

INTELLIGENT AGRICULTURE AND CLIMATE WARMING IN NORTHERN AND FAR NORTHERN REGIONS CAMEROON: UNCERTAINTY, RESILIENCE AND FORWARD-LOOKING

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Abstract: *In Cameroon, agriculture must undergo a profound change to meet the many challenges posed by climate change, malnutrition, poverty and environmental degradation in the regions. The study of the case of North and Far North Cameroon is just one of the climate-smart practices already implemented in these regions. Our analysis aims to inspire Cameroonian farmers to take part in smart agriculture in the face of global warming and to accelerate the transformation of Cameroonian agriculture so that it becomes a more sustainable and profitable sector.*

Key words: *Intelligent Agriculture; climate warming; Cameroon; Uncertainty; Resilience; Forward-looking.*

1. Introduction

All over Cameroon, farmers are adopting climate-smart innovations likely to promote a sharp increase in food production despite the growing difficulties facing the agricultural sector, and this probably without increasing global greenhouse gas emissions. The Cameroonian climate changes regularly and rainfall (Mohapatra, 2011: 3) patterns change throughout the territory. In many parts of Cameroon, droughts are becoming more frequent, more intense and lasting longer. In others, new rainfall patterns because flooding and soil erosion. Climate change (Barume, 2005: 169) appears to be one of the main threats to Cameroon's development. Many innovative climate-smart agricultural practices have been implemented in Cameroon and help increase productivity and build resilience. At the same time, the Cameroonian population continues to grow and agricultural production must increase by 2050 to meet the food needs of the future population of Cameroon. So how can Cameroonian agriculture undergo transformation to meet the many challenges posed by climate change, food insecurity, poverty and environmental degradation? Does climate-smart agriculture encompass practices and technologies that aim to sustainably increase productivity, support farmers in their adaptation to climate change, and reduce levels of greenhouse gas emissions? Can it also help governments achieve their goals in terms of food security and poverty reduction at the national level? Our analysis highlights that some of the practices implemented in different farming systems and climatic conditions that exist in Cameroon on the one hand, the strategies and practices that can play a driving role and serve as a model to transform agriculture in Cameroon.

2. The resilience of Cameroonian farmers to climate change and the development of value chains

Farmers need markets. Helping them access fair markets increases their incomes, improves food security and creates viable livelihoods. Adopting a value chain approach to solving the problem of climate variability and risk involves helping farmers at all stages of the value chain: production, business organization, market access or financial services (Neate, 2013: 2). Efficient value chains allow farmers to earn more income from their production. Through better organization, operators can bargain collectively and obtain higher prices for their products.

2.1. Access to markets and increased resilience of farmers

Dairy farmers in Cameroon are seeing their incomes increase thanks to a program helping to develop skills, strengthen links with markets and improve access to financial services. Livestock is the sector that offers the most opportunities to rural populations in the Sudano-Sahelian regions (UMA, 1999: 10), both for the diversity of types of livestock (cattle, sheep, goats, poultry, etc.) and for the multiplicity of activities that take place. Are developing more and more in this sector: fattening, milk production, processing of dairy products, etc. Cattle breeding is the one that provides the most wealth to families and to the State, provided it is well supported, supervised and accompanied in the process of its modernization. More specifically, the dairy sector is the one that deserves the most attention because of its many implications in the national and family economy as well as in the strategy to improve the country's food security. The contribution of livestock to agricultural GDP is estimated at 14.47% and 4.85% of total GDP. The population of cattle herders in Cameroon is estimated at between 400,000 and 600,000 people². This figure is certainly lower than the reality as all family members are often involved in the activity. A third of this population is affected by milk production. It is extremely difficult to give details on the distribution of these breeders by gender and by breeding system. However, the vast majority of these breeders do extensive (traditional) breeding. The national cattle herd is estimated at six million heads, 20% of which are lactating cows. The main cattle breeds are White Fulani, Red Fulani, Goudali, Holstein-Friesian (imported breed).

