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Discourse on Climate-Smart Agriculture for REDD+ Strategy in the Congo Basin

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Abstract

Sustainable agriculture is central to the development challenges of the Central African sub-region. It is the nexus for achieving the Millennium Development Goals. The Congo basin in the central African sub-region stores a vast amount of carbon. However, deforestation and degradation from agricultural practices compromise the forest carbon stocks at the expense of sustainable forest management. This paper contends that in the advent of climate change, agriculture must be one that meets the triple challenge of ensuring food security, adapting to climate stressors and contributing to climate change mitigation. The goal of this discourse is to unveil the potentials for climate-smart agriculture in contributing to a better REDD+ strategy for countries in the Congo Basin. The paper reveals that agriculture based on agroforestry systems and conservation practices will be required to conserve forests and ensure food production, and also contribute to meeting the objectives of REDD+. The paper demonstrates that sustainable land management and climate-smart actions that form the panoply of agroforestry actions could help increase carbon sequestration, increase overall productivity and ensure systems cope with the adverse effects of climate change. Harnessing these opportunities requires that the prescribed strategies strengthen the link between forestry and agriculture, and agrarian efforts maximize synergies and minimize trade-offs in addressing agricultural production, food security and climate change adaptation and mitigation challenges.

Keywords: climate change, REDD+, climate-smart agriculture, congo basin

1. Introduction

More than 70 million people inhabit Congo Basin's trans-boundary pool of natural resources, 62% of whom still live in rural areas depend for their everyday needs by direct use of forest ecosystem goods and services for household consumption, including food and fuelwood (Food and Agriculture Organization [FAO], 2005). It is now recognized that deforestation and forest degradation through agricultural expansion, conversion to pasture, infrastructure development, destructive logging and possibly fires account for nearly 20% of global greenhouse gas emissions - more than the entire global transport sector and second only to the energy sector (United Nations Environment Programme [UNEP], 2010). According to the FAO (2005), deforestation, mainly conversion of forests to agricultural land, continues at an alarming rate of approximately 13 million hectares per year (for the period 1990-2005). Deforestation results in immediate release of the carbon originally stored in the trees as CO_2 emissions with small amounts of carbon monoxide and methane, particularly if the trees are burned and the slower release of emissions from the decay of organic matter (Miles & Kapos, 2008; Millar et al., 2007). The Intergovernmental Panel on Climate Change [IPCC] estimated emissions from deforestation in the 1990s to be at 5.8 $GtCO_2$/yr (IPCC, 2007).

The Congo basin together with the Amazon basin and the Southeast Asia basin forest store a vast amount of carbon. According to FAO (2011a), the world's forests store 652 gigatonnes (Gt) of carbon in their biomass, deadwood, litter and soil. As noted in Table 1, 42% of this (or 271 Gt) is found in the three rainforest basins, despite the fact that these countries only account for 33% of the total forest area. This is because forests in these three basins store a higher amount of carbon per hectare (202 t/ha) than the global average (162 t/ha). While sustainable management, planting and rehabilitation of forests can conserve or increase forest carbon stocks, deforestation, degradation and poor forest management reduce them. The challenge, therefore, is to develop appropriate incentives for economic sectors that are responsible for deforestation, which simultaneously alter land use decisions, conserve forests and promote sustainable development. Since ecosystem services contribute to reducing the vulnerability of forest- and tree-dependent communities and the broader society to climate change, we must tap into the synergies between adaptation and mitigation. Thus, initiatives aimed at both adaptation and mitigation should be explored as a win-win proposition to effectively tackle climate change and provide significant benefits to local development and biodiversity conservation.

Table 1. Carbon stocks in forests in the three rainforest basins, 2010

Région	Carbon in biomass		Carbon in dead wood		Carbon in litter		Carbon in soil		Total carbon stock	
	million tonnes	t/ha	million tonnes	t/ha	million tonnes	t/ha	million tonnes	t/ha	million tonnes	t/ha
Amazon Basin	95 495	119.5	6 025	7.5	3 108	3.9	71 669	89.7	176 297	220.5
Congo Basin	35 992	119.3	2 664	8.8	634	2.1	17 452	57.8	56 741	188.0
Southeast Asia	23 469	97.0	491	2.0	547	2.3	13 696	56.6	38 203	157.8
Rainforest Basins	154 956	115.4	9 180	6.8	4 288	3.2	102 817	76.5	271 241	201.9
World	288 821	71.6	32 904	8.2	38 984	9.7	291 662	72.3	652 371	161.8

Source: FAO, 2011a.

