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Climate Change and Small Farmers' Vulnerability to Food Insecurity in Cameroon

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Abstract: There is interconnectedness between small farmers' productivity, climate change, and the state of food security in Africa south of the Sahara. The neglect of small farmers amidst climate change challenges in the Global South suggests the existence of a vicious circle of low productivity and deprivation that exacerbates the vulnerability of small-scale farmers, who largely depend on rain-fed agriculture to feed their families and nations. The limited adaptive capacity of these farmers in the face of growing instability in rainfall and temperatures is affecting the output, profitability, and survival of these small-scale farmers, whose production is principally for the local market and therefore critical for community food security. The underdeveloped local agricultural sector and limited investment in climate-smart agriculture also affect small farmers' productivity and ability to meet the food demands of increasing populations. This paper examines the challenges of small-scale farmers in a resource-rich economy, their vulnerability to climate change, and the effects on food insecurity. It is based on an in-depth qualitative case study of 30 residents from the Tiko and Santa areas in the South West and North West regions of Cameroon, respectively. The paper argues that small farmers' vulnerability to climate-induced agricultural losses increases the risks of food insecurity for the growing Cameroonian population.

Keywords: climate change; small-scale farmers; food security; agriculture; Cameroon

Citation: Mbuli, C.S.; Fonjong, L.N.; Fletcher, A.J. Climate Change and Small Farmers' Vulnerability to Food Insecurity in Cameroon. *Sustainability* **2021**, *13*, 1523. https://doi.org/10.3390/su13031523

Academic Editors: Marc A. Rosen and Adriana Del Borghi
Received: 1 December 2020
Accepted: 26 January 2021
Published: 1 February 2021

1. Introduction

Climate change today poses a threat with devastating effects on individuals, communities [1], and the food and agricultural sector [2]. With predictions of rising sea levels, higher global surface temperatures, increasing variations in precipitation, acidification of the oceans, increasing severity of tropical storms [3], and temperature rise between 1.5 to 4 degrees Celsius by 2100 [4], food insecurity concerns may be worsened. Food security exists "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" [5]. Globally, approximately 795 million people are undernourished, with more severe cases of hunger, malnutrition, and health-related undernutrition in Sub-Saharan Africa (SSA) [6]. About 28 percent of the African population suffers from severe hunger [7].

The disturbing food insecurity concerns in SSA are partly caused by climate change effects, which in turn are influenced by the limited adaptive capacity of the agricultural system, poor policies, and high dependence on rain-fed agriculture [8]. Rain-fed agriculture contributes about two-thirds of global food demand and—as the main source of livelihood for most populations across the world—is most vulnerable to climate change and climate variation [9]. Small-scale farmers who depend on rain-fed agriculture are central to agriculture and food security in Cameroon and other developing countries, yet these farmers may

be ill equipped to respond to climate shocks [10]. Worsening climate events like droughts and floods exacerbate the vulnerability of the agricultural system [11]. Meanwhile, policies enhancing small-scale farmers' sustainability could have direct positive effects on agricultural productivity, food security, and livelihoods of most rural communities [6].

Climate change directly affects small farmers' ability to meet increasing food demand at the local level. Cameroon is a resource-rich country plagued with food insecurity concerns, partly because of the lack of due attention to the agricultural sector by the government [12,13]. The agricultural sector, which employs a high proportion of the population and over 90 percent of some rural populations [14], and contributes about 30 percent of national income, is left in the hands of poorly equipped smallholders. Producing over 80 percent of food consumed in Cameroon, small-scale farmers are a major contributor to food security and socio-economic sustainability of the nation [15]. Even with diverse climate change adaptation methods, such as local irrigation, delayed sowing dates, land conservation, two-season farming, and inter-cropping [16], small-scale farming in Cameroon is increasingly threatened by climate change and climate variation. Government support to the small-scale farming sector is either grossly inadequate or, in some contexts, monopolized by corrupt government representatives [17]. The consequence is seen in the increasing numbers of Cameroonians (about 3.9 million, or 16 percent) facing moderate to severe food insecurity [18]. This study examines how the contribution of small-scale farmers—most of whom depend solely on rain-fed agriculture and are ill equipped for food security—has been affected by climate change. We examine how climate change vulnerability of this important group impacts food security more broadly.

1.1. Agriculture and Climate Change in Cameroon

Agricultural production generally depends on favorable weather conditions [19], which determine the types of crops cultivated in different regions, overall productivity, and farmers' livelihood [20]. Global increases in temperature and recurrent climate hazards like droughts, floods, and wildfires [3,21,22] threaten agricultural sustainability [23–27] and the livelihood of farmers [28–30]. Climate effects in the agricultural sector are seen in the deterioration of water and land resources, outbreaks of crop disease, pests, and increasing crop failure [31–33].

Notwithstanding, the agricultural sector is expected to increase food production by 60 percent to meet the increasing food demands of approximately nine billion people by 2050 [34]. This increases pressure on small, impoverished farmers in developing countries trapped in the vicious cycle of poverty, low productivity, and vulnerability. With slow collaboration at the global level to reduce climate change effects [35], especially in farming communities, it may be difficult to achieve Sustainable Development Goal Two ("End hunger, achieve food security and improve nutrition and promote sustainable agriculture").