Between this exotic breed and the local cows has developed a genetic type resulting from interbreeding. Dairy production contributes significantly to the income of herding families. A study carried out on the dairy economy in the department of Mbéré, province of Adamaoua, shows that the annual income generated by dairy activity in a family cattle farm is estimated at 152,000 CFA francs. Dairy production represents 20% of the farm's income. The "local" breeds exhibit fairly good meat skills. The local cattle herd thus meets almost half of the country's demand for meat, the rest being covered by the production of short-cycle species (sheep, goats and poultry) and imports. On the other hand, the performance of milk production remains very limited. Total production was estimated at 189,300,000 tonnes all species combined in 2005, against 183,000 tonnes in 1996, an increase of 3.16 % in ten years (FAOSTAT). However, in recent years, average production has stabilized at 125,000 tonnes. To develop the sector, the State has set up SODEPA and has been able to integrate other organizations to regulate the sector. The population is also active in subsistence agriculture and produces staple crops and subsidiary crops; she also raises cattle. However, farmers often lack the business skills, knowledge of production techniques, and access to the inputs, services and markets needed to thrive.

2.2. Multiple advantages linked to the reduction of greenhouse gas emissions

In Cameroon, farmers face a multitude of challenges related to climate change (Beyene, 2013:11-15) and variability, land degradation, poverty and food insecurity. With the effects of climate change already being felt, many projects and operators are looking for solutions. The Cameroonian state can help farmers adapt to climate change and reduce its effects (Bergqvist, 2006: 3). When farmers plant trees to control soil degradation, they also help reduce the effects of climate change by removing CO₂ from the atmosphere (Bele et al., 2009: 1) and conversely, projects whose main objective is to reduce CO₂ emissions; for example, ending deforestation and forest degradation can also have many other benefits for local communities. Forests produce wood and non-

wood products, fruits, fibers, medicines and honey, all of which play an important role for people living nearby. Given their role in climate stabilization, practices promoting sustainable forest management can simultaneously bring many benefits to local communities. Likewise, land degradation control and soil erosion reduction practices have many benefits for farmers beyond adapting to or reducing the effects of climate change. Where reforestation results in better productivity of nearby plantations due to changes in the microclimate, farmers derive only a few of the multiple benefits of public policy practices.

In some cases, the state will help local communities understand what resources are available and also push them to exercise control over those resources. By mapping forests, water and land as part of a climate-smart response, local communities are helped to exercise their rights to manage their resources. Farmers are more likely to adopt a farming practice if they immediately experience the benefits. In many cases, these other benefits of state practices in Cameroon can be far more important to farmers and communities than adapting or reducing the effects of climate change, being more immediate, tangible and easy to communicate.

2.3. Strengthen resilience, “green” the areas of the North and the Far North-Cameroon

A Cameroonian alliance aimed at combating desertification must improve food security by planting trees and promoting natural regeneration managed by farmers. Throughout Cameroon, threats of desertification and land degradation are still present, as are poverty and hunger, especially in the Extreme. Faced with these problems, farmers and communities in drylands are developing methods to sustainably manage forests, grazing areas and other natural resources (UNFCCC, 2006:1-2). A number of projects support farmers in their efforts to prevent desertification and improve their land. These projects aim to improve the food security of Cameroonian communities, by helping them to increase their food and wood production. They also contribute to the resilience of farmers in the face of climate change. In addition, reforestation and tree regeneration offer significant potential for storing CO₂ and reducing the effects of climate change. Trees help adapt to climate change by reducing wind speed and damage to crops from blown sand, and help prevent the effects of climate change by removing CO₂ from the atmosphere

In the Far North, the Green Revolution had started the process. Today, farmers practice natural regeneration. Local farmers fertilized a few hectares, simply by protecting and managing the natural regeneration of trees and shrubs on their land; they have thus achieved the most important environmental transformation of arid zones (Thibaud, 2010: 22-25). Farmers have planted thousands of trees on cultivated fields; when they only had 2 or 3 trees per hectare. Natural regeneration and the improvements it brings in terms of soil fertility, fodder, food and firewood have been evaluated at millions of Francs / ha / year, or a total annual value. These fields produce additional grain, allowing people to feed. Trees help adapt to climate change by reducing wind speed and damage to crops from blown sand, and help prevent the effects of climate change by removing CO₂ from the atmosphere. The processes of desertification and climate change in the northern part of Cameroon are largely due to uncontrolled agropastoral activities, on the one hand, and the use of wood as the main source of domestic energy, on the other. Present in the northern part of Cameroon for about ten years, ABIoGeT (Actions for Biodiversity and Land Management) is committed to developing with the technical support of the Regeneration, Reforestation and Forest Monitoring Unit. Sylvicole Extension (CSRRVS) of MINFOF, the Forestry

Action Plan entitled: Jeunes Emploi Vert: 05 million trees. The general objective of the project is to contribute to the sustainable and participatory management of natural resources through actions for the development of forest plantations, restoration, conservation and monitoring of forests and degraded lands, through mobilization, awareness and the training of young people in the Communes of the North and Far North Regions of Cameroon.

