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Agriculture on the Brink: Climate Change, Labor and Smallholder Farming in Botswana

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Abstract: Botswana is a semi-arid, middle-income African country that imports 90 percent of its food. Despite its relative prosperity, Botswana also suffers from one of the highest measures of income inequality in the world, persistent poverty, and relatively high levels of food insecurity. The objective of this paper is to explore how political economy, climate change and livelihood dynamics are synergistically impacting household food security. The major finding is that the marginalization of smallholder farming in Botswana has as much or more to do with domestic, regional and international political economy as it does with climate change. As such, international efforts to support climate change adaptation in Botswana will have a limited effect on smallholder farming livelihoods and rural food security unless such efforts take account of political economic constraints. Effective support must be based on a grounded understanding of the real drivers of marginalization and food insecurity. One initiative that merits further exploration is the government's backyard gardening initiative, which could be viewed as a pro-poor climate adaptation strategy. The findings of this paper are based on semi-structured interviews with policymakers and surveys with urban, peri-urban and rural households undertaken in 2012 and 2015.

Keywords: agriculture; climate change; farm labor; food security; gardening; livelihoods

1. Introduction and Context in the Literature

There is a growing global discourse on the linkages between global climate change and food insecurity. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report [1] predicts that the impacts of climate change will lead to more flooding, famine, drought and disease, which could have a negative impact on millions of people in the poorest parts of the world, especially Africa. There is also an increasing recognition that climate change impacts various countries, and groups within countries, differently. For example, the climate change vulnerability index [2] is one tool for understanding these differential impacts.¹ It has been used to show how many areas of the Global South, especially the Africa region, are more vulnerable to climate change.

Botswana is likely to suffer greatly from climate change [3]. Most of the country's agriculture is rainfed and occurs in areas of relatively higher precipitation of around 400–600 mm of rainfall per annum (see Figure 1). Different climate change scenarios make varying predictions for the 2000–2050 period. Of the four downscaled global climate models that have been used in Botswana (IPCC Fourth Assessment Report, Commonwealth Scientific & Industrial Research Organisation and Model for Interdisciplinary Research on Climate), most predict a 50–100 mm decline in rainfall in the

¹ This index is based on three factors: exposure to extreme climate-related events; the sensitivity of populations, in terms of health, education, agricultural dependence and available infrastructure; and the adaptive capacity of countries to combat the impacts of climate change.

south and southeast parts of the country and an increase in annual maximum temperature from 1.5 °C to 2.5 °C [4]. While these may seem like small changes, they could be quite significant for an area that was already marginal for agriculture. Even though this marginality, or precarity, has long been a fact of life for farmers in areas close to the limits for rainfed agriculture (400 mm per annum for the most drought-tolerant grains), irregular rainfall in recent years has contributed to anemic production [5]. Sorghum and maize are the two primary food crops produced in Botswana, and both are typically grown under rainfed conditions. Sorghum is the more traditional crop, predating colonialism, and needs 450–600 mm of annual precipitation for optimal production [6]. Maize was introduced during the colonial period [7], has expanded rapidly in recent decades, and requires 500–800 mm of rainfall per annum [8]. Were the wettest parts of the country to drop to 500 mm of rainfall per annum, maize would be nearly impossible to grow [9]. Less impacted by seasonal variation in rainfall is irrigated agriculture, which includes some large grain farms in the northeast part of the country (near the town of Kasane), as well as commercial and subsistence horticulture of various sizes in urban, peri-urban and rural areas. Nearly all forms of agriculture in Botswana are dominated by women.