Africa, a continent most exposed to climate change [3,36], may be poorly equipped to face the increasing effects due to limited technical resources and poor management of natural resources [37]. The agricultural sector in Africa retains approximately 60 percent of the population and employs about 51 percent of the active population [38]. In some SSA countries, the agricultural sector contributes approximately 70 percent of the GDP [39], and small-scale farmers occupy about 80 percent of farmland [40]. With rapidly growing populations in SSA, the growth of which seems unequal with economic growth [38], poorly adapted agricultural communities will be most vulnerable to climate change [11], and increasingly at risk of poverty and hunger [24]. In light of multiple stressors, there is a risk that farmers may resort to maladaptive practices in their efforts to sustain production [41].

Like elsewhere in the continent, the sustainability of Cameroon's small farmers was affected by the IMF and World Bank-led Structural Adjustment Programs (SAP), which promoted export-led growth and deprived smallholders of essential extension services and farm inputs [42]. The post-SAP orientation that undermined the agricultural sector and disregarded the mismanagement of natural resources is partly blamed for food insecurity concerns in Cameroon [12,13]. Amidst climate change challenges, Cameroon's Vision

2035 emergency plan and the Growth and Employment Strategy Paper (GESP) place more emphasis on economic and financial growth than environmental degradation [43] and the survival of local agricultural systems. Cameroon's commendable policies may not necessarily target small farmers or unexploited irrigation resources to reduce crop losses caused by rainfall variation [44,45]. O'Brien and Leichenko [46] have noted that small-scale farmers are often relegated to marginal land, with no fair livelihood substitute. This affects their climate change adaptation [47] as most of them have limited access to financial resources and farm inputs to improve soil fertility on these over-exploited farmlands [48]. Smallholders' efforts in reducing climate change losses are frustrated by strict collateral measures by local financial services. Access to land serves as major collateral in obtaining bank loans [49] to improve crop yields. Moreover, access to advanced farm technology [50] and the exploitation of irrigation resources in rain-fed Cameroonian agricultural communities is necessary to reduce climate-related crop losses [44]. Limited access to these resources affects the adaptive capacity of most small farmers compared to large scale farmers who are better equipped to weather some of these climate-related challenges [51] and are able to compete at international levels [52].

While socio-political crises are not always directly linked to climate change, such crises may worsen climate vulnerability. For instance, recent armed conflicts in Cameroon's English-speaking regions, where this study was carried out, have aggravated food insecurity, poverty [53], and negatively affected the survival of rural communities whose livelihood largely depends on agriculture [18]. This increases the burden of local food producers who are also vulnerable to insecurity, climate change, and food insecurity. Achieving food security in SSA largely depends on the ability to solve present and future challenges [54]. In Cameroon, solving food insecurity will depend on how far the country is able to understand and integrate both small and large-scale farming systems into the policy framework.

1.2. The Sustainable Livelihood Approach

In Cameroon, "small scale" generally refers to farmers who cultivate crops on less than one hectare of land (on single or multiple farm plots), mostly relying on family and hired labour (during peak farming periods like planting and harvesting), and who have limited capacity and assets to increase farm productivity and enhance livelihood. Livelihoods, according to Chambers and Conway [55], include such things as "capabilities, assets (stores, resources, claims and access), and activities required for a means of living". A sustainable livelihood "can cope with and recover from stress and shocks, maintain, or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation" [55]. The international federation of Red Cross and Red Crescent Society [56] adds the component of security of the necessities of life in a context where people are able to "cope with and recover from shocks and stresses" from natural disasters and economic or social upheavals "without undermining the natural environment or resource base". The Sustainable Livelihood Approach (SLA) offers an important connection between climate change, smallholders' vulnerability, and food insecurity. Mostly used in rural agrarian communities, the SLA suggests that limited access to natural, physical, social, and human capital affects vulnerability, productivity, and livelihood options for farmers [57].

As seen from both definitions, SL variables of a population include its capacities, assets, income, economic activities, etc., to response to an external shock. Capacities and assets are generally referred to here as resources. For most small farmers, the sustainability of their livelihood is determined by climate change adaptive capacity and access to productive resources. The vicious cycle of low productivity, poverty, and food insecurity in Cameroon can be linked to the neglect of small-scale farmers amidst climate change [16] and other vulnerabilities. There is a likelihood for the majority of Cameroon's rural workforce, where local economies are heavily intertwined with agriculture, to be at risk of mild to severe food insecurity if agricultural policies overlook small-scale farming. How this applies to small farmers in Tiko and Santa currently can provide a glimpse into the future.

2. Materials and Methods

2.1. Study Area

Cameroon is a lower-middle-income country endowed with agricultural products [58], and other natural resources such as oil, minerals, biodiversity, and land [12,58]. As a major player in the Central Africa Economic bloc, Cameroon has long served as the food basket for the neighboring countries of Chad, Central Africa Republic, Equatorial Guinea, Gabon, and even Nigeria. With a growing population of about 25 million inhabitants [58], 48 percent of Cameroonians live below the poverty line [59] and food insecurity remains one of the nation's concerns. Politically, Cameroon is a product of two separate colonial historical pasts, from the French and British. Eight of its ten political regions are in the former French part of the country. This study has been carried out in Santa and Tiko sub-divisions, located in the North West and North West regions respectively of the former British part of the country (Figure 1).