Gauging the importance of the Congo Basin forest relative to other significant forest repositories in Table 1, the provisions from forestry activities, wood industries and the pulp and paper industry which together contributed on average 2% to the GDP in all three rainforest basins combined, compromise these ecological assets. In the Congo Basin, more than 80% of the value added comes from forestry and logging, and only 1% from the pulp and paper industry, while in Southeast Asia, less than 40% is attributed to forestry and logging, with an additional 34% from the wood industry and 27% from the pulp and paper industry (FAO, 2011). This calls for measures to address the accessibility and exploitation of forest and optimization of the ecological and economic assets of forests.

In 2007, at the UN climate talks in Bali, the scope of REDD as a potential strategy for tackling of emissions arising from destruction of tropical forests, was broadened to include conservation of forest carbon stocks, sustainable forest management and enhancement of forest carbon stocks, given birth to REDD+ officially adopted by the UN Framework Convention on Climate Change (Harvey et al., 2010; UNFCCC, 2008). Under the United Nations Framework Convention on Climate Change (UNFCCC), all Parties, taking into account their common but differentiated responsibilities, have commitments to "promote sustainable management and to promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems." At COP-16 in Cancun, Parties to the Convention finally agreed that REDD+ provides a unique opportunity to reverse the ongoing trend of deforestation and degradation of forests and improve Sustainable Forest Management implementation in developing countries (UNFCCC, 2010; Miles & Dickson, 2010).

While REDD+ is also of interest to the Convention on Biological Diversity (Cowie et al., 2007), the IPCC also notes that reducing and/or preventing deforestation is the mitigation option with the largest and most immediate impact in controlling for emissions into the atmosphere (IPCC, 2007). REDD+ thus comes with potentials to encourage conservation, improve forest management practices and improve forest governance through tenure reform and better law enforcement (Miles & Dickson, 2010; Dutschke & Pistorius, 2008). To stabilize global average temperatures within two degrees Celsius, limits within which society will reasonably tolerate, it will practically require reducing emissions from the forest sector, in addition to other mitigation actions (Ravindranath, 2007; Millar et al., 2007). Thus, finding ways to maintain terrestrial carbon pools and to reduce carbon emissions from land use change will be key elements in future climate change management. This could have significant implications for both agriculture and forestry sectors, as well as land use and rural livelihoods.

Whatever forms international REDD+ mechanisms will take, REDD+ readiness requires that developing country governments develop policies to address the underlying causes of deforestation and degradation to tap into new opportunities to promote sustainable development and attract investments as viable alternatives to competing land use demands, particularly for agriculture and food and biofuels. This paper therefore sets as its goal to examine the adaptation and mitigation potentials of climate-smart agriculture in contributing to a REDD+ strategy for countries in the Congo Basin. This is important as it unveils opportunities for policy change which promote emissions reductions from deforestation and forest degradation through the employment of conservation techniques, which enhance carbon stocks, as a potential climate mitigation option (Bele et al., 2011; Klein et al., 2005; Adger et al., 2001). In fact, where the Congo Basin Forest is concerned, the intersection between climate change and agricultural investments is critical to conservation strategies (Brown, 2011). The region, without doubt, provides an excellent context within which to consider the interaction between climate change and sustainable adaptation choices (Hallegatte, 2009; Adger et al., 2003). Since changes in the climate system will continue into the future regardless of emissions mitigation, strategies for protecting climate-sensitive ecosystems through management will be increasingly important (Nkem et al., 2007; Guariguata et al., 2007).

2. Theoretical Review of Farming and Deforestation in the Congo Basin

The traditional farming systemis a mixture of perennials and annuals like citrus, manioc, banana, mango, cacao, coffee, and rubber. However, the slash-and-burn shifting cultivation which dominates the basin comes with inevitable decline in land productivity. Organic matter and nitrogen storage in the soil is thereby accelerated. Equally important, ICRAF (2002) notes that tree-based systems have higher returns on labour than traditional land uses but have other constraints to adoption by small scale farmers (high labour requirements, high start up cost, multi-year delays in achieving positive cash flow, high maintenance requirements). Despite agriculture being predominant, its productivity is persistently low with very little or no external inputs resulting in mining of the soil of nutrients. This combined with the high population growth rate is resulting in the continual extension of the forest margins for more productive land.

Economic profitability and environmental sustainability calls for the need to rationalize and optimize the system, domesticate high value indigenous species, integrate small-stock production into the system, and develop an enabling policy environment (Vignola et al., 2009) that caters for marketing, plant protection, land tenure and transformation of primary products from the agroforests. The virtues of trees in agroforests hinge not only on their economic benefits, but on the environmental wealth they generate, particularly in terms of soil productivity, especially in smallholder systems. Fast-growing trees with high nitrogen demand, e.g. *Calliandra calothyrsus, Sesbania sesban and Eucalyptus grandis* take up subsoil nitrate more effectively than a natural grass fallow in extracting subsoil water, thus suggesting less leaching loss of nutrients under these trees than under natural uncultivated fallows (Buresh & Tian, 1998). Duguma et al. (2001) observed that in terms of carbon sequestration and bio-diversity, cacao (*Theobroma cacao*) agroforest is superior to alternative food crop production land use. They note that the food crop production system is based on the practice of slash-and-burn farming, which, due to population pressure and reduced fallow cycle, is no longer sustainable.