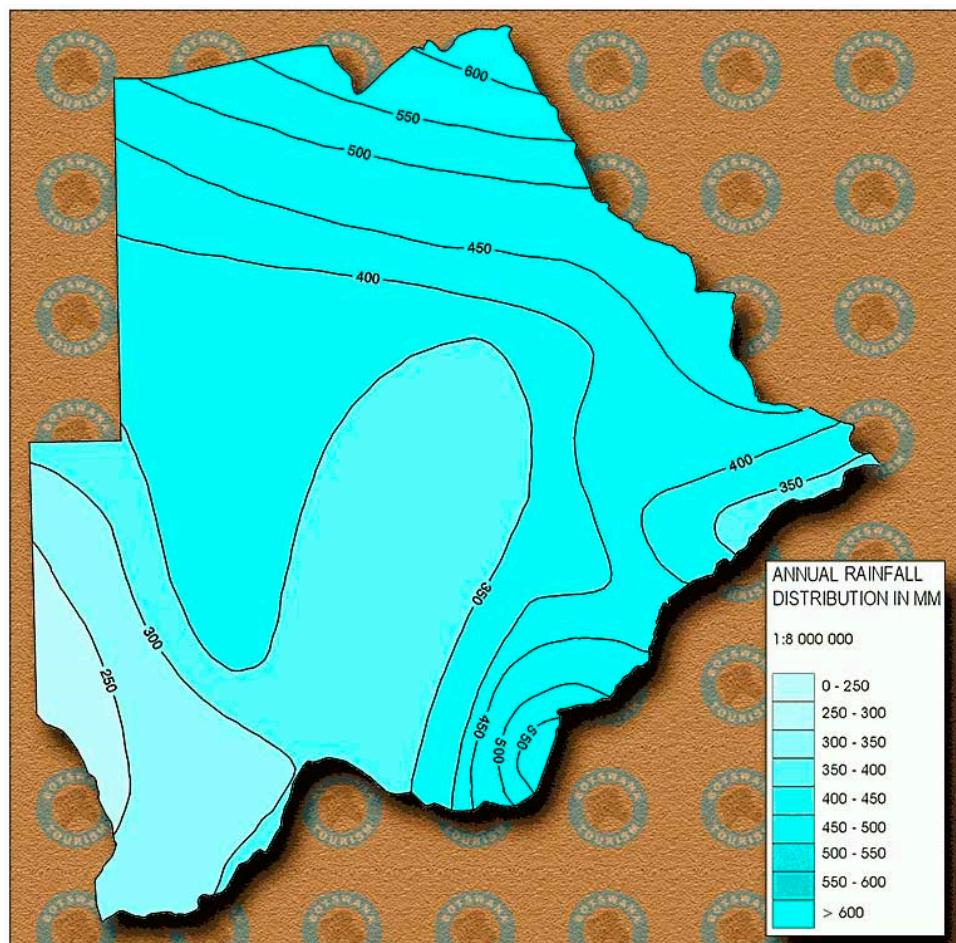


Figure 1. Rainfall in Botswana. Source: Botswana Tourism Organization [10]. Used with permission.

The Government of Botswana is concerned about the impacts of climate change on agriculture, often framing vulnerability as externally driven and best addressed by technology. As early as 2010, the Government began working on a climate change adaptation and mitigation policy, noting that this problem could drive the country back into poverty [11]. President Ian Khama has urged farmers to adopt more innovative approaches to cope with the impacts of climate change, citing the example of technologies developed by Israel [12]. In response, the Government has launched a climate smart agriculture program [13]. It has also been a pioneer among African countries on

this issue. For example, Botswana played a leading role in crafting the Gaborone climate change declaration (October 2013), which calls for an African voice in global climate change negotiations. Another example is the 2014 Tripartite Climate Change 2014 Meeting. The COMESA-EAC-SADC² Tripartite Programme Management Units of the Programme on Climate Change Adaptation and Mitigation met in Gaborone, Botswana in January, 2014. This group has: “supported countries developing strategies in climate change as well as scaling up climate smart agriculture; and developed vulnerability assessments to help avert and mitigate suffering and vulnerability by providing clear information on populations vulnerable to food insecurity and the effects of shocks including climate change” [14]. Finally, the Southern African region, via the Southern African Development Community (SADC), has programs to support climate smart agriculture, a controversial approach given its frequent reliance on high tech solutions [15], as well as vulnerability assessment programs.

While the impact of a shifting climate could be significant for agriculture and food security in Botswana, political ecology and political agronomy³ [16] scholars argue that we must understand this situation as refracted through the context of local livelihood dynamics and political economy. In this case, livelihood dynamics refers to the ways in which households interact with the environment, allocate labor and distribute resources within the immediate and extended family. Political economy has more to do with the macroeconomic structures and policies at the state, regional and international level which impinge on household maneuverability and decision-making. These lenses complicate conventional analysis in a couple of ways.

First, according to these scholars, the links between food supply and food security are not direct. For example, even if there is plenty of food on the market, poor households may not be able to access this because of high prices or low incomes, a problem known as entitlement failure [17]. This is particularly relevant in the case of Botswana because food had not been in short supply due to ample imports, but prices spiked in 2007–2008 and 2011–2012 because of global market conditions [18,19]. Despite being a middle-income country, Botswana has segments of its population which suffer from the interlinked phenomena of persistent poverty and food insecurity [20–22]. Botswana’s Gini index of 63 means that it has one of the most unequal income distributions in the world, along with neighboring South Africa and Namibia. Persistent poverty and food insecurity are accentuated when food prices rise, something which is a particular issue for Botswana given its exposure to global food price fluctuations resulting from a very high dependence on imported food (90 percent in recent years).