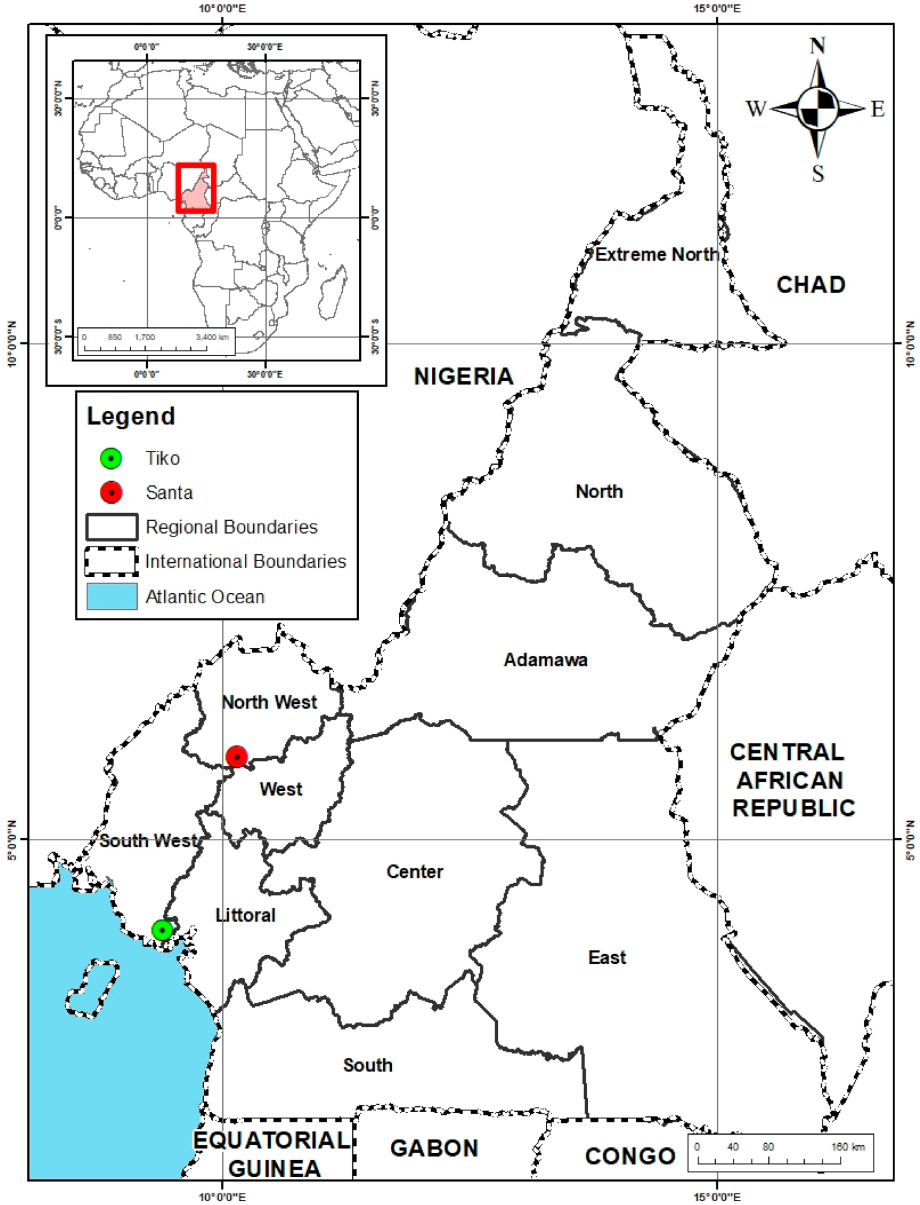

Figure 1. Santa and Tiko subdivisions of Cameroon.

The choice of both localities was informed by their unique ecological zones and other economic factors. Santa subdivision, otherwise known as Santa, is found in the savanna

ecological zone and is known for market gardening [60]. With annual precipitation of 2000–3000 mm and temperature variations of 21.8–30.8 °C, most of its agriculture is rain-fed agriculture [61]. Just like in Santa, Tiko subdivision, or Tiko, represents a coastal ecological zone. It has a rich volcanic soil that has attracted major agro plantations like the Cameroon Development Corporation (CDC), to occupy most of the land, pushing small farmers into the fringes. Annual precipitation currently ranges between 2000–4000 mm with increasingly dry conditions [62] (Table 1).

Table 1. Annual precipitation (mm) and mean temperature (°C) distribution for Santa and Tiko.

Year	Santa		Tiko	
	Annual Rainfall	Annual Mean Temperature	Annual Rainfall	Total Temperatures
2001	2306	19.6	2260	28.3
2002	2554.8	19.09	1681.1	28.0
2003	1914.6	19.1	1503.3	28.5
2004	2376.7	19.3	1710.4	28.6
2005	2625.5	20.3	1979.6	28.3
2006	2305.4	19.3	2071	28.6
2007	2173.6	21.3	1524.5	28.6
2008	2221.3	21.3	1635	28.5
2009	2550.1	19.9	2095.7	29.1
2010	2555.7	20.4	2887.8	29.0

Source: Adapted from Cameroon Development Cooperation Meteorological Service [63] and Gur et al. [60].