While agriculture is the sector most vulnerable to climate change, given its inherent relationship with weather and climate factors, it is also a significant cause of global warming induced climate change, directly accounting for about 14% of global greenhouse gas emissions, and indirectly much more as agriculture is the main driver of deforestation and land-use change responsible for another 17% of global emissions (IPCC, 2001). Climate change stresses forests because of higher mean annual temperatures, altered precipitation patterns and more frequent and extreme weather events. At the same time, forests and the wood they produce trap and store carbon dioxide, playing a major role in mitigating climate change. However, when destroyed or over-harvested and burned, forests become sources of greenhouse gases, particularly carbon dioxide and methane (Feddema & Freire, 2001; IPCC, 2001).

The traditional causes of deforestation (Robiglio et al., 2010; Geist & Lambin, 2002) are noted in the Congo Basin to also include public policy encouraging deforestation and degradation particularly through the allocation of private commercial concessions in public forests, large-scale land deals for commercial agriculture, insecure tenure rights propelling farmers to clear land to stake their claim to the land, intra-regional immigration provoked by the creation of new opportunities thanks to infrastructural development and the development of new markets, and creation of new settlements or expansion of previous ones to support major development projects like dams, sea ports etc. There are also locally-led agricultural causes such as land degradation encouraging farmers to clear new forests, demographic pressures pushing young farmers to clear new lands, uncontrolled fires from agricultural systems spreading into forests, and shortening of forest fallows in shifting cultivation due to population pressures (de Wasseige et al., 2009; Duveiller, 2008). Economic and technological issues have also been noted to be important particularly in relation to market growth for both export and domestic commodities (Ndoye & Kaimowitz, 2000), urbanization resulting in increased demand for timber and commodities like pineapples, increase in cocoa prices and stable prices for palm oil, increased access to improved varieties of inputs for crops such as cocoa or oil palm, and increased accessibility to hand chainsaw in rural areas.

Slowing the rate of deforestation requires the sustainable intensification of agriculture if food security is to be assured in the Congo basin. Sustainable intensification will relate to the increase in yield per unit of land to meet current needs without exceeding current resources or reducing the resources needed for the future. This implies a number of compounding issues that have significant impact on agriculture production and sustainable access to safe and nutritious food. The most significant ones being weak institutional arrangements and legal frameworks for the ownership, allocation and use of land and water resources; inadequate access to markets and low value addition of agricultural produce (Brown, 2011; Ndoye & Kaimowitz, 2000); inadequate research, extension and communication for agricultural development (Duguma et al., 2001); low public allocation of finances required for investments in the development of agriculture (Ndoye & Kaimowitz, 2000); and lack of adequate and effective strategies for coping with climate variability and change (Goklany, 2007).

This implies a need for coordination among sectors, contrary to the current mode of governance which is dominated by an intra-sectoral forestry approach. This approach lacks consistency between, on the one hand, forest policies and laws and, on the other hand, those of other sectors that have an impact on deforestation and forest degradation. As a consequence, impacts expected from actions taken to combat deforestation and forest degradation may not be attained, as the dominant drivers of deforestation are in the other sectors particularly agriculture and energy e.g. slash-and-burn agricultural expansion and illegal or unsustainable firewood extraction and charcoal production. Multi-sectoral approach is required to improve integration between the forest sector and other sectors with potential impacts on trees and forests.

3. Methodological Approach

This is a qualitative review of the works of public and private sector prospects in the Congo Basin countries. These include consideration of information on forest and climate at both scientific and policy-making levels, with the aim of understanding of adaptation and mitigation in Congo Basin forests. In addition, regional policy documents, strategies, press releases and government statements at international and national meetings, workshops and dialogues on forest and climate change were reviewed. The goal of these programmes is preservation of the ecology and biodiversity of the wildlife and forests, and placing their use and protection on a sustainable basis for the long-term benefit of both the region’s inhabitants and its global common good.