Second, cropping and livelihood systems are differentially vulnerable to climatic shocks (such as periodic drought). Furthermore, this vulnerability (read sensitivity and resilience) is often shaped by histories of colonialism or economic integration into the global system. For example, Watts’ [23] groundbreaking work in Northern Nigeria showed how famine was not the result of drought and overpopulation, but farming systems made more vulnerable (through the transition to monocrops for cash) by British colonial policy. More recent critiques of the climate change and vulnerability literature by Ribot [24,25] and Bohle et al. [26] make similar points, arguing that vulnerability can have as much or more to do with livelihoods constrained by political economic factors than shifting climates. For example, colonial policies creating a regional maize market in Southern Africa [7], labor constraints [27], or both acting synergistically [28], may be limiting adaptation to climate change. The squeeze or tension that agrarian livelihoods face as they simultaneously cope with fluctuating global markets and shifting weather patterns has been explored by O’Brian and Leichenko [29,30] in India. They dubbed this problem ‘double exposure,’ or the layering of vulnerabilities to the perils of globalization and climate change.

² COMESA-EAC-SADC stands for: Common Market for Eastern and Southern Africa—East African Community—Southern African Development Community.

³ The term ‘political agronomy’ refers to the study of relationships and processes which link political, economic and social forces and factors to the creation and use of agronomic knowledge and technology [16].

Debates about climate change, vulnerability and political economy intersect with those on gardening in interesting ways. Gardening, as a government or NGO-led initiative, has a mixed legacy in Botswana and Africa more broadly. Some scholars and policymakers have conceptualized gardening and urban agriculture as pro female and as solutions to poverty and food insecurity [31,32]. Others are quite critical of this approach, noting that gardening has been overly romanticized by outsiders, and that it narrowly conceives of hunger as a supply-side problem [33,34]. Gardening also has come under attack in Botswana for not producing the desired results or being a drain on water resources [35]. Rarely, however, has gardening been conceived of as a water efficient alternative to dryland farming or livestock rearing. In the particular case of Botswana, feminist political ecology⁴ [36] scholars argue that women's traditional livelihood activities (e.g., poultry raising, gardening and crop agriculture) are often undervalued and disadvantaged relative to male livelihood activities, such as livestock rearing [37,38]. As such, arguments about water scarcity and agricultural efficiency merit examination from a feminist political ecology perspective.

The overarching objective of this paper is to explore how political economy, climate change and livelihood dynamics are synergistically impacting household food security. The major finding is that the marginalization of smallhold farming in Botswana has as much or more to do with domestic, regional and international political economy as it does with climate change. As such, international efforts to support climate change adaptation in Botswana will have a limited effect on smallholder farming livelihoods and rural food security unless such efforts take account of political economic constraints. Effective support must be based on a grounded understanding of the real drivers of marginalization and food insecurity. One initiative that merits further exploration is the government's backyard gardening initiative, which could be viewed as a pro-poor climate adaptation strategy.

2. Methods

Botswana is 60 percent urban, urbanizing at a rate of 2.5 percent per annum. The top destination for migrants leaving the rural areas is the capital city, Gaborone, with a population of almost 250,000. Many rural migrants move in with existing family members in urban areas, rent rooms in the city's poorer neighborhoods, or settle in peri-urban areas around the city [37]. While rural households are, on average, poorer than urban households, those in urban areas tend to acquire a larger portion of their food via the market. This makes poor urban households especially vulnerable to fluctuating prices for basic foodstuffs. However, given the historically tight connections between urban and rural households [39], the impacts of fluctuating food prices on urban households may impact remittance flows from urban to rural areas.

The findings in this paper are based on qualitative, semi-structured interviews with policymakers, as well as 158 questionnaire surveys with urban, peri-urban and rural households in Southeastern Botswana in 2012. A small set of follow-up, semi-structured interviews were also conducted with government officials and households in 2015. The details of these interviews and surveys are outlined below.

The author interviewed representatives of a number of offices involved with different dimensions of food security and agriculture in Botswana in 2012 and 2015. These included the Ministry of Agriculture's poverty eradication and horticulture units, the famine early warning unit, the Southern African Development Community (SADC) early warning system, and various non-profit agencies. These qualitative interviews focused on the government's food security strategy, how it is being implemented, and whether or not this strategy is evolving given increasingly volatile global food

⁴ Feminist political ecology explores the role of gender in the political ecological landscape. These scholars see gender roles as socially constructed, yet important to consider when examining human-environment interactions. Such scholars have explored resource use, agrarian reconstruction and rural-urban transformation, among other topics [36].

prices and global climate change scenarios. In some cases, questions were also asked about the government's backyard gardening initiative.

Household questionnaire surveys were conducted in three poorer neighborhoods in Gaborone: Old Naledi, White City, Broadhurst (see Figure 2), and one peri-urban area: Tlokweng. The urban neighborhoods selected for sampling cannot be considered representative of the city more broadly (as they likely lean towards being poorer). These areas were chosen, in part, so that comparisons could be made with a survey undertaken four years earlier by African Food Security Urban Network (AFSUN) [20]. The author and two research assistants systematically selected 89 households for semi-structured interviews in these urban neighborhoods by moving across these areas from east to west and knocking on the door of every fourth house for a potential interview. Representatives of these households were interviewed if they played an active role in household budgeting and food purchases. A similar selection process was undertaken for 30 households in the peri-urban village of Tlokweng. The urban and peri-urban household interviews focused on: income and expenditures; percent income spent on food; level of food insecurity; the changes in food status since 2008; the extent to which high food prices are a problem; coping strategies employed by households to deal with food shortfalls; and the potential impacts on extended family in rural areas of coping strategies in urban areas.