2.2. Research Design

The qualitative approach, which enables the natural unfolding of experiences [64], was used for the studies. The semi-structured interviews facilitated understanding of the subjective experience of participants [65] and allowed for a conversational approach with elaboration and follow-up. A total of 30 small-scale farmers were selected for the study, with 15 participants from each area (Table 2). Participants were selected based on information collected from local government reports and informal discussions with village authorities. The main criteria used to select study participants include the size of the farm (less than 2 hectares) and vulnerability to climate change due to dependence on rain-fed agriculture. The project used snowball sampling, in which new participants were referred by previous participants. A challenge with snowball sampling is that participants may tend to recruit close friends or relations [66]; however, the researcher ensured equal representation of participants from the different neighborhoods in both areas, selecting participants from different neighborhoods in Santa and Tiko.

In the current study, we have limited our focus to two elements of climate change: temperature and precipitation. To refer to actual measures of changes in temperature and rainfall to correlate farmers' experience, we obtained actual data of these variables from 2000 to 2010 for illustrative purpose only. We calculated the changes within this ten-year period to determine the trends and use this trend in the discussions of our findings.

To ensure comprehension, interviews were carried out in "pidgin" (the Cameroonian lingua franca). Interviews were recorded, transcribed, translated, and imported into NVivo 12 [67]. Data were analyzed using an inductive thematic analysis approach, in which patterns were identified directly from the dataset without pre-determined categories [65]. Codes were used to identify repeating ideas that give insight to the situation of small-scale farmers (Table 3); for example, farmers often mentioned limited resources, rainfall variation, weather unpredictability, food insecurity, and crop losses. The phases of thematic analysis included familiarization with the data by repeatedly reading the transcripts,

coding the data, combining codes into potential themes, reviewing themes and generating a thematic map, and naming the themes [68]. The resulting themes are discussed in the following section.

Table 2. Summary of participant demographics.

Area	Total #	Farming Type		Gender (#)		Age (Avg)	Income (Avg)	Livestock (Avg #)	Farm Size (Avg Acres)
		Crop Farmer	Mixed Farmers	Women	Men				
Santa	15	8	7	7	8	40	1.5 M to 2 Million FCFA	25	4.942
Tiko	15	11	4	8	7	40	950,000 to 1 Million	25	4.942
SAMPLE TOTAL	30	19	11	15	15	40	900,000 to 1 million	50	4.942

Source: Field Survey July–September 2019, September 2020. NB. Some participants did not provide complete demographic information.

Table 3. Climate change views, vulnerabilities, themes, and sample quotations.

S/N	Theme	# of References	Factors	Sample Quotations (S-Santa Interviews, T-Tiko)
1.	Climate Change, Awareness, uncertainties	36	Natural	"I barely survived through last year. After cultivation my crops the rains ceased and it affected my productivity. My crops withered, and some were also destroyed by insects as a result of prolonged droughts. I made the least proceeds in 10 years." (S-10)
		20	Human actions	"I have had devastating fire incidences on my cash crop farm. I lost all of my plantains and I had to replant. That was a huge loss for me. My neighbour could not control the fire on her farm and it destroyed other farms including mine. Some people practice the grass burning method which may be cheaper but it is a huge problem, even if it does not consume the entire farm, it causes the crops to wither. The devastating effects of fire is also because the wind helps spread the fire to other farms" (T-14)
		2	Supernatural	"We don't have control over the weather, only God does" (S-8)
2.	Climate Change Vulnerabilities	28	Climatic factors	" . . . Either the rains delay or there is heavy downpour that destroy the crops. Last year (2019), was a challenging year as I had losses from dry conditions and floods. The unusual long period of the dry season and harsh sunlight dried my pumpkin plant. Then when it later rained, we experienced floods which carried away other plants. Sometimes we are short of options". (T-09)
		8	Economic, institutional, and political factors	"Large land grabbing is worse than other natural challenges we face, we cannot speak out even when we are ripped off our resources because we neither have financial resources for legal procedures nor people to support us. It is difficult to win a case against a large-scale farmer since they use their influence in courts. Government's laxity is enabling large-scale farmers to exploit smallholders, all these investors care about is making profit" (T-03)

