

Preliminary reflections of the potential of climate smart agriculture (CSA) in the Tshopo Province (DRC)

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Abstract

Agriculture is the main activity in Tshopo province and concerns about 84% of households. In the post-conflict context of the Democratic Republic of the Congo where the country needs to use agriculture for food and employment, responses to climate change protection of biodiversity hotspot as it is the case in the Tshopo province cannot be ignored. The current agricultural practices are still very vulnerable to climate change and are threatening the biodiversity and carbon stock of the Tshopo forest landscapes. The challenges of the state and other stakeholders are thus to improve the productivity of this agriculture and make it resilient with less carbon footprint. Such 3 pillars (increase of productivity, provide adaptation and mitigation responses) correspond to CSA (Climate Smart Agriculture) that need to be achieved in an integrated way. Unfortunately, from the review at the national level and at the Tshopo principal scale, activities in which agriculture is involved target mainly one/two main objectives (food security, mitigation, adaptation or Biodiversity conservation) during a well-defined period and specific geographical locations. CSA could thus be a potential frame to improve the sustainability of the agricultural sector in the Tshopo Province, in the center of Congo Basin.

Keywords: climate change, adaptation and mitigation, climate smart agriculture, Tshopo Province, Democratic Republic of the Congo (DRC)



1. Introduction

Agriculture is one of the most important activities in the Democratic Republic of the Congo (DRC), about three-quarters of the working population (Kadima *et al.* 2017). It is crucial for food security, smallholder's income and many ecosystem services (FAO 2010).

However, it is largely dominated by traditional low input/low output subsistence systems, and the gap between potential and actual yields is huge (Megevand *et al.* 2013). It is also vulnerable to the effects of climate change, which are unavoidable and even in the most optimistic scenario will have adverse effects on agricultural production and performance (Locatelli *et al.* 2008, Brown *et al.* 2011). The province of Tshopo is not an exception to this reality face by agricultural sector in developing world. Agriculture in this forested province is almost rainfed and exposed to multiple constraints due to climate change (Kasongo 2013, Bokana 2016).

Nowadays, in the context of climate change, agriculture must be developed to ensure food security and the sustainable management of forest resources that are linked to the agricultural sector. To do so, there is a real need to contribute to adaptation to climate change and to mitigation efforts (FAO 2010).

Climate smart agriculture (CSA) is emerging as an approach that ensures food security and provides income-generating opportunities by enhancing the productivity of the farming systems while responding to climate change (Both Adaptation and Mitigation). By protecting ecosystems and landscapes, it contributes to the protection of natural resources for future generations. It has great potential to help farmers achieve food security while adapting to changing conditions and combating climate change (Sullivan *et al.* 2012). The current working paper explore the potential of climate smart agriculture in the context of the Tshopo Province, in the northeast of DRC.

2. Tshopo province (brief history, administrative context, geography, socio-economy context)

2.1. A brief history

Tshopo Province was an integral part of Orientale Province, which was dismembered following the promulgation of Programming Law No. 15/004 of 28 February 2015 determining the modalities for the establishment of 26 new provinces in the Democratic Republic of the Congo, in accordance with Article 2 of the Constitution (Ndeke and Tamidribe 2018).

2.2. Geographical location

Tshopo province is located in the northeastern part of the DRC. It is located on the Equator between 2° South latitude and 2° North latitude, i.e. about 400 km and between 22° and 28° East longitude, i.e. about 600 km. The province is also crossed by the Congo River, which flows through the main upstream and downstream entities: Ubundu, Kisangani, Yangambi, Isangi and Basoko (Lejoly *et al.* 2010).

It is bordered to the east by the provinces of Ituri, North Kivu and Maniema, to the west by the province of Mongala, to the north by the provinces of Haut-Uélé and Bas-Uélé, to the south by the

province of Tshuapa and to the southeast by the province of Sankuru (Ndeke and Tamidribe 2018).