The Congo basin and its drainage network, lying astride the equator in west-central Africa as noted in Figure 2, extends from about 4°N to about 5°S comprising an area of more than 1.3 million square miles, which includes almost the whole of the Republic of the Congo (RC), the Democratic Republic of the Congo (DRC), the Central African Republic (CAR), western Zambia, northern Angola, and parts of Cameroon and Tanzania. The rainforest expanse in Figure 1 covers 180 million hectares, spreading across the DRC, most of RC, the southeast of Cameroon, southern CAR, Gabon and Equatorial Guinea. Dominated by vast rivers systems and lakes e.g. the River Congo for which two countries are named: DRC and RC is 4,374 km (2,718 miles) long, being one of the longest in the world. The basin itself stretches for more than 1,200 miles (1,900 km) from north to south (from the Congo-Lake Chad watershed to the interior plateaus of Angola) and also measures about 1,200 miles from the Atlantic in the west to the Nile-Congo watershed in the east. Largely an equatorial rainforest, it is bordered on either side by belts of savanna forests where much of the region's agricultural productivity is found. Characterized by hot and wet weather on both sides of the equator, the equatorial strip is influenced by the inter-tropical convergence zone, which causes heavy and intense precipitation. The mean annual temperature in the area varies between 77 and 80 F. However north and south of the equator strip, the dry season increases in intensity. The equatorial climate that prevails over a significant part of the basin is coextensive with the dense evergreen forest.

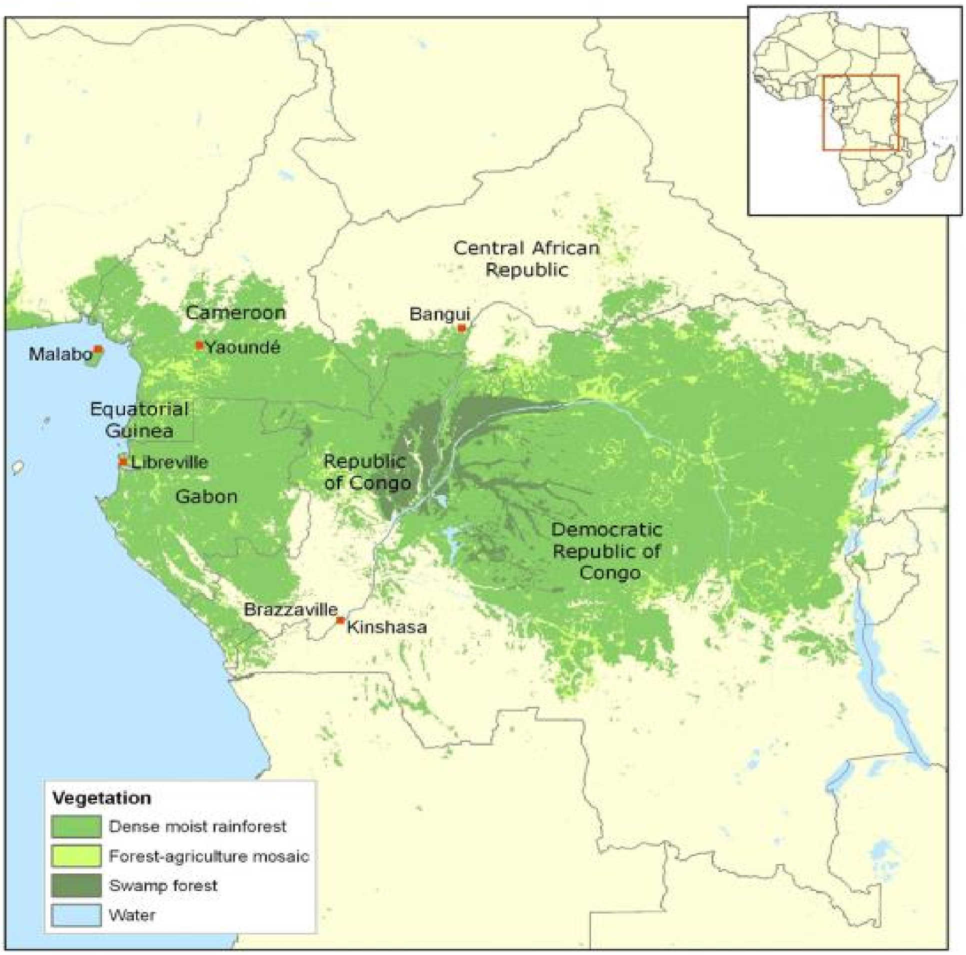

Figure 1. Map of the Congo Basin Forest (Source: WRI)