The Action Plan will: plant at least 8,000 hectares in the form of forest plantations and orchards for individuals and families, community and communal plantations; distribute 5,000 improved stoves to households; sensitize and train young people of both sexes on forestry, conflict prevention and management, association life and payroll promotion; to support micro-projects of young people and women in connection with Income Generating Activities (IGA) and the sustainable management of natural resources. Actions to restore, protect and monitor forest dynamics will be carried out through: the characterization, development and enhancement of the Green Sahel Sites, Forest Reserves and Reforestation Perimeters; protection and restoration of soils and areas with fragile ecology (Lake Chad Basin, watersheds, river banks, etc.). The main beneficiaries of the project are individuals, decentralized local authorities and communities, thanks to the use of the HIMO approach (High Intensity in Workforce) which will make it possible to massively mobilize the workforce of young people.

3. More resilient and productive operations

Faced with global warming, the Cameroonian State is developing spatial planning strategies to face the climate challenge.

3.1. The double benefit of reforestation

Cameroonian communities whose livelihoods already depend on limited resources and with a high level of poverty are particularly vulnerable to environmental shocks such as droughts and floods. The Community Natural Regeneration Project, the Land Use, Land Use Change and Carbon Exchange Forestry initiative, was launched under the Clean Development Mechanism of the Kyoto Protocol. Recognizing a link between forests and livelihoods, the project aims to reduce the effects of climate change and reduce poverty through reforestation (Cooper, 2013:2). The project restores ha of degraded forest using various native species. These areas which were permanently exploited for wood, charcoal and fodder are now protected and in the process of being managed in a sustainable manner. The operators manage the natural regeneration and more than 90% of the project area has been reforested with the stumps of trees already cut. New nurseries have been created to produce more seedlings each year to restore forests where there is no living stump.

Over 30 years, more than 870,000t of CO₂ will be removed from the atmosphere. Ultimately, the credits of this carbon could bring additional income to the community. Meanwhile, forest restoration has enabled loggers to increase their production of timber and wood products, including honey, medicines, fibers, fruits and wild animals contributing to the household economy. Better land management has stimulated grass growth, which provides fodder that can be cut and sold to generate additional income. Reforestation also reduces land degradation and soil erosion, and promotes water infiltration. Given the likelihood of climate change causing increased rainfall in the Cameroonian highlands, improved soil stability is an important benefit. Crops surrounding reforested areas also benefit from changes in the microclimate, due to a combination of various factors: reduced wind speed, lower temperatures, higher humidity and better water infiltration.

3.2. The benefits of conservation agriculture in Cameroon

Cameroon faces complex social, economic and environmental issues due to a large and growing national population. Landholdings are shrinking, low-yielding land is cultivated, and fallow has been replaced by continuous rotation, in destructive and labor-intensive practices. Family work is declining as family members find employment off the farm. Households headed by a woman are particularly vulnerable, being overwhelmed by additional tasks. In their struggle to survive, Cameroonian farmers are unable to arbitrate between the sustainable use of resources and their short-term needs. Here, any agricultural intervention must meet the challenge of providing farmers with techniques that require few inputs and labor, but which increase yields and protect the soil. Over the past 10 years, IRAD has developed conservation agriculture practices to meet these needs, the objective of which is to improve the productivity and profitability of small farms while strengthening their resilience to climate change (CGIAR, 2014:1).

The conservation agriculture system requires minimum soil disturbance (Haub, 2013:2), prohibiting all clearing, ridging, plowing or heavy mechanical weeding; maintaining good soil cover by conserving plant residues and weed biomass on the soil surface, without burning; and crop rotation. Experience has shown that conservation agriculture produces higher and more stable yields than the traditional ridge work system, starting with the second growing season. In addition, the absence of plowing and weeding, and the maintenance of good soil cover favor the infiltration of precipitation. Soil structure improves and organic matter, populations of beneficial termites and earthworms increase. Combinations of crops with legumes improve soil health and reduce pests and diseases; they can also provide additional cultivation, providing farming families with a more nutritious diet or additional income.