Table 3. *Cont.*

S/N	Theme	# of References	Factors	Sample Quotations (S-Santa Interviews, T-Tiko)
				"They [referring to the government] sit on resources which can benefit peasant farmers and want us to beg from them. The Cameroon system is so corrupt, even the little support to farmers, we never benefit from it as it is monopolised by few government officials. The government needs to recognize small farmers and focus on helping us improve on farm productivity and adaptive capacity". (S-02)
3.	Climate Change Adaptation Pessimism	39	Institutional, political factors	" . . . Crop cultivation requires timely intervention and when you miss a date to water, spray, or feed the animal because of a shutdown then that is all. Sometimes there is little or nothing to do with insecurity" (S-10)
				"We sometimes abandon our animals and farms and run to the bush for safely. You can imagine how much we can loss during such times of insecurity when what matters is your life." (S-10)
		29	Resources	" . . . I had my worse experience this year (2020). We were deceived by the early rains to plant our crops and after that the rains ceased. All crops dried up since we cannot afford irrigation equipment. Water scarcity is also a big concern here. We were compelled to do the second round of planting" (T-08)
				"To succeed with farming here you must irrigate your crops. If you don't have the resources to, it increases vulnerability" (S-11)
4.	Climate Change/Agricultural Productivity	38	Climatic factors	" . . . as for my crops I can manage the losses with local irrigation. But overall I can lose about 25–50 percent even after doing my best. It also depends on the season, between July and August, when the rains become so stubborn we can lose more than 50 percent of crops to heavy rains. Fire is even worse because it can consume the whole farmland" (T-09)
5.	Food Insecurity/Livelihood	34	Climatic factors	"With the inconsistent rainfall our yields are affected. It even affects the quantity of food we consume at the household level. We struggle with other needs" (S-03)
		15	Resource Factors	" Farming is 'hand to mouth' living", "survival of the fittest", (T-08)
				"It is an unregulated system. Markets prices fluctuate depending on availability of food in the markets. Market prices are high during seasons of poor harvest. This means that those with limited resources are at risk of food insecurity and malnutrition. Unfortunately, that is the reality". (T-03)

3. Results

3.1. Vulnerability of Small-Scale Farmers to Changing Climatic Conditions

The results reveal key factors influencing small-scale farmers' vulnerability to climate change. The interrelationship between these factors affects farmers' overall adaptive capacity. Several themes from the data shed light on the vulnerability of smallholders in Santa and Tiko.

The study focused on several climatic variables that particularly affect farmers in the two regions: rainfall and temperature (heat and intensity). Climate change and climate variation, as seen in changing rainfall patterns, has become a "new normal" for most small-scale farmers (Table 4). The realization of this variation has led to no significant change

in farming practices in both areas as many farmers continue to depend on the traditional rainfall calendar. With two major seasons (rainy season from March to October and dry season from November to March) in Cameroon, most farmers have limited access to the weather forecast and they begin sowing after the first rains in March. With a significant alteration of the traditional farming calendar, these crops dry up, are destroyed by insects, or the seeds are baked by sun heat and never geminate. Farming is regarded by many participants as a very risky profession as they lack access to financial and technological resources, such as irrigation, to manage climate stressors.

Table 4. Changes in annual rainfall (mm) and mean temperature (°C) distribution for Santa and Tiko (2001 to 2010).

Year	Tiko				Santa			
	Annual Rainfall		Total Temperatures		Annual Rainfall		Total Temperatures	
	Rainfall	Changes	Temp.	Changes	Rainfall	Changes	Temp.	Changes
2001	2260	−578.9	28.3	−0.3	2306	248.8	19.6	−0.51
2002	1681.1	−177.8	28.0	0.5	2554.8	−640.2	19.09	0.01
2003	1503.3	207.1	28.5	0.1	1914.6	462.1	19.1	0.2
2004	1710.4	269.2	28.6	−0.3	2376.7	248.8	19.3	1
2005	1979.6	91.4	28.3	0.3	2625.5	320.1	20.3	−1
2006	2071	−546.5	28.6	0	2305.4	−131.8	19.3	2
2007	1524.5	110.5	28.6	−0.1	2173.6	47.7	21.3	0
2008	1635	460.7	28.5	0.6	2221.3	328.8	21.3	−1.4
2009	2095.7	792.1	29.1	−0.1	2550.1	5.6	19.9	0.5
2010	2887.8	0	29.0	0	2555.7	0	20.4	0

Source: Adapted from Cameroon Development Cooperation Meteorological Service, [63] and Gur et al. [60].

High temperature and drought have exacerbated the risk of bush fires that destroy crops in Santa and Tiko. Most farmers in Santa are also exposed to human-induced climate hazards like grass fire, which is mostly caused by traditional farming practices like the "slash and burn" method used by farmers to increase productivity and by grazers to enhance the growth of the best grass for grass fed-animals. The effects of the fire are devastating as it sometimes leaves farmers with little or no harvest. A farmer narrated her experience with fire, saying, "I have had devastating fire incidences on my cash crop farm. I lost all of my plantains and I had to replant. That was a huge loss for me. My neighbour could not control the fire on her farm, and it destroyed other farms including mine. Some people practice the grass burning method which may be cheaper but it is a huge problem, even if it does not consume the entire farm, it causes the crops to wither. The devastating effects of fire is also because the wind helps spread the fire to other farms". While awareness raising has led to a reduction of this maladaptive practice, little or no support to invest in more healthy options may cause farmers to fall back on this method. There is a need for a cost-effective substitute to improve farmers' adaptive capacity.

Water scarcity is an ongoing problem as uncontrolled water resources are monopolized by a few privileged farmers. Small-scale farmers have limited access to irrigation resources. In both areas, fertile farmlands are held by only a few large-scale producers. In Santa, these large farmers mostly cultivate crops in marshy areas to increase crop yield and cultivate crops all year round. In contrast, two-season farmers in Santa struggle through the seasons because of water scarcity. With limited financial resources, farmers can neither develop existing water sources nor connect water from neighbouring communities.