2.3. Administrative context

From an administrative point of view, the province of Tshopo has one city (the city of Kisangani: the capital of the province), 7 territories (Bafwasende, Banalia, Basoko, Isangi, Opala, Ubundu and Yahuma), 6 urban communes, 8 rural communes, 39 sectors, 19 chiefdoms, 269 groups and 2,438 villages. It has an area of 199,567 km² (Termote *et al.* 2011, INS 2018), which corresponds to 8% of the area of the DRC (Lejoly *et al.* 2010).

The land use of Tshopo Province is as follows: 21.5% forest concessions, 12% mining squares and 4% protected areas. The rest of the territory is either unoccupied or made up of agricultural complexes where local communities practice slash-and-burn agriculture. There are also about 100 to 300 old abandoned medium-size plantations (100 to 500 ha) containing oil palm, rubber, coffee and cocoa trees (FONAREDD 2019).

2.3.1. Socio-economic context

The population of Tshopo province is estimated at 5,032,472 inhabitants (Ministry of Public Health 2014), corresponding to 7% of the national population, of which about 20% live in the city of Kisangani alone. The rural population represents 73.3% of the provincial population (IPC 2017).

The Province of Tshopo is characterized by a very high ethno-cultural diversity. Bantu represent the majority ethnic group although there is a small minority of pygmies (indigenous peoples) in the territories of Bafwasende, Banalia and Opala (FONAREDD 2016).

The province offers several economic opportunities, including its equatorial forests, which are rich in precious and rare species of wood, as well as its ecosystem rich in biodiversity. There are also several non-industrial mining resources (Ndeke and Tamidribe 2018).

The province's economy is based on traditional agriculture and livestock (Moloba *et al.* 2019). The main economic activity in the region is agriculture, which is practiced in a shifting cultivation system. Furthermore, exploitation of non-timber forest products (bush meat, caterpillars, wild edible plants), commercial and artisanal logging, artisanal mining and petty trade provide sources of income to households (Moonen *et al.* 2016).

2.3.2. Climate, relief and soil

The province of Tshopo is under a humid (continental) equatorial climate characterized by an absence of a specific dry season. It belongs to the Af type of the Köppen classification. Annual rainfall varies between 1800 and 2000 mm. Temperatures remain high throughout the year, ranging from 23 to 32°C (Bolakonga 2013). In Tshopo, rains are suitable for planting from March to November, with some days/weeks of dry season in July or August. The 1st and 2nd planting seasons start in March and

September, respectively. In Tshopo, the 1st rainy season is more suitable for cropping as it is followed by the shorter dry season. Furthermore, during the 2nd season in Tshopo rains may be excessive from September to November. On average, 36% of the total annual rainfall occurs during these months (Kintché *et al.* 2017).

The landscape is characterized by a relatively flat relief, whose altitudes vary between 200 and 500 m (Sys, 1960). The major soil groups dominant in the Tshopo are ferralsols and undifferentiated rock ferrisols, Yangambi type plateaus ferralsols, Salonga type sand areno-ferralsols and recent tropical soils (Ministère du Plan 2005).

2.3.3. The biodiversity

The animal and plant biodiversity of Tshopo province is rich and diverse. Many protected areas have been created to protect this biodiversity. The province of Tshopo is totally forested.

The total gross area of its forest ecosystems is estimated at 87% of its area (FONAREDD 2016). Vegetation is mainly composed of dense and humid equatorial forests (Bamba 2010). Swampy or periodically flooded forests occupy large areas in the Ubundu, Opala, Isangi, Yahuma and Basoko Territories (Ministère du Plan 2005).

With regard to protected areas, the main ones are the Yangambi Biosphere Reserve with an area of 6,297 km² (Drachoussoff *et al.* 1991) containing an important species diversity (Raghuathan *et al.* 2013), the Yoko Forest Reserve with an area of 6,975 ha and the Masako Forest Reserve with an area of 2,105 ha (Iyongo *et al.* 2013).

From a phytogeographic point of view, the province of Tshopo is part of the central forest sector of the Guinean region (Germain and Evrard 1956).