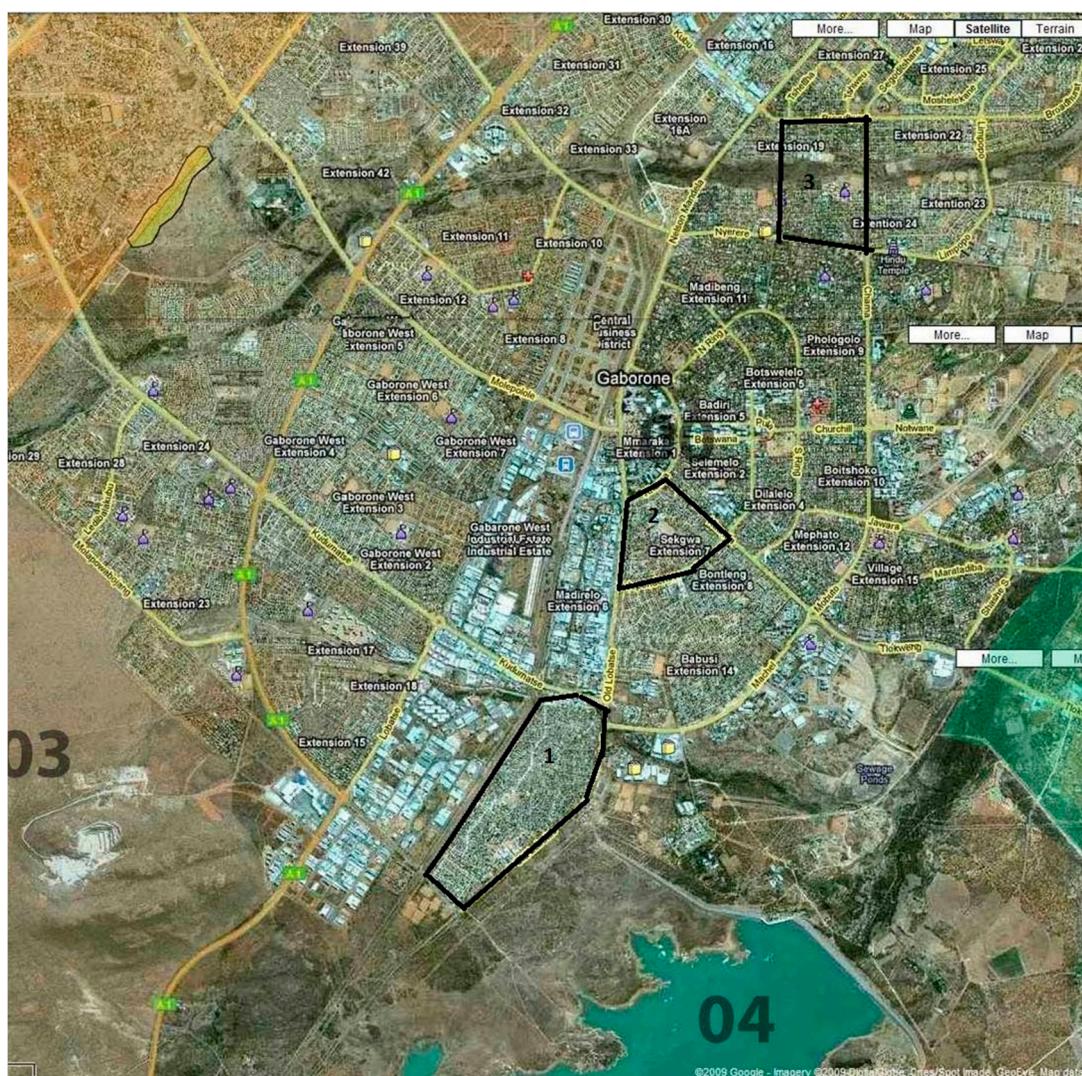


Figure 2. Map of Urban Survey Locations (outlined in black). Survey neighborhoods as follows 1. Old Naledi, 2. White City and 3. Broadhurst. Source: Base photo from Google imagery and used within fair use guidelines.

An additional 39 questionnaire surveys were undertaken in two rural communities outside of Gaborone: Molepolole and Thamaga. These are relatively large villages within one hour's drive of Gaborone. They could be considered representative of rural Southeastern Botswana, but not the country as a whole. Households were selected in a similar manner: moving from east to west across communities, systematic selection by knocking on the door of every fourth house for a potential interview, and representatives of these households interviewed if they played an active role in household budgeting and food purchases. The author asked a similar set of questions to those posed to urban households. The goal of these interviews was to examine how coping strategies in a period of high food prices may differ from those of urban households. The author also explored how food and cash transfers with urban-based family members may be changing.