Financial capital is a huge concern in these areas as most farmers are unable to recover from climate shocks. They lack collateral to obtain loans from local financial institutions

and mostly depend on social capital. Farmers either contact friends, family members or local unions to obtain loans at a minimal- or interest-free rate. The increasing rate of poverty and food scarcity in Santa and Tiko is aggravated by the changing rainfall pattern. While interview questions were not focused on psychological issues, more than half of the participants expressed growing stress, anxiety, and depression from weather-related productivity changes. This is reflected in their stories " . . . It [climate events] really affects my relationship with my husband and children. I'm always depressed during bad seasons and I get angry at everyone. I always think about what I go through as a farmer, my labor, capital, time . . . and when I see signs of bad harvest I'm so worried. I worry about how I'll take care of the children and meet their needs. I get angry because they seem not to understand what I go through". Another farmer said, "I feel so discouraged when I go to the farm and my crops are not doing well. Many people in urban areas are not aware of this stress; they don't know how we struggle to make food available in the markets".

3.2. Food Insecurity

Food insecurity, undernutrition, and poverty are common among small-scale farmers and most rain-fed dependent communities. Food security is determined by the quantity and quality of farm produce consumed, and how fluctuating market prices affects affordability of balanced diets. Food insecurity mostly results from poorly adapted agricultural practices, which affect productivity. Farming, to most participants, is considered "'hand to mouth' living" and "survival of the fittest", as they barely have enough for their families or the future. The quality of food is often compromised because most farmers consume what they cultivate and have little proceeds to spend on nutritious food. While most farmers in Santa have abandoned vegetables because of their vulnerability to rainfall variation, vegetables are a vital source of nutrients. Farmers described how markets are saturated with food during harvest periods and, therefore, they sell farm produce at less than half the normal prices. This reduces the amount of money they can spend on healthy food options.

The availability of food is also shaped by climatic factors. Some farmers, especially in Santa, have resorted to abandoning some food crops highly affected by rainfall variation, such as potatoes, cabbage, and green vegetables. Others are delaying sowing dates as they claim that relying on the traditional farming calendar is misleading. Instead of planting around the 15th of March with the first rains, farmers wait until late March to plant. While most farmers use the local irrigation system of watering crops with water cans, they consider it time consuming and energy sapping. The delay in rainfall and the heavy downpour described by a participant as "when the rains become stubborn" are challenges aggravated by limited information on weather changes. The periodic heavy rainfall also has devastating effects on crop yields as farmers are placed in a more vulnerable position: "Either the crops are dried up by drought conditions or swept away by heavy rains". Despite farmers' climate change vulnerability, adaptation may be difficult when supernatural forces are blamed for increasing climate events. A common statement among farmers is: "We don't have control over the weather, only God does". Farmers depend largely on support from social networks like friends, family members, and social groups to reduce climate stresses.

3.3. Economic and Institutional Factors

The results reveal how economic and institutional barriers inhibit small-scale farmers' livelihoods, even in a context rich in natural resources. First, powerful agribusiness interests have increasingly relegated small-scale farmers to marginal lands, which affects their capacity to adapt to climate change and directly impacts food production. Compared to climate change, participants consider large-scale land acquisition as a greater evil that deprives them of their main source of livelihood. Explaining their ordeal, a farmer said: "Large land grabbing is worse than other natural challenges we face, we cannot speak out even when we are ripped off our resources because we neither have financial resources for legal procedures nor people to support us. It is difficult to win a case against a large-scale

farmer since they use their influence in courts. Government's laxity is enabling large-scale farmers to exploit smallholders, all these investors care about is making profit".

The influence of agribusinesses like the Cameroon Development Corporation (CDC) in Tiko and the Ndawara plantation in Santa has been detrimental to smallholders' sustainability amidst climate change stresses. Large-scale agribusinesses have amassed rich farmlands, engage in uncontrolled use of fertilizers, and wield political influence. In Tiko for instance, many landless small farmers rent unoccupied CDC farmlands, which may be their only option: "I do not have money to buy my farmland. I need this for survival since I have no formal skill . . . The CDC has acquired vast lands and they rent it out to us". Corporate-owned lands come with many usage restrictions. On these rented plots, farmers are restricted to less than two acres of land, must cultivate short-term crops like vegetables lasting a maximum of 3 months, and must be ready to be evicted at any time. Besides the fact that these farm plots are over-exploited, farmers have limited flexibility to implement long-term and climate-smart agricultural practices that can increase farm yield. From a farmer's experience, "working on rented farms is so challenging, we invest so much in fertilizers because the plots are overused. The uncertainty of how long we will work on the plot affects any long-term plan to increase yields".

Farmers in the study also discussed how fluctuating market prices, poor roads from farm to market, and limited advanced food storage resources affect their ability to provide food to impoverished populations. With soaring food prices in Cameroonian cities, abundant food produced in farming communities is left to decay. This affects smallholders' sustainability, as seen in a participant's experience: "My three decades of experience is filled with painful memories. I remember there was a time I traveled a long distance on the poor road to sell my produce in the city. But when I arrived with the oranges and other perishable food, the market price was very low. I could not even compensate for my transport or labor cost. Money that should be invested in buying farm machinery or irrigation equipment is wasted because of the unregulated market prices and poor roads. These are the indirect causes that increase farmers' vulnerability". While most farmers express dissatisfaction with the government's lukewarm attitude in enhancing the adaptive capacity of small-scale farmers, improving the road infrastructure, regulating market prices, solving the political crisis, and reducing the influence of large-scale farmers, existing policies may not address these concerns. Farmers' dissatisfaction with policy processes is reflected in this statement from a participant: "I am not aware of government policies that can help small-scale farmers. The strength of policies lies in their implementation".