3.3. More resilient, more productive farms

Cameroon is also a country sensitive to droughts, which makes agriculture a risky activity in the Far North for smallholders who depend on rainfall to water their crops. Aridity leads to poor harvests and climate change will only exacerbate the problem as the temporal distribution of precipitation changes and temperatures rise. As the precipitation intensifies (Boé, 2006: 2-3). Also, we see the general rainfall decrease, at the risk that drought situations become more frequent, more intense and last longer. By 2080, the area of arid and semi-arid lands could increase from 5 to 8% across the African continent. Thus, farmers need more diversified crops and agricultural practices that allow them to continue to produce or even produce more under different climatic conditions.

Concerted efforts are underway to create new varieties of crops that are more resistant to climate change (UNFCCC, 1992:29), including drought. Many Cameroonian farmers are already using improved varieties resistant to drought and insects that help them improve their productivity (Cenacchi, 2014:2). It is not enough to create new varieties of crops. Projects aimed at creating crops resistant to drought are carried out in collaboration with public authorities in order to accelerate the marketing of new varieties and help develop competitive seed markets to expand access to quality seeds. At affordable prices, Climate-smart farming practices can help farmers be more resilient in the face of drought and other changing weather patterns. Changing the way farmers manage their livestock can help them produce more and better animals; other interventions reduce the dependence of livestock keepers on degraded pastures or allow them to make better use of water. A multitude of climate-smart agricultural practices and interventions are currently being developed in Cameroon to meet the

challenge of climate change and, in particular, the prospect of increased droughts. Their success will lay the foundations for climate-smart agriculture of the future.

4. Cameroon's approaches to developing climate resilience in Cameroon

In North and Far North Cameroon, productivity is boosted in the face of drought through the establishment of more resilient crops and livestock, and more diversified production systems.

4.1. Stimulate more resilient and diversified crops, livestock and production systems

The mountainous areas of the North and the Far North of Cameroon are facing great difficulties, which are further exacerbated by climate change (Nyamsimi, 2014:1). Recurrent droughts and water scarcity have worsened over decades of inefficient water use; arable land is limited and desertification is a threat. The Sustainable Agricultural Development project aims to reduce poverty and improve food security and nutrition by developing and disseminating new technologies, as well as building community capacities (Perez, 2014:2). By creating improved crops and more productive livestock species, optimizing and diversifying production systems and acting on markets and national policy, the project aims for climate-smart agriculture that promotes the resistance of agricultural systems to drought and increases productivity, even under drought conditions. Thanks to the project, new species have been made available to operators. Seeds of wheat and corn, and sorghum certified in the regions and facilitated farmer's access to fruit tree seeds. High yielding and rust resistant varieties of wheat were distributed to farmers; sorghum varieties have also been produced. Improved varieties of wheat able to resist and improve productivity have been distributed.

Over the past 20 years, the area covered by crops has increased by 7 % in the North and Far North regions of Cameroon encroaching on pastures. The quality of the remaining degraded pastures decreases as livestock overconsume accessible plants (CGIAR, 2014: 2-3). The project is therefore developing inexpensive animal feed, such as acacia and cactus species. Agroforestry systems that combine shrubs and cacti with barley, oats, vegetables for food and indigenous plants have significantly reduced the costs of feeding livestock and reduced the dependence of farmers on food.

4.2. Develop varieties of corn resistant to drought in the North and in the Far North Cameroon

The food security of Cameroonians depends on the cultivation of maize and one relies mainly on rainfall to water these crops. As maize is very sensitive to drought, many people suffer from famine. Due to climate change, more and more frequent and severe droughts are expected (ICCP/IPPC, 2007: 3-4). Faced with this problem, IRAD launched more improved and resistant varieties (Gnangle and al, 2012: 1-2.). The aim is to develop and distribute high-yielding maize varieties adapted to local conditions and capable of withstanding drought. The project seeks to increase yields by at least 1 t / ha in moderate drought, with a 20-30% increase over current farmers' yields. It intends to benefit 30 or even 40 million people. Over 34 new drought tolerant maize varieties have been developed and distributed to farmers with increased yields. The new varieties give a decent harvest under reduced rainfall conditions, and produce yields equal to or even greater than other common maize varieties when rainfall levels are good. Today, enough seeds are produced to plant acres and benefit thousands of people (FAO, 2010: 2). By collaborating with public authorities, IRAD has accelerated the

marketing of new varieties and created competitive seed markets, thus providing farmers with better access to quality seeds at affordable prices.