A number of international initiatives in the region seek to promote economic development, poverty alleviation, and effective governance by the conservation and sustained management of natural resources, including wildlife and forests. This includes the Congo Basin Forest Partnership (CBFP) launched at the Johannesburg World Summit on Sustainable Development (WSSD) in 2002 aims to promote the sustainable management of the Congo Basins' forests and wildlife by improving communication, cooperation, and collaboration among all the partners. The CBFP works closely with the Central African Forest Commission (COMIFAC) - the regional body in charge of forests and environmental policy, coordination and harmonisation, with an objective of promoting conservation and sustained management of the Congo Basin's ecosystem. In 2008, the AfDB, in partnership with COMIFAC and the United Kingdom Department for International Development (DFID), the Congo Basin Forest Fund (CBFF) was initiated to mobilize resources to finance activities and projects aimed at promoting the equitable and sustainable use, conservation and management of the Congo Basin forests and ecosystems for poverty alleviation, sustainable social-economic development, regional cooperation and environmental conservation. Within the context of its objectives, the CBFF has identified capacity building in REDD; in monitoring, assessment and verification; and in sustainable forest management as key thematic areas.

4. Discourse on REDD+ Strategy and Farming Systems in the Congo Basin

The contribution of forests and trees to carbon sequestration and mitigation of emissions recognized in the international negotiations on REDD+, requires national strategy initiatives and many farm-scale efforts to reduce deforestation and forest degradation. Better management of farming systems and practices is a precursor not only to proactive adaptation but also reactive mitigation. Thus, the better management of forests, tree resources and crop fields is an effective response to the climate change challenge. However, countries in the sub-region are in two tier REDD+ readiness. Cameroon, Republic of Congo and Gabon have formed national REDD+ task force or coordinating units being responsible for promotion of participatory forest management at the national and application of biodiversity conservation and other co-benefits; and promotion of participatory monitoring, reporting and verification. The challenge has been on capacity building for local actors e.g. local forest depended communities who should be seriously involved. For Equatorial Guinea and Central African Republic REDD+ coordinating units are in the preparation of national strategies and documentation of state of knowledge on national forest cover. The national REDD+ initiative in the DRC have been hampered. The challenges for these countries have been insufficient collaboration and co-operation to find common approaches and develop consolidated methods for forest inventory and assessment. In all countries in the basin, the political challenges have included lack of proper communication among various local actors and development partners, and inadequate awareness building at all levels.

Despite these initiatives, proper optimization of forest land uses and development of plans to accommodate agriculture still remains elusive to forest management in the basin. Deforestation and forest degradation remains unabated. It is estimated that in Cameroon, about 85% of the deforestation is due to small-scale farmers using extensive slash and burn techniques (Duveiller et al., 2008; ICRAF, 2002a). In addition, Ezzine de Blas et al. (2009), de Wasseige et al. (2009) and Laporte et al. (2007) note that the extensive logging compromise forest sustainability. Alternatively, the steady erosion of the stock of carbon in the Congo Basin forests impacts on the value of the basin in mitigating and adapting to climate change, and limits benefits from international REDD+ efforts. The total carbon stocks in the Congo Basin forest decreased by an estimated 153 million tonnes annually during the period 1990-2000 and 154 million tonnes between 2000-2010, mainly because of reduction in the forest area and accompanying significant loss of carbon in biomass and in soil. As noted in Table 2, during the period 2000-2010 total carbon stock declined by 27%.

Table 2. Trends in total carbon stocks in forests in the Congo Basin, 1990-2010

	Total carbon stock(million tonnes)			**Annual change(million tonnes)**		**Annual change rate(%)**	
	1990	**2000**	**2010**	**1990-2000**	**2000-2010**	**1990-2000**	**2000-2010**
Carbon in biomass	37 727	36 835	35 992	-89	-84	-0.24	-0.23
Carbon in deadwood	3 115	2 923	2 664	-19	-26	-0.64	-0.92
Carbon in litter	665	648	634	-2	-1	-0.26	-0.22
Carbon in soil	18 300	17 873	17 452	-43	-42	-0.24	-0.24
Total carbon stock	**59 807**	**58 278**	**56 741**	**-153**	**-154**	**-0.26**	**-0.27**

Source: FAO, 2011a.

The erosion of carbon stocks is in tandem with the increasing threats of climate change (Feddema et al., 2005; Justice et al., 2001) and the potential implantation of large scale plantations by foreign investors to produce biofuels and food crops (FAO, 2008). These challenges compromise some of the commitments made by countries of the basin as Parties to the UN convention on climate change. For instance, the agenda on “reducing emissions from deforestation in developing countries and approaches to stimulate action” introduced into COP-11 in Montreal (UNFCCC, 2005); Parties to the process recognized the contribution of greenhouse gas emissions from deforestation in developing countries to climate change and the need to take action to reduce such emissions. The COP-13 decision on “Reducing emissions from deforestation in developing countries: approaches to stimulate action” (Decision 2/CP.13), provides a mandate for several elements and actions by Parties relating to reducing emissions from deforestation and forest degradation in developing countries. It also provided for further strengthening and supporting ongoing efforts, support for and facilitate capacity-building, technical assistance and transfer of technology relating to methodological and technical needs and institutional needs of developing countries, and exploring a range of actions and options to address drivers of deforestation and enhance forest carbon stocks due to sustainable management of forests.

