: All stakeholders are involved in negotiations on climate change projects. To avoid duplication, the partners brought together so that implementation of the various issues in climate adaptation are shared among the partners.

(c) Gender and Public-Private Partnership: Women's advocacy groups and private sector societies could be trained to disseminate climate change-related technologies which have been developed by researchers. Collaboration involving gender issues may also receive support from donors, who usually appear to prioritize funding projects in which women participate actively. Furthermore, the donor community appreciates projects which clearly show public-private partnerships, the two sectors working together harmoniously for the achievement of project goals.

7. Conclusion and Recommendations

7.1 Conclusions

In summary, it is concluded that considerable research effort is needed in climate change adaptation in the Central African region. There are national policies on climate change in the Central Africa countries but national governments should make a greater commitment to prioritize climate change adaptation in their political and economic agendas, to facilitate allocation of adequate funds for implementation of climate change adaptation strategies.

Finally, the problem of stakeholder coordination in the various countries needs to be addressed to provide opportunities for collaboration among them for the enhancement of climate change adaptation in agriculture in the Central African region.

Gaps in climate change adaptation research and policy

(a) Gaps in research: In crop production, manipulation of genetic resources to generate climate-smart genotypes and the refinement of climate-smart farming practices need to be studied. Investigations on natural resource management, effects of livestock mobility and exposure of livestock to diseases and pests as they migrate from their original niches to others in search of pasture and water need to be intensely investigated to enhance livestock and pastoralism. Ocean and river warming and rise in sea levels and their effects on fish species and other marine life and inland fisheries and aquaculture should be studied. Studies are also urgently needed on the protection of mangroves and coral reefs as these relate to marine life, fisheries

and aquaculture. Research gaps also exist in climate forecasting of imminent climate changes and in remote sensing.

(b) Gaps in policy: The policy gaps relate to the slow or non-implementation of agreements with international partners (UNFCCC, AAP, etc.); the apparent lack of commitment by governments in providing the necessary resources for climate change adaptation research; as well as regional and national policies for effective climate forecasting.

7.2 Recommendations

Crop farming adaptation

- (a) Central African countries should allocate adequate resources and investments in genetic enhancement research to develop crop genotypes that are adapted to harsh climates.
- (b) Establish appropriate mechanisms to ensure safer movement of propagules of vegetatively propagated crops from one country to another within the regions.
- (c) Reinforce the agricultural extension systems throughout the region, bringing in civil society, to be aware of possible threats of epidemics.
- (d) Support research to investigate cultural practices such as changes in the dates of planting, length of growing seasons, sensitivity to increased droughts, flooding, periodic water logging, increased temperature, salinity, acidity and aluminium toxicity which negatively affect crop performance.

Livestock and Pastoralism Adaptation

- (a) Invest in research and communication to improve understanding of the complex relationship between livestock, pastoralism and climate change.
- (e) Build capacity of livestock extension agents through community-based and participatory processes whilst promoting collaborative research into endogenous and exogenous adaptation options.

Fisheries Adaptation

- (a) Strengthen regional governance of the fishery industry to reduce over-harvest in the region.
 - (b) Communicate clearly with stakeholders, and the public, on how climate change will affect fisheries in the short-term and in the long-term.
 - (c) Protect ecosystems from degradation and pollution.
 - (d) End environmentally harmful subsidies made in the fisheries sector.
 - (e) Extend rights-based management systems.
 - (f) Restore and protect mangroves and coral reefs, which will contribute to carbon dioxide absorption, coastal protection, fisheries and livelihoods.
 - (g) Focus attention on aquaculture and on demand for sustainably caught seafood.
- Central African countries are aware of climate change and that climate change impacts are important to save farmers and populations from perishing.

Cross cutting recommendations

- (a) Build capacities and infrastructure for improved climate forecasting and warning and increase awareness of climate change and its consequences.
- (b) Strengthen human capital through basic education and public awareness and disseminate information widely on adaptation options.
- (c) Treat climate change adaptation as a generic capacity rather than once specific only to climate change, and focus on building adaptive capacities among all stakeholders, deploying the preferred response measures and creating an enabling environment to implement these measures.

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