There are also two protected areas, large part of which are located in the Tshopo province: Maiko National Park and Lomami National Park. Maiko National Park (MNP) covers an area of 1,083,000 ha. Its fauna is very rich and diversified. Wildlife specificity is marked by the presence of both rare species, which are okapi (*Okapia johnstoni*), eastern lowland gorillas (*Gorilla gorilla graueri*), Congolese peacocks (*Afropavo congoensis*) and pangolin (*Manis sp*) (UICN 2010, Katembo 2011). Lomami National Park (LNP) covers an area of approximately 888,000 ha. More than 50 species of large mammals are present, including the emblematic species: the bonobo (*Pan paniscus*), the forest elephant (*Loxodonta cyclotis*), the okapi (*Okapia johnstoni*), the bongo (*Tragelaphus eurycerus*) and the leopard (*Panthera pardus*). In addition, a new species of *Cercopithecus* was described in this park in 2012: the lesula (*Cercopithecus lomamiensis*). This park has the highest number of endemic animals in the DRC of any protected area in the country (Hart *et al.* 2015).

2.4. Agricultural activities

Agriculture is the main activity of Tshopo and concerns about 84% of households (UNDP 2014). This

is done by slash-and-burn and is mainly oriented towards food crops, with cassava, rice, plantain bananas, maize and groundnuts as the main crops in order of importance (Van Hoof 2011, Moonen 2017). Although in decline, perennial crops (coffee, cocoa, rubber, and oil palm) are also present. There are two operational agro-industrial concessions in the province: PHC/FERONIA (Basoko and Yahuma) and Busira Lomami/Groupe Blattner (Isangi) both operating oil palm plants (FONAREDD 2016).

Access to arable lands is by family inheritance or by cutting down a primary forest. Generally, farmers clear around 0.5 to 2 ha either in a primary, secondary or fallow forest. The fields are cultivated twice and then abandoned. The observed fallow period is too short, not enough for the restoration of soil fertility. The age of the fallow land selected for cultivation varies according to household preferences and needs, but a deviation from the preferred age is dependent on the increase in population density (Moonen 2017).

The main constraints of agriculture in Tshopo province are the lack of technical supervision, difficulty in obtaining quality inputs and equipment, declining soil fertility, the proliferation of diseases and pests, the absence of rural microfinance services and very weak local capacity for the conservation and processing of agricultural products. In addition, there are difficulties in accessing markets due in particular to the lack of transport, storage and marketing equipment and infrastructure, as well as the lack of reliable market information (CIFOR 2018).

Otherwise, the lack of access to credit is the major factor limiting the expansion of industrial crops and their transformation (Bolakonga 2013). Also, the political climate is unstable and the previous inter-ethnic conflicts considerably slowed down agricultural development. In addition, poor governance leads to a loss of confidence in producers who no longer dare to invest in their productions (CTB 2012).

Table 1. Evolution of the main agricultural food crops in the Tshopo province (DRC)

Crops	Crops informations	Crop years				
		2013/2014	2014/2015	2015/2016	2016/2017	2017/2018
Cassava	Cultivated area (ha)	17,774.1	16,761.6	276,799.3	235,283.2	
	Production (t)	188,405.00	177,673.00	2,934,073.00	2,494,002.20	3,101,149.10
	Yield (t/ha)					8.83
Rice	Cultivated area (ha)	1,818.1	1,674.2	1,781	1,919.5	
	Production (t)	2,327.2	2,143	2,279.7	2,457	
	Yield (t/ha)					0.82
Maize	Cultivated area (ha)	10,677.6	14,864	21,0541.4	24,2619.7	16,2352.6
	Production (t)	12,172.5	16,945	240,017.2	276,586.5	131,662.3
	Yield (t/ha)				1.14	0.62

Source: MINAGRI-RDC (2018).

3. Forest importance and threats

The tropical forests of Tshopo province have significant potential to ensure the survival and economy

of the local population (Lisingo *et al.* 2010). They store carbon and contribute to the regulation of climate change. They also help to regulate one of the world's largest river basins. It is also a unique reservoir of biodiversity (Debroux *et al.* 2007). The vast majority of the population depends on the forest for their livelihood. This forest is a source of protein, medicines, energy, materials and income for the local population. It also has a great importance of social and cultural significance for people living in forest areas (Makana 2004, Debroux *et al.* 2007).