Finally, even in the face of additional climate stresses and political instability, government and public support for the small-scale farming sector in Tiko and Santa is severely lacking. The challenge, according to a farmer, results from how farmers are categorised: "When small and large-scale farmers are considered as a homogenous category then small farmers continue to suffer . . . I would say the Cameroon government has relegated small-scale farmers to the background, they don't even come to farming communities to understand our challenges". Referring to the government, another farmer claimed: "They sit on resources which can benefit peasant farmers and want us to beg from them. The Cameroon system is so corrupt, even the little support to farmers, we never benefit from it as it is monopolised by few government officials. The government needs to recognize small farmers and focus on helping us improve on farm productivity and adaptive capacity".

Farmers obtain support primarily from local NGOs and social networks in the face of increasing farm losses. On average, most farmers suffer crop losses between 10–15 percent caused by rainfall variation, over 50 percent by floods and grassfires, and 50–75 percent by the socio-political crisis which has led to the abandonment of farmlands. Estimating their losses, a farmer stated: " . . . as for my crops I can manage the losses with local irrigation. But overall I can lose about 25–50 percent even after doing my best. It also depends on the season, between July and August, when the rains become so stubborn we can lose more than 50 percent of crops to heavy rains. Fire is even worse because it can consume the whole farmland. With the political crisis, losses can go up to 75 percent. Crop

cultivation requires timely intervention and when you miss a date to water, spray, or feed the animal because of a shutdown then that is all. Sometimes there is little or nothing to do with insecurity". With limited access to farm inputs, advanced farm machinery, drought-resistant species, reliable climate predictions, capacity building on climate change, and financial capital to increase farm productivity, farmers are increasingly vulnerable to food insecurity. While farmers largely depend on social networks to reduce vulnerability, such informal supports may be insufficient in the face of growing challenges. Social networks cannot solve increasing problems with poor harvest, post-harvest losses, climate change maladaptation and food insecurity.

4. Discussion

Overall, our findings reveal the complex interaction of economic, institutional, and climatic factors affecting small-scale farming in Cameroon. Paradoxically, the neglected small-scale farming sector is the mainstay of Cameroon's economy [69]. With pre-existing infrastructural, socio-economic, and political challenges, poor climate change adaptation aggravates food insecurity and the vulnerabilities of smallholders. Poorly adapted small-scale farmers are trapped in a vicious cycle of low productivity, food insecurity, and poverty. Most farmers continue to depend on the traditional farming calendar and practices that are significantly altered by climate change. Even with significant rainfall and temperature changes affecting crop yields, most farmers have limited resources to diversify production. Besides financial constraint, most farmers are reluctant to change common crops produced to new crops because of uncertainty in demand.

Increased vulnerability and stressors can lead to maladaptive practices that ultimately exacerbate those same vulnerabilities [41]. Innovations to improve climate change adaptation are limited as farmers resort to common adaptive practices, such as delaying sowing dates, increasing fertilizer use, using rudimentary irrigation resources, and the "slash and burn" method. While these can reduce crop losses, uncontrolled use of fertilizer and the burning method are maladaptive methods that contribute to financial vulnerability and climate change. Slash and burn is a "planned" grassfire, considered a cost-effective traditional method by small-scale farmers and grazers who use it to increase pastureland, fire-existence ecosystem, and crop productivity [70].

Global climate change discourse [71] suggests that food security is dependent on smallholders' ability to adopt climate-smart agricultural practices. This is also essential in meeting Cameroon's Vision 2035, and the Sustainable Development Goal (2) of ending hunger and promoting sustainable agriculture. The food insecurity situation in both areas results from climate change vulnerability and the neglect of the small-scale farming sector. Even with abundant natural resources [12] and underutilized irrigation resources [69], smallholders and local Cameroonian communities are increasingly exposed to food insecurity.

In climate change discourse, little attention is given to the added challenges of national conflict and insecurity. For example, in one of our study areas—the North West Region—an estimated 18.1 percent of the population is food insecure as a result of the Anglophone crisis [18]. This increases pressure on local farmers who are also vulnerable to insecurities. Due to these interacting structural factors, farming communities may, paradoxically, be unable to meet their own nutritional requirements by relying on the food they produce. For example, reducing the cultivation of vegetables because of weather unpredictability affects nutrient intake at both household and community levels.

With the understanding that policies enhancing smallholders' sustainability can improve livelihood and crop yields [6], the Cameroon government must intensify actions to support local agricultural systems to reduce maladaptive outcomes and enhance livelihoods. These actions may include implementing and following up on agricultural policies, diversifying climate change adaptation strategies, improving poor road infrastructures, and regulating processes of large-scale land acquisition. The introduction of new farm technology should be accompanied by subsidies to avoid putting impoverished farmers

deeper into debt. Most importantly, early weather warnings are imperative in improving crop productivity and climate change adaptation. This can be facilitated by awareness creation in farming communities on the importance of climate forecast, and flexibility to change traditional farming calendar or crops with changing climatic conditions.