Capacity building events for maize breeders, technicians, seed producers, agricultural extension workers (Zahar, 2001: 5). Non Governmental Organizations (NGOs) and Farmers' Groups were organized. Based on cooperation agreements with national maize-related programs and private seed companies, the project shares its international resources and knowledge with local partners. This allows them to test varieties under local conditions and to benefit from the expertise of farmers and agricultural extension workers. The new varieties give a decent harvest under reduced rainfall conditions, and produce yields equivalent to or even greater than other common maize varieties when precipitation levels are good Working with public authorities, IRAD has accelerated bringing new varieties to market; and creating competitive seed markets, thereby providing farmers with better access to quality seeds at affordable prices (Thibaud, 2010: 23-24). Capacity building events for maize breeders, technicians, seed producers, agricultural extension workers, Non Governmental Organizations (NGOs) and farmer groups were organized. Based on cooperation agreements with national maize-related programs and private seed companies, the project shares its international resources and knowledge with local partners. This allows them to test varieties under local conditions and to benefit from the expertise of farmers and agricultural extension workers.

4.3. Develop better management of risks linked to global warming

Farming is a risky business anywhere in the world. Farmers have to deal with climate contingencies: aridity, floods, cold, heat, humidity, hail, wind, etc. in Cameroon, the risks are even higher, given recurrent droughts, low soil fertility and lack of access to markets for entry and exit (Donfack, 2009:2) . Smallholders cannot afford to invest the scarce resources they have in quality seeds, fertilizers, equipment and other inputs on the assumption that an unforeseeable climatic event destroys their crops, at the risk of having none. Return on their investment, or worse, having debts that are impossible to repay. It is a cycle that locks smallholders and their families into poverty and survival. Low investments in turn make crops more susceptible to droughts. According to the United Nations Office for Disaster Risk Reduction, rural poverty is both a cause and a consequence of drought risk. Climate change will only make the weather even less reliable and increase the risks. To break this vicious circle of low inputs, low productivity, poverty, farmers need knowledge, tools, techniques and institutions that reduce the risks associated with investments.

5. Conclusion

The complexity of the atmospheric dynamics at work in Cameroon imposes a questioning on the value of observation scales retained in time and space. We know, for example, that an increase in temperature or average annual precipitation has no precise meaning for the farmer and herder in semi-arid or humid to sub-humid areas. What must be taken into account, however, are seasonal averages because an increase in temperatures in the dry season has less impact on fields and pastures which are already dry and little used than during sowing, harvesting or grazing. . Conversely, in cool mountain uplands, increasing temperatures have differentiated effects. It is now accepted that an increase in average temperatures can have multiple and sometimes quite unexpected repercussions depending on the scale, the relief and the seasons. The concepts of "climate change" and "climate change" have thus replaced that of "global warming". Finally, the human variable seems to have been too often neglected or

reduced to binary approaches: either the anthropogenic factor is considered to worsen climatic phenomena through its interventions on the environment (overgrazing, deforestation) or Cameroonian societies adapt their practices to fluctuations. Resources thanks to their local techniques and knowledge. However, the contemporary development of Cameroonian societies (accelerated and poorly controlled urbanization, intensification of agriculture through irrigation and development of hydro-agricultural facilities, growing inequalities between agro-pastoralists and farmers) produces vulnerabilities. For Cameroonian farmers in North and Far North Cameroon, the objective is to perpetuate their cultivation with a view to quality production, typical of a given agricultural land. To do this, studies of the impact of the future climate make it possible to predict increasingly severe extreme hazards. Even if the approaches to climate change by climate modellers are too approximate today to provide answers at local scales, they encourage the anticipation of possible changes at the scale of an agroecological zone. For the North and the Far North, planting trees today and tomorrow is an effective way to fight against global warming. It is therefore important to anticipate the conditions that can help farmers achieve better yields.

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