However, this forest is a victim of anthropogenic pressure that leads to deforestation and forest degradation. The direct causes of deforestation and degradation at the provincial level are slash-and-burn agriculture, industrial and artisanal forestry, mining, wood energy and brick making. The indirect or underlying causes are the migration of populations, economic factors, former armed conflicts, weak enforcement of legal texts, corruption and impunity (MECNT 2011).

The loss of fertility of agricultural land is forcing the population to clear more and more forest areas to meet their ever-increasing needs. Trees felled when new agricultural plots implantation are collected for fuelwood or charcoal production (Defourny *et al.* 2011). Clearing for the installation of new fields is best done in the forest for several reasons: (i) drop in yield in fallows due to soil impoverishment after 1 to 2 crop cycles, (ii) arduous work (ploughing, weeding in particular) in fallows, (iii) availability and easy access to land in forest areas, (iv) internal competition between clan members for the securing of land to descendants or sharecropping, through the 'right of axe', (v) lack of viable alternatives to slaughter-burning techniques, as well as various socio-cultural aspects perpetuating these practices. The factors favouring the expansion of slash-and-burn slaughter are (i) the absence of well-structured agricultural sectors, which benefit small producers, (ii) the absence of economic alternatives and (iii) the lack of support from the technical services of agriculture (FONAREDD 2016).

From a public administration perspective, deforestation and degradation hotspots in Tshopo province are concentrated mainly along practicable roads (roads, Congo River, rivers) and around major urban areas, the Isangi territory and the entire north-eastern part of the province (MECNT 2011, Potapov *et al.* 2012).

4. Vulnerability to climate change

Climate change is having a negative impact on agriculture. They are inevitable, and even in the most optimistic scenario, they will have adverse effects on agricultural production and yield (Locatelli *et al.* 2008, Brown *et al.* 2011). Climate change affects agriculture and food production in complex ways. It affects food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes, and thus demand for agricultural production (Schmidhuber and Tubiello 2007).

The National Action Program for Adaptation to the Effects of Climate Change (PANA) presents agriculture as the sector most vulnerable to climate change in the DRC (Kengoum 2014). This

vulnerability is linked to the rainfall character of agriculture (GIEC 2007), extremely low adaptive capacity and lack of investment in mitigation and resilience building systems.

Rural areas are the most vulnerable to the impacts of climate change because of their high dependence on rainfall agricultural production systems. Their capacities for adaptation and mitigation are still very low or almost non-existent (Brown *et al.* 2011, Bele *et al.* 2014).

It should be noted that about 70% of the population in the DRC lives in rural areas. In Tshopo province, the rural population represents 73.3% of the provincial population (IPC 2017), making the province more vulnerable to the impacts of climate change.

5. Food insecurities

The province of Tshopo has significant agricultural potential through its arable land and abundant rainfall and water (FIDA 2016). However, despite its considerable agricultural potential, Tshopo is highly food and nutritionally insecure and has a high poverty rate. The main causes are low productivity, low diversification and value-added of agriculture.

In addition, more than 80% of households live below the poverty line. Indeed, the decline of the agricultural system in the region is characterized in particular by the lack of availability of agricultural inputs, the lack of supervision of farmers and the non-existence of cooperatives ensuring the purchase and sale of agricultural products. Also, there are climate changes and the consequences of the slash-and-burn system, which affects soil fertility. Over all, around 26% of food are supplied by other provinces or is abroad (CIFOR 2018)

6. Climate smart agriculture (CSA) as potential responses

Climate smart Agriculture (CSA) is an approach based on 3 pillars: sustainable increase in agricultural productivity and income through sustainable use of natural resources (production); adaptation of populations to the effects of climate change and strengthening their resilience (adaptation); and reduction of emissions and/or absorption of greenhouse gases and deforestation (mitigation) (Caron 2016, FAO 2018).

6.1. Agriculture in food security projects

Agriculture is crucial for food security (FAO 2010). Several programs aimed at ensuring food security through the promotion of agriculture have emerged in the province. This is particularly important in the post conflict context of DRC in which agricultural sector had been affected by conflicts.