The main measure the author used to assess household food insecurity in surveys was the Household Food Insecurity Access Scale (see Table 1). This measure was developed by the United Nations Food and Agriculture Organization (FAO) [40] and asks a series of questions, gradually increasing in severity, about a household's state of anxiety over food and access to meals, as well as actual experienced food scarcity, over the past four weeks.

Table 1. Household food insecurity access scale.

No.	Occurrence Questions
1.	In the past four weeks, did you worry that your household would not have enough food?
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to lack of resources?
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?
6.	In the past four weeks, did you or any household member have to eat fewer meals in a day because there was not enough food?
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of a lack of resources to get food?
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

Note: Each question is scored for 0–3, with 0 = never, 1 = rarely (once or twice in past four weeks), 2 = sometimes (three to ten times in past four weeks); and 3 = often (more than ten times in past four weeks). The household food insecurity access score, or HFIA, (1 = food secure, 2 = mild food insecurity, 3 = moderate food insecurity and 4 = severe food insecurity) is tabulated based on the scores to the nine questions in Table 1. A score of 1 to 4 is based on the following: HFIA category = 1 if [(Q1a = 0 or Q1a = 1) and Q2 = 0 and Q3 = 0 and Q4 = 0 and Q5 = 0 and Q6 = 0 and Q7 = 0 and Q8 = 0 and Q9 = 0]; HFIA category = 2 if [(Q1a = 2 or Q1a = 3 or Q2a = 1 or Q2a = 2 or Q2a = 3 or Q3a = 1 or Q4a = 1) and Q5 = 0 and Q6 = 0 and Q7 = 0 and Q8 = 0 and Q9 = 0] HFIA category = 3 if [(Q3a = 2 or Q3a = 3 or Q4a = 2 or Q4a = 3 or Q5a = 1 or Q5a = 2 or Q6a = 1 or Q6a = 2) and Q7 = 0 and Q8 = 0 and Q9 = 0] HFIA category = 4 if [Q5a = 3 or Q6a = 3 or Q7a = 1 or Q7a = 2 or Q7a = 3 or Q8a = 1 or Q8a = 2 or Q8a = 3 or Q9a = 1 or Q9a = 2 or Q9a = 3].

Thirty follow-up, semi-structured interviews with peri-urban and rural households in 2015 focused more narrowly on gardening. These included 10 peri-urban households interviewed in 2012, plus 20 new rural households in different villages than 2012. All representatives of households interviewed were engaged in gardening, some with the government's backyard gardening initiative and others on their own initiative. Questions in these shorter interviews focused on the degree to which gardening may or may not be contributing to food security, dietary diversity or income generation.

3. Results

The results of this research are organized into two sections. The first is the empirical findings related to household food security. The second is an analysis of policy and macroeconomic factors driving food insecurity. In particular, the second section discusses the political economy of the livestock, diamond and ecotourism sectors and their role in driving inequality, as well as the precarity of smallholder production in Botswana today.

3.1. Food Insecurity

In Botswana, 30 percent of the general population lives below a \$2/day poverty threshold [20]. The mean per capita income of the households surveyed in Gaborone was \$3.55/day, whereas that for peri-urban households was \$5.56/day, and that for rural households was \$1.67. Household interview data revealed challenging food security circumstances for the poorest households (see Table 2).

Table 2. Food security findings.

Sample Size	Demographic	Mean per Capita Income per Day		Percent Income Spent on Food	Food Security	
		Pula	USD		HFIA Score	Qualitative
89	All Urban	25.5	\$3.55	35%	2.8	Moderate
30	Urban lower tercile	1.71	\$.24	38%	2.9	Moderate
30	Urban middle tercile	16.9	\$2.35	35%	2.9	Moderate
29	Urban upper tercile	59.14	\$8.21	31%	2.5	Moderate
30	Peri-urban	40.1	\$5.56	26%	2.8	Moderate
39	Rural	12	\$1.67	61%	3.2	Moderate

Note: The household food insecurity access score (HFIA) is tabulated based on the scores to the nine questions in Table 1: 1 = food secure, 2 = mild food insecurity, 3 = moderate food insecurity and 4 = severe food insecurity.