While post-colonial agricultural policies focused on developing peasant agriculture contrary to export-led agriculture promoted during the colonial period [72], little has been done to reduce the vulnerability of smallholders to external shocks. Recent agricultural policies and programs focusing on rural agricultural development, such as the National Strategy for the Development of Agricultural and Rural Sector (SDSR—French acronym), is based on a holistic approach to modernizing the agricultural sector which is no doubt beneficial. The main challenge is the high rate of corruption in Cameroon, now considered "endemic" [72], which can affect progress in improving food security, environmental degradation, rural livelihood, and smallholders' sustainability.

Climate change is a considerable external shock and an extreme that exposes small farmers and affects their livelihood in poor countries. The ability to recover from shocks and stresses are major aspects of the sustainable livelihood approach [55]. With poor climate change capacity and limited climate-smart options, the neglect of the small-scale farming sector in Cameroon increases vulnerability to climatic shocks and stressors and affects agricultural productivity. Farmers are left with limited options to meet their basic needs, obtain income, and increase well-being, all of which are vital elements of the SLA [73]. Urgent actions must be taken by Cameroon decision-makers to improve the livelihood and climate adaptive capacity of small-scale farmers necessary to improve national food security. Growing landlessness and the relegation of smallholders to marginal land is an added layer to climate change complexities.

While large-scale export-led agriculture enables international recognition and gains, small-scale farming boosts the national economy and sustains its populace. While research has demonstrated that large-scale farming in Cameroon and other African countries increases food insecurity, poverty, and underdevelopment [12,45], relegating smallholders to marginal lands exacerbates their vulnerability. The dual challenge of managing climate change and depreciated farmlands directly affects farmers' livelihood and adaptive capacity. Moreover, restricted rights over rented lands frustrate farmers' efforts to make vital long-term decisions on increasing farm productivity and climate change adaptation. If small farmers continue to farm on marginal lands they will be "farming and yet hungry" [74] (p. 3) and poor. The high rates of poverty among peasant farmers are not limited to financial resources but include insecurities to shocks of climate change impacts, global pressure, fluctuating markets [75], and marginalization in land deals. The inability to recover from stresses and shocks [55] affects livelihood sustainability.

5. Conclusions

In this study, we sought to examine the implications of small-scale farmers' vulnerability to climate change and climate variation on food insecurity in Cameroon. In emphasizing the importance of smallholders' sustainability in meeting Cameroon's laudable Vision 2035 emergency plan, and SDG (2) on ending hunger, achieving food security, we reiterate that social and economic sustainability largely depends on the sustainability of the small-scale farming sector which is increasingly vulnerable to climate change. Relegating smallholders to marginal lands and marginal positions in local climate discourse exacerbates food insecurity concerns. Therefore, discontinuing the vicious cycle of poverty, low productivity, and vulnerability in local farming communities also depends on the active participation of small farmers in agricultural decision-making processes. An in-depth analysis on the contribution of smallholders to national economic sustainability will spur actions towards improving climate change adaptation, increasing access to new farm technology, exploiting local irrigation resources, and enabling access to productive resources—especially fertile agricultural land.

Climate change impacts on agricultural production directly affect the livelihood of farmers. To ensure sustainable farming societies, there is urgent need for the adoption of climate smart agricultural practices that can improve productivity and food security. This can be achieved by strengthening partnership with government bodies, local farmers associations, and agricultural institutions. Partnerships, accountability, and effective follow-up are essential in climate change interventions.

Informal social networks are currently the main source of support for farmers experiencing climate shocks and stresses; however, such systems cannot fully solve climate change vulnerability [76]. Even national policies and international commitments are not sufficient to solve pre-existing and emerging agricultural challenges in Cameroon. As one participant put it: "The strength of policies lies in its implementation". Concrete government action is required in Cameroon in order to ensure the full implementation of policies, improving agricultural extension services, and subsidizing small-scale farmers.

Author Contributions: Conceptualization, C.S.M. and L.N.F.; Data curation, C.S.M. and L.N.F.; Formal analysis, C.S.M. and A.J.F.; Funding acquisition, A.J.F.; Investigation, C.S.M.; Methodology, C.S.M., L.N.F. and A.J.F.; Project administration, C.S.M.; Resources, C.S.M., L.N.F. and A.J.F.; Software, C.S.M. and A.J.F.; Supervision, L.N.F. and A.J.F.; Validation, C.S.M. and L.N.F.; Writing—original draft, C.S.M.; Writing—review & editing, L.N.F. and A.J.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Queen Elizabeth Scholars Program.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and was approved by the Research Ethics Board at the University of Regina (#2019-118, approved on 16 August 2019).

Informed Consent Statement: Participants' informed consent was sought and obtained prior to data collection.

Data Availability Statement: Data that has been analyzed without participant identity may be available on request.

Acknowledgments: We are immensely grateful to all research participants in Santa and Tiko for their willingness to share their experiences. We also thank our research assistant (Louisa Linwe) who facilitated the interviews and transcription.

Conflicts of Interest: The authors declare no conflict of interest.

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