One of the most important of these programs is the Agricultural Rehabilitation Program in the district of Tshopo, former Eastern Province (PRAPO) from 2008 to 2013. The overall objective of the program was to contribute in a sustainable way to increase incomes, food security, nutritional status and improving living conditions for 50,000 households, including about 25,000 agricultural households and

about 6,000 fishermen in the former Tshopo district (FIDA 2016).

To date, in the agricultural sector, the main program in which the province is involved is the Program for Agricultural Development and Access to Markets in Tshopo Province (PRODAT). It operates in 3 territories (Banalia, Opala, Isangi) and 3 sectors (rice, cassava and oil palm). The targets are family farms that should improve their production and direct it towards markets. The levels of intervention are access to improved seeds and markets through the strengthening of grassroots agricultural organizations to develop services to facilitate the improvement of agricultural techniques. A second component is aimed at strengthening provincial public actors in their support, monitoring and coordination functions in the agricultural sector. This program began in 2015 and will end in 2020 (FONAREDD 2019).

6.2. Agriculture in adaptation responses

Adaptation to climate change in the agricultural sector requires improved production systems and adaptive capacity building (IPCC 2007). In relation to climate change, agriculture is both a victim (because it suffers from climate change: temperature rise, water shortage or excess, new diseases, etc.) and a responsible (because it emits significant amounts of greenhouse gases: 12% directly and up to 24% indirectly) (IPCC 2014). Thus, as the challenges are interconnected, they must be addressed simultaneously. This implies the direct integration of climate change adaptation and mitigation into agricultural development planning and investment strategies (FAO 2010). Agriculture is therefore at the crossroads of climate change mitigation and adaptation efforts (Harvey *et al.* 2014).

For agriculture development to become ‘compatible’ with climate change challenges, it is necessary to combine mitigation and adaptation objectives with the aim of higher yields and food security. This is the genesis of the CSA concept (Torquebiau 2017).

CSA helps to ensure that climate change adaptation and mitigation are directly integrated into agricultural development planning and investment strategies. It is widely promoted as the future of agriculture and as a viable solution to climate change. Because agriculture remains the key to development in Africa, CSA has the potential to increase productivity and resilience while reducing the vulnerability of hundreds of millions of smallholders (Sullivan *et al.* 2012).

However, there is no explicit policy or strong CSA practices in the DRC (Chinedum *et al.* 2015) in general and in Tshopo province in particular. Similar situation is found in the entire Congo Basin. For example, the Congo Basin Forest Fund (CBFF) launched in June 2008, in order to promote sustainable forest management by communities and governments with the coordination of the African Development Bank in 10 Central African countries (the DRC included) where aiming at providing multiple benefits practices such as increase productivity, carbon sequestration, rehabilitate degraded lands and build resilience. This regional program was implemented primarily for reducing deforestation, forest degradation and poverty through better land use planning; developing sustainable management

mechanisms for the natural forests of the region; stabilizing the agricultural sector; and promoting local development. It is only some year ago, that some activities of the program were labeled as CSA examples (Nyamisi *et al.* 2014). One of the Pilot site (Named: ‘Projet Pilote REDD Géographiquement Intégré d’Isangi (PPRGII)’) of this program was implemented in the Tshopo Province.

We thus have a situation where beside adaptation objective, other ambition are related to climate change mitigation and improvement of food yields.

6.3. Agriculture in REDD+ responses

In 2009, the DRC embarked on the REDD+ process (which aims to mitigate GHG emissions and combat deforestation and forest degradation) in order to reduce its emissions and thus participate in the global climate change mitigation effort (REDD-RDC 2014). This process seeks to save forest land by reducing the yield gap or developing agriculture on available non-forest land (MINAGRI 2010, Carter *et al.* 2015). In 2017, for the agricultural sector several studies done within the Tsopo province reveal 5 key value chains (Cassava, Maize, Rice, Groundnut and Plantain) that can be supported in the Yangambi Protected area landscape (CIFOR 2018). The study proposed that each step/node of the Value chain be strengthened. Some propositions included: the development of a reliable and sustainable seed system for each crop to provide efficient varieties that are also resistant to the main diseases; the reorganization of the extension service that properly ensure the knowledge transfer of research results to farmers; strengthening of the involvement of the private sector in the supply of agricultural inputs ; new settlement of the agricultural system by promoting integrated soil fertility management and by introducing perennial crops such as coffee; avoid/reduce seasonal fluctuation in the price of products by staggering the planting and harvesting of cassava, and by irrigating cereals and legumes; enhancement of post-harvest capacities by constructing of pilot storage, processing and sales units (CIFOR 2018).