In Gaborone, the poorest tercile of urban respondents had a per capita income of \$0.24 per day and a household food insecurity access (HFIA) score of 2.9, indicating moderate food insecurity (see note following Table 1 for a description of how question responses were converted to HFIA scores). Amongst the urban households surveyed, the low and middle income categories spend 38 percent and 35 percent of their income on food (as compared to 31 percent for wealthiest third). The average for the urban group was 35 percent. In total, 12 percent of the urban respondents were experiencing moderate food insecurity and 44 percent were experiencing severe food insecurity (see Table 3). Interviews revealed that urban residents have a very limited ability to cope with fluctuating global food prices. Some respondents in the Old Naledi neighborhood (area #1 in Figure 2) did discuss the spatial or locational advantage of their neighborhood in terms of coping. They mentioned that it was close enough to the city center to minimize the cost of commuting, yet also within walking distance of the Gaborone dam area to the southeast where firewood could be collected. Historically, residents from this neighborhood also salvaged food scraps from a dump in the Gaborone dam area [41]. The most common strategy for coping came in the form of reducing remittances to rural areas. This is important because it means that rural areas may be bearing the brunt of belt tightening in urban areas in response to fluctuating food prices.

Table 3. Proportion of households facing food insecurity.

Sample Size	Demographic	Food Secure	Mild Food Insecurity	Moderate Food Insecurity	Severe Food Insecurity
89	Urban	24%	20%	12%	44%
30	Peri-Urban	27%	7%	23%	43%
39	Rural	18%	6%	19%	57%

In the survey, the proportion of households facing food insecurity was highest in rural areas (see Table 3). Here some 76 percent of households in the sample were moderately or severely food insecure, as compared to 56 percent in the urban sample and 66 percent in the peri-urban sample.

The rural sample was composed of 39 households. Sixty-one percent of the rural respondents were female, with an average age of 47 and an average household size of 4.7. Average assets for these rural households were: 7 cows, 10.6 goats, 5 sheep, and 13.6 chickens. These mean asset figures mask lower numbers for poorer and more food insecure households. Thirty eight percent of rural inhabitants surveyed identified as farmers, of which 87 percent were women. The major crops raised were maize, sorghum and cowpeas. The minor ones included: watermelon, sweet reed and pumpkins. The typical farm was five hectares in size and all benefited from government support for seeds and plowing.

Of the farmers interviewed, 20.5 percent reported that weather impacted their household's access to food. Furthermore, 67 percent of these farmers cultivate less than they did five years ago. When asked why they farmed less, two-thirds indicated that it was because of labor constraints. The second most common reason for farming less was weather, mentioned by 20 percent.

In terms of cropping strategies, very few farmers indicated that they alter what they grow in response to market signals. As such, farmers do not necessarily grow more maize, sorghum or cowpeas when the prices for those crops are high. One of the most surprising findings was that farmers are growing considerably less sorghum than they did 10 years ago. This was surprising because six of the 10 years prior to 2012 (the year of the survey) were drought years, and sorghum is generally considered to be much more drought tolerant than maize. Informants reported that sorghum is mainly being replaced with maize. According to interviewees, the advantages of maize (even though it is more susceptible to drought) are that it is less labor intensive, it matures in a shorter time period and it is not subject to predation by birds to the same extent as sorghum.

Finally, of the sample of 30 peri-urban households (all from Tlokweng, a large peri-urban village next to Gaborone to the east), ten were involved in urban gardening. The majority of these gardeners were female and their average age was 44. Urban gardening in Botswana is largely supported by the Ministry of Agriculture's Backyard Gardening initiative, part of President Ian Khama's signature Poverty Eradication Programme. This program targets households and individuals living below the poverty line and generally frames "backyard gardening" as a female activity. Beneficiaries of this program receive shade netting, rain barrels to collect roof water, drip irrigation tubing, seeds, tools and extension services (see Figure 3). Based on interviews with these ten gardeners, the major constraint they face is access to affordable water. Follow-up interviews in 2015 (including backyard and commercial gardeners) revealed that access to affordable water was the key variable impacting food security and economic success [42]. This program has been criticized in the local press for being impractical due to the high cost of water, as well as for not being a priority for some recipients [3,43].

3.2. Agriculture, Poverty and Botswana's Political Economy

Understanding Botswana's political economy is critical for gaining insights into the major drivers of poverty, inequality and food insecurity in the country. While agriculture was once Botswana's most important sector, accounting for 40 percent of GDP at independence, it now accounts for only 1.8 percent of GDP [44]. Not unlike many African countries [45], Botswana adhered to a policy of food self-sufficiency in the first few decades following independence. In the early 1980s, however, Botswana transitioned from a policy of food self-sufficiency to one of food security [21]. This shift, from trying to produce as much food as possible, to importing increasing quantities of food, was consistent with neoliberal economic reforms of the era which emphasized specializing in one's comparative advantage and trade for other goods [45,46].



Figure 3. The backyard gardening initiative in Botswana (photo by author).

Today Botswana imports 90 percent of its food overall, and crop agriculture (not to be confused with livestock rearing) is in a more marginal position than ever in the country's political economy. Despite this fragility and marginality, crop agriculture still remains an important activity for the poor and women. Small farmers (defined as those who cultivate 20 hectares or less) work 80 percent of planted area and produce 38 percent of the harvest. Agriculture employs 30 percent of the total workforce and 35 percent of women [47].