Therefore, taking advantage of Rio+20 or post-12 international arrangements and carbon market access will require that these countries explore the range of actions, identify options and undertake efforts to address optimal forest and agriculture land uses. This will require building capacity and address institutional weaknesses for proper land use and land-use change management particularly by local actors e.g. local forest depended communities, and development partners. While Congo basin countries are parties to the UNFCCC and also members of the Convention on Biological Diversity (CBD), they recognize that biodiversity and livelihoods of local communities may be affected by REDD (i.e. “co-benefits”), with the possibility of complications (Harvey et al., 2010; Hajer & Versteeg, 2005). Since agriculture and natural resource extraction form the life-wire of these countries, national strategies that optimize conservation and extraction must be the backbone of any national or regional climate framework. According to Article 6 of CBD on General Measures for Conservation and Sustainable Use, “each Contracting Party shall, in accordance with its particular conditions and capabilities: (a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, inter alia, the measures set out in this Convention relevant to the Contracting Party concerned; and (b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.” More important, the Stern Review, an analysis of the economics of climate change published by the UK government, emphasizes avoided deforestation as one of four “key elements” of future international climate frameworks.

The peculiarities and ecological assets in the Congo Basin require that REDD+ policies for countries in the region deal with different drivers of deforestation in both the forestry and the agricultural sector (Harvey et al., 2010; Ndoye & Tieguhong, 2004; Myers et al., 2000). When designing national REDD+ strategies, policies, laws and action plans, it may be therefore necessary to consider agricultural and rural development goals and adopt an integrated landscape approach (Kissinger, 2011; Tallis et al., 2008; Klein et al., 2005). This approach takes into account all land uses in a holistic way and works to lessen the competition for natural resources among different sectors. Such an approach ensures that the best possible balance is achieved among a range of different development objectives, including climate change mitigation and adaptation, environmental conservation, enhanced agricultural productivity and improved livelihoods (Brown et al., 2010; Campbell et al., 2008; Guariguata et al., 2007; Klein et al., 2005). Prato (2008), Tallis et al. (2008) and Robledo et al. (2005) expound important measures for managing climate change adaptation and mitigation measures through ecological-landscape approach. First, actions that help to reduce pressure on the natural resources should be prioritized, e.g. on land used for grazing, a mitigation action could be the planting of trees to sequester carbon. Second, vulnerability to climate change, such as the possibility of soil erosion from more intense rainfall, should be included as one of the risks to be analyzed before interventions are carried out. Third, priority should be accorded to mitigation activities that enhance local adaptive capacity, for example by adopting agroforestry practices, such as using trees to create living barriers to support nutrient cycling and counter erosion. Fourth the sustainability of livelihoods, with particular consideration for the poor, should be increased through a range of activities, including building or improving infrastructure, protecting the soil and safeguarding food security.

Though REDD+ proposes action beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks, the pressure of global warming and urgency to mitigate the effects of ensuing climate change, requires that promoting measures of general sustainable use of forest resources. Since the Congo Basin forest is invaluable to national and international objectives (FAO, 2011b; Myers et al., 2000), it must be the goal of all stakeholders and partners to balance environmental values, the social and economic needs of the basin, and the capacity of its forests to provide for sustainable levels of all forest values. As noted in Figure 2 below, the environmental or global objective for the Congo Basin must be for existing forests to be preserved to mitigate climate change by carbon sequestration; preserve biodiversity since undisturbed forests are home to a large number of plant and animal species; and protect watersheds to reduce the destabilization of the hydrological cycle. As the region's population rises and consumes more food, industries and urban development’s expand, and the emerging biofuel crops trade also demands a share of freshwater resources, water scarcity will become another important issue. Concerns on rising food prices and food security and increasing water scarcity and the high proportion of water used in agriculture draw attention to the urgent need to improve water management in both irrigated and rainfed agriculture.

The challenge of better land and forest management means that climate-smart agriculture is required to direct agricultural development along pathways that lead to sustainable increases in agricultural productivity; contribute to climate change adaptation by increasing social and ecological resilience; mitigate climate change by reducing and/or removing greenhouse gases; and support the achievement of national food security and development goals. Climate-proofing is required to ensure that climate related risks are reduced to acceptable levels through long-lasting and environmentally sound, economically viable, and socially acceptable changes implemented either at planning, design, construction, operation, and decommissioning of agricultural projects and programmes. Therefore, farming activities will not only have to be climate-proof but also employ effective methods that ensure ecosystem resilience to climate change stressors (Kissinger, 2011; Hallegatte, 2009; Klein et al., 2005). This will require specificities in the practice of either small or large-scale agriculture.