The agricultural techniques most recommended for REDD+ and whose feasibility in the DRC has been demonstrated concern ecological agricultural practices, including the use of fallow improvement plants, cultivation under plant cover, the use of biochar, composting, agroforestry and the use of natural fertilizers or pesticides (MINAGRI 2010).

The REDD+ National Fund (FONAREDD) plans to launch in 2019 the ‘support program for the sustainable development of savannahs and degraded forests’ for a period of 5 years. The aim of this program is to ‘contribute, through an improved service offer, to the appropriation by agricultural farms and (SMEs) of sustainable practices for the development of savannah lands and degraded forests, in order to consolidate local economies, maintain forest landscapes and reduce pressure on forest resources.’

This program supports the development of degraded forests and savannahs will work closely with the Sustainable Agriculture Management Program (SAMP) implemented by FAO, the Youth Entrepreneurship Project in Agriculture and Agro-Business (YEPA) funded by the African Development Bank (AfDB) and the Sustainable Forest Management Program (SFMP) of the Agence

Français de Développement (AFD). Its purpose is to encourage the mobilization of private investment in the implementation of the agricultural sector program of the REDD+ investment plan. On this 'private investment' dimension, it will complement the Integrated REDD+ Programs (PIREDD). It will be carried out in two provinces: Kwilu province (Kikwit Capital) and Tshopo province (Kisangani Capital). The project will work in collaboration with integrated PIREDDs to also respond to productive alliance initiatives in their provinces of intervention.

A forest cover monitoring system will be set up in the Project's right-of-way areas, and a duly mapped annual report will be produced, in order to ensure that forest cover and landscapes are maintained, that there is no rebound effect and that the deforestation front in Tshopo Province is limited to the farms supported by the project (FONAREDD 2019).

With Agriculture already been recognized as one of the main drivers of deforestation, many REDD+ project generally have an agricultural response.

6.4. The need for better coordination for CSA at the provincial level

Climate smart agriculture (CSA) is not a single specific technology or agricultural practice that can be universally applied. This is an approach that requires site-specific assessments of social, economic and environmental conditions to identify appropriate agricultural production technologies and practices. A key element of the CSA is the integrated landscape approach that follows the principles of ecosystem management and sustainable land and water use (Williams *et al.* 2015).

It should be noted that of all sources of growth, the agricultural sector has the greatest potential for poverty reduction. First of all, it is labour intensive. Second, farm incomes tend to be spent on locally produced goods and services, which has a significant multiplier effect on the local economy. Finally, agricultural productivity growth reduces food prices, thus providing 'invisible transfers' to the entire population and other sectors of the economy (Chausse *et al.* 2012). Hence the need to promote agriculture through the CSA approach.

From the previous review at the national level and at the Tshopo principal scale, we noticed a multiplication of activities in which agriculture is involved targeting mainly one/two main objectives (food security, climate mitigation, climate adaptation or biodiversity conservation) during a well-defined period and specific geographical locations. For the sustainability of the agricultural sector, coordination between research institutions, government, the private sector, and local and international NGOs is thus essential to promote CSA in Tshopo province.

7. Conclusion

The agricultural sector in Tshopo province has enormous production potential. However, the current productivity is well below the potential. This is due to multiple constraints, including those related to climate change. As rural populations are the most vulnerable, it is therefore necessary to put in place

strategies to strengthen resilience and enable the population of Tshopo to adapt to climate change while at the same time protecting the biodiversity and carbon stock of the forest landscapes of the province. The promotion of agriculture from traditional subsistence agriculture to climate-smart agriculture is an appropriate response to climate change as more than three-quarters of the population is engaged in this activity. The implementation of climate smart agriculture requires support and coordination from many stakeholders around smallholders' farmers including research institutions, non-governmental organizations and government institutions.

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