As agriculture has stagnated and other sectors of the economy have grown, many rural Botswanans purchase more of their food or have moved to the city in search of employment [48,49]. The government of Botswana does provide a fairly robust safety net for poor urban and rural dwellers—especially when compared to other African countries. In rural areas, the key welfare support comes in the form of drought relief whenever an official dry year has been declared (more than half of the last ten years). In urban areas, there is a significant public works program, known as Ipelegeng in Setswana, which employs those who fall below the poverty line, and are able-bodied, in activities, such as street sweeping and trash collection. Botswana's current president, Ian Khama, has made poverty eradication a major policy priority. Despite these efforts to address poverty, and inter-related food insecurity, it is structural shifts in Botswana's economy over the past 50 years that explain the growing gap between Botswana's rich and poor. The three main components of the country's economy are cattle, diamonds and high-end ecotourism. Below, each of these components is discussed briefly, followed by an articulation of how a comprehension of the political economy of these three sectors allows us to understand the precarity of smallholder production in Botswana today.

3.2.1. Cattle

The livestock industry is Botswana's original export activity and accounts for 80 percent of the agricultural sector. While livestock represented 85 percent of exports at independence (largely on the hoof to South Africa), this had shrunk to two percent by 2006 as other sectors of the economy grew. There has been significant public investment in the livestock sector since independence, including the sinking of thousands of boreholes, land tenure reform favoring large cattle ranchers [50], and the establishment of the Botswana Meat Commission (BMC). The BMC regulates the livestock industry, provides veterinary services and disease control, runs or oversees slaughter houses, and facilitates the export of meat to lucrative European Union markets [51]. What is critical to understand is that these public investments have largely benefitted wealthy men who own the majority of the nation's

livestock herd. Even urban elites continue to invest surplus wealth in cattle. The national herd grew ten-fold from beginning of 20th century, reaching three million in 1978. It then declined to two million by 1990 because of drought and is now back up to three million today.

3.2.2. Diamonds

Botswana is the largest producer of gem-quality diamonds in the world (as opposed to industrial diamonds). After discovering diamonds a few short years after independence, Botswana shrewdly negotiated with DeBeers for a 50/50 split of revenues [52]. This industry has been incredibly well managed, and the Government of Botswana now owns 15 percent of DeBeers today. It is diamond revenues which largely fund the government, including education and health care for all citizens. While this wealth is shared by all citizens, it tends to be wealthier, better educated citizens who hold the highest paying civil service positions [44]. The government's stake in the diamond industry has allowed it to bankroll services, employment and contracts in cities and towns that have fueled urbanization in Botswana and drawn labor away from agriculture [44,49].

3.2.3. Eco-Tourism

Last, but not least, Botswana is known for its high-end, low-volume eco-tourism sector. After looking at the eco-tourism industry in neighboring African countries, Botswana decided early on that it would focus on the wealthy end of the market to maximize revenues and limit potential environmental degradation related to high-volume tourism [53]. Most eco-tourism is located in the northern parts of the country in and around the Okavango Delta. Here the government leases out concessions to tourism operators for extremely high prices. Unfortunately, the highest paying jobs in this sector are held by wealthy investors, many of whom are naturalized Botswana citizens (often former white South Africans and Zimbabweans). Most employment in this sector is composed of low paying, service sector jobs.

The structure of the Botswana economy, dominated by the cattle industry, diamond mining and high-end eco-tourism, has tended to deepen inequality and done little to alleviate poverty and related food insecurity. This structure has also served to pull labor and resources away from crop farming, a sector involving more women and poorer members of society.

4. Discussion

Climate change has had minimal direct impact on the food security of the majority rural households surveyed in this study. First and foremost, with agriculture becoming less and less of a factor in Botswana's rural food economies (largely due to structural changes in the economy), production declines related to poor rainfall only impact a relatively small source of food for most rural households. Furthermore, rainfall declines, as an exogenous shock, only explain part of the crop losses experienced in dry years. Labor constraints have forced changes in Botswana's farming systems (namely a shift from sorghum to maize production) that have exacerbated losses in dry years because maize is less drought tolerant than sorghum.

While this only impacts a fraction of rural households, declining rainfall does constrain the government's backyard gardening initiative because gardens often receive minimal rainfall in the December to March 'rainy season' and roof top rain barrels are only minimally replenished during this period. Absent sufficient rainfall, most urban and peri-urban backyard gardeners cannot afford to cover the cost of municipal tap water with their meager returns from gardening. Given an on-going water shortage, most municipalities also frown on the use of tap water for gardening purposes. More rural gardeners with access to borehole water typically face less of a constraint.