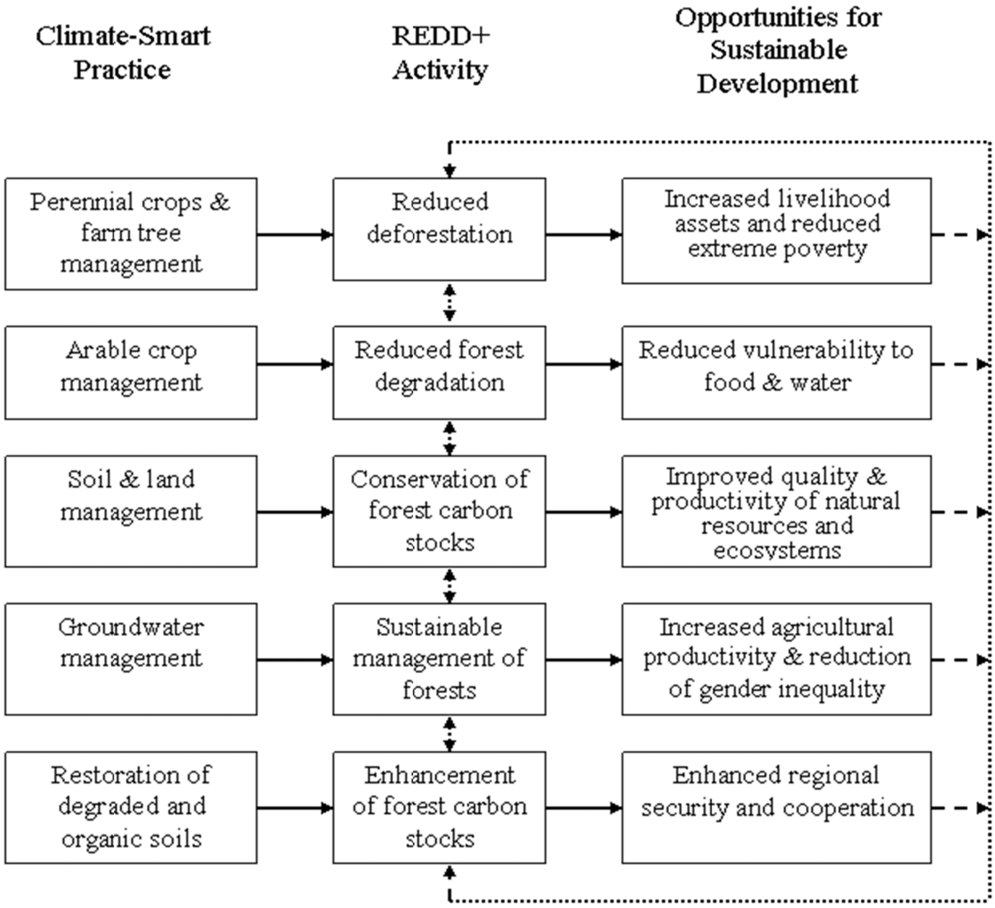

Figure 2. REDD+ activity and opportunities for sustainable development from climate smart practices

For small farms, intensifying agriculture on current agricultural land (i.e. already deforested areas) as well as reclaiming degraded landscapes is required. Where long fallow lands are available, small-scale farmers would have to capture fertility through improved fallow. In areas with insufficient land, settling of small farmers for intensive agriculture shall be required to reduce the need to clear new forests. This will require improved fallow agroforestry systems which use nitrogen fixing trees and shrubs to enhance soil fertility. Combining agroforestry with conservation agriculture maintains permanent or semi-permanent organic soil cover to protect the soil physically from sun, rain and wind and feeds soil biota; zero tillage or minimum tillage not to disturb the activities of soil micro-organisms and soil fauna; and crop rotations to reduce disease and pest problems, to explore different soil strata for water and nutrients. The extension service system and communication unit would have should to be reinvigorated to popularize the virtues and long-term benefits of these systems and practices, more especially in the era of declining farm labour supply and increasing costs of chemical inputs. The use of conservation agriculture practices within agroforestry systems saves labour and allows farmers to diversify their activities including processing of agricultural products, hiring themselves out in off-farm employment and reduce the cultivated area-made possible because of increased yields-and allowing marginal areas of poor fertility to regenerate. The profitability of these system and practices is contingent on adequate market access reduction of post-harvest losses through better storage facilities and transport infrastructure. Through market cooperatives successive market power may be exercised at each stage of the agricultural produce chain, influencing prices upward or downward to enhance farm profit. The formation of either producers or marketing cooperatives means that farmers enter into downstream arrangements with enhanced bargaining power, higher levels of income and the possibility of wealth creation rather than mere poverty alleviation.

