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Exploring the Role of Horticulture in Alleviating Food Insecurity Among Women in Botswana

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Abstract: By most measures, Botswana is an African development success story. However, there are still segments of the population that suffer from the interlinked phenomena of persistent poverty and food insecurity. The Government of Botswana and its partners have increasingly sought to address household food insecurity through gardening initiatives of various sizes and commercial orientation, but the success of these efforts has not yet been evaluated. I use an interdisciplinary approach, incorporating both econometric analysis and qualitative data viewed through the theoretical lens of political ecology, to determine how effective these women's gardening initiatives are in addressing household food insecurity. I compare the relationship between commercial orientation and food security for women who rely on borehole water, tap water, and river water. I find that food security status improves with commercial orientation *only if* a woman is already experienced with the commercial market or if commercialization will help her cover her water bills. I also challenge the discourse that women who receive food aid put forth less effort in their gardens; I find that there is no significant difference in harvest for those who rely on government food assistance, and that a woman's attitude toward gardening is a much more important determinant of garden success. This study's results call into question claims that commercialized horticulture will improve food security without addressing the gendered dynamics of water access.

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[1] See Appendix 2

I. Introduction

Before arriving in Botswana to conduct research for this paper, I assumed that water access would simply be one factor among many that determined a woman's food security status. As we began scoping out potential interviewees, however, it quickly became clear that water was of paramount importance. We would drive through the villages surrounding Gaborone searching for the shade nets that indicated the presence of a garden, only to find that many contained nothing more than an arid plot of dirt, overgrown with weeds and lacking any signs of recent cultivation. The worsening scarcity of water in Botswana, and the severe inequalities in access to that water, had condemned these gardens to failure in spite of their owners' best efforts. Despite this challenge, we found many successful horticulturalists that helped shed light on the complex dynamics of water access, commercialization and food security.

The Government of Botswana and its partners have increasingly sought to address this issue through poverty alleviation efforts, including women's gardening initiatives of various sizes and commercial orientations. These gardening programs have struggled to bring about improvements in women's food security statuses. This project aims to determine why these horticulture initiatives

have seen such mixed success by using data collected through semi-structured interviews with 100 female horticulturalists and regression analysis. I find that food security status improves with commercial orientation *if* a woman is already experienced with the commercial market or if commercialization will help her gain access to water.

I found that it is crucial to recognize that the relationship between commercialization and food security differs depending on a horticulturalist's water source. For women who have the resources to drill a borehole, there are food security benefits to increased commercialization because these women are already relatively experienced in the commercial market and, thus, increased commercialization translates directly into increased profitability. Less experienced women with fewer resources face a more difficult choice in determining whether increased commercialization will be beneficial. Women who are just breaking into the commercial horticulture market face both benefits and costs to increasing their commercial orientation. For women who have no options but to use tap water, the benefits outweigh the costs because increased revenue allows them to pay their water bills. Women who rely on river water, which is relatively cheap and available to most women in the area regardless of wealth and

status, more often see the costs of increased commercialization eclipse the benefits; I find that their food security deteriorates significantly with an increase in their commercial orientation. The key difference between this group and the group that uses tap water is that women who have access to the river have lower costs of accessing water and thus do not need to commercialize as much to cover these expenses. Many women who use river water are small-scale horticulturalists in transition between subsistence and commercial cultivation. For these women, the costs of commercialization, such as transport and packaging, and the high levels of risk involved in commercial enterprises leave these women worse off than they would have been if they simply consumed what they grow.

I first review the existing body of literature on the definition of food security, gender-based inequalities in agriculture and in water access, and on horticulture as a food security strategy. I then explain how I use feminist political ecology as a framework for this study. Next, I briefly explain my methodology, which includes semi-structured field