A more likely and significant impact of climate change is on the overall price of grain in regional and global markets (which is an issue for Botswana which imports 90 percent of its food). That said, global food price fluctuations to date have not been tied to weather related supply shocks—but more clearly to increasing energy prices. A stronger argument could be made for importance of regional

climate change, especially that affecting South Africa, because it supplies the majority of Botswana's food. This has been especially evident in 2016 with an El Niño-related drought devastating crop production across Southern Africa [54].

The major direct constraint on rural food security in Botswana is increasingly high and variable food prices—both directly and indirectly—coupled with constrained income-generating opportunities for rural households. The problem is that the vast majority of Botswana's rural households are not food self-sufficient and purchase a large proportion of their food. This means that rural households (like urban households) are often equally affected by high and fluctuating food prices. Rural households are also affected indirectly by high food prices, as interviews with rural and urban informants suggested that rural households receive fewer remittances from urban relatives when food prices go up. As discussed previously, the structure of the Botswana economy, dominated by the cattle industry, diamond mining and high-end eco-tourism, has tended to deepen inequality and done little to alleviate poverty and related food insecurity. This structure has also served to pull labor and resources away from crop farming, a sector involving more women and poorer members of society. In terms of moving forward, it may be worth thinking about backyard gardening in different terms than just poverty alleviation, but as a climate proof, small-scale production initiative. While Southeastern Botswana used to benefit from some of the better rainfall in the country (an area of the country where the nation's capital and majority of the population are located today), the spatial distribution of rainfall seems to be shifting away from this region [3]. Although groundwater reserves are not sufficient to support the irrigation of extensive row crop cultivation, an argument could be made for small, intensive horticulture production, which is more frugal with water resources and produces higher value crops. As such, the government of Botswana may want to consider framing backyard gardening as a climate change adaptation that is worthy of international support. The initiative could also be improved upon. For example, while most backyard gardening and commercial horticulture in Botswana has largely focused on European vegetable production to date, there may be other types of vegetables or fruits (such as traditional beans whose leaves are consumed), which require less water. The targeting of recipients for government backyard garden support could also be strengthened, as some of the current beneficiaries did not see this as their first priority for a livelihood activity).

Detractors may argue that it is inefficient for a water-constrained country like Botswana to produce more of its own food when it can import food from more water-rich countries (essentially importing what some have referred to as virtual water) [55]. The Ricardian argument suggests that Botswana should focus on those goods for which the country has a comparative advantage (namely cattle, diamonds, and high-end ecotourism) [19]. There are at least two counter arguments to this line of thinking. First, backyard gardening is a pro-poor activity (rather than investing in the core elements of Botswana's economy that may deepen inequality) and subsistence food production protects the poorest of the poor against food price fluctuations. Small-scale, irrigated backyard gardening is also quite different from traditional irrigation schemes that have often marginalized the poor [56]. Second, given the fact that South Africa produces the vast majority of Botswana's food, and South Africa increasingly faces similar climate change threats [57], the environmental comparative advantage argument in favor of South African foodstuffs is somewhat weak.

A key challenge for making small-scale, irrigated gardening a viable, pro-poor adaptation in Botswana will be overcoming the politics and power dynamics involved in water allocation in southeastern Botswana. With rainfall declining in the most densely populated area of the country, the powerful livestock industry has tightened its grip on borehole water resources in this region. Furthermore, municipal water, which increasingly comes to Gaborone via the north-south water carrier (a huge pipeline bringing water from the north to the south of the country) [58] because the Gaborone dam no longer fills, is mainly allocated for domestic use. Critics have pointed out that these domestic uses also include watering golf courses, as well as lawns in wealthy Gaborone suburbs, such as Phakalane (arguably frivolous uses that far exceed the quantities that might be used in vegetable

gardens). Reorienting water use over the long term will be key to developing more viable livelihoods for the poor.

5. Conclusions

Despite the growing concern about the impact of climate change on livelihoods and food security in Sub-Saharan Africa, there are larger structural issues driving the coupled problems of poverty and food insecurity in Botswana. Poor urban households in Botswana's capital, Gaborone, are challenged by increasingly volatile food prices. Facing a limited ability to cope, these households often reduce remittances to rural households as a way to address rising food prices. This creates a double burden for rural households, who are rarely food self-sufficient, buy a large proportion of their own food, and are squeezed by declining remittances from family members in the city. As such, it is the structure of the economy and periodically high food prices that are the main drivers of food insecurity in both urban and rural areas, not climate change. While rainfed agriculture is an important source of food for some rural households, labor constraints mean that this approach to agriculture is increasingly vulnerable to declining rainfall regimes as households grow less labor intensive crops that also happen to be less drought tolerant. While the government's backyard gardening initiative was only moderately successful according to official accounts, and recently discontinued amidst criticism, small-scale, irrigated horticulture may represent a form of climate change adaptation that deserves further experimentation. However, given that horticulture, and women's farming more broadly, is marginalized within Botswana's economy in terms of access to water, addressing this constraint is a prerequisite for women's horticultural success.

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