Box 1. Check-list for policy making and planning

Policy Review

・Do agricultural policy instruments influence the promotion and adoption of agroforestry and conservation agriculture?

・Do fiscal policy instruments influence investments in the agricultural sector and agribusiness?
・Do trade policy instruments influence the export and imports of agricultural products and inputs?

Farming System

・Does the current farming system restrict adequate agriculture and food production?

・Does the current farming system perpetuate drudgery, discomfort and poverty among farming communities?
・Does the current farming system have adverse environmental impact
・Does farming restrict the performance of men and women in their performance of household tasks?

Marketing and Distribution

・Does the local marketing provide farmers with their needed farming inputs and equipments?

・Does the import of agricultural inputs meet the demand of the farming community?
・Are there significant post-harvest losses between harvest and consumption?
・Does the distribution and marketing ensure profitable returns to the farming community?

Supporting Institutions

・Are there adequate credit facilities for farmers and distributors of farm produce?

・Is there adequate training of farmers on sustainable environmental friendly and climate resilient agriculture?
・Does the extension service provide adequate support?
・Is there adequate training and extension support for practicing agroforestry and conservation agriculture?
・Do farmers, distributors and manufacturers in the food and beverage industry have sufficient market information to make informed choices?
・Is there adequate protection of consumers from poor or illegal business practices, such as hoarding and adulteration?

5. Recommending Policy Actions for Climate-Smart Agriculture in the Context of REDD+

Proactive agro-economic policy environment is required to cater for governance, coordination and distribution along commodity value chains. This requires promoting ecosystem climate-friendly farm practices, properly conceptualizing national and regional market structures for key agricultural commodity, correcting institutional and structural issues in the commodity markets, addressing farmers' constraints in commodity development and sectoral investments and timely addressing changing market structures and distributional issues (Vignola et al., 2009; Hallegatte, 2009; Nkem et al., 2007). A policy framework that ensures agriculture remains climate-smart and achieves its multiple objectives (Kissinger, 2011), will have to include the following:

- Strengthening the capacity of training, extension, research and technology development institutions in climate-smart agriculture based on scientific knowledge, indigenous knowledge of the Congo basin and appropriate innovations in line with the proposed agriculture development model. For example capacity building, extension and research programmes must screen and match species with the right ecological zones and agricultural practices for agroforestry.

- Promoting research to determine the optimum combination of tree spacing and orientation of the trees for maximum productivity.

- Securing tenure rights to land, trees, carbon and associated benefits of farmers to reduce land clearing as a means to establishing property rights to land with trees on it and also for farmers to invest in a piece of land and benefit from the investment.

- Developing public-private partnerships for the supply of inputs required for climate-smart agriculture (e.g. jab planters, no till direct drills, seeds for cover crops, pesticides, etc).

- Providing for access to markets for produce from agricultural intensification.
- Increasing access to credit facilities for farmers to be able to invest in climate-smart agriculture with preferential interest rates and payment conditions compared to what obtains in commercial banks.
- Providing institutional and financial support to enable smallholders to make the transition from slash and burn to climate-smart agriculture. The financial support could be from REDD+ compliance being put in place.

Therefore, to assist policy reviews a check-list for government policy makers and planners to employ in addressing emerging issues on agricultural land-use and food security is presented in Box 1.

6. Conclusion

Agriculture in the Congo Basin, as well as globally, is under significant pressure to meet the demands of rising populations using finite, often degraded, land and water resources. Climate change is expected to add to the pressures on land and forest resources. Since increasing food production and achieving food and energy security will remain the priority for households and national governments, coherent national mitigation strategies encompassing all land uses would require better management of synergies, trade-offs and leakages between different sectors. This means that the practice of agriculture has to undergo significant transformation in order to meet the related challenges of food security, environmental sustainability and climate change. Therefore, effective climate-smart practices which already exist through indigenous knowledge would thus have to be promoted in conjunction with newly proven practices that increase productivity, resilience and reduces greenhouse gases. In this situation, governments in the sub-region must be vigilant on the performance of the agricultural sector including land and water management, market issues and agricultural research and extension service effort with renewed focus, and ensure adequate budgetary provision for agricultural sector's renewed mandate. This discourse therefore recognizes both the current need to develop synergies between mitigation and adaptation at the farm-level, and also the proper quantification of these options and synergies. The generation of quality information on the optimal mixes of various options shall feed win-win policies on adaptation and mitigation, and inform regional science dialogues on better ways to include REDD+ in future global environmental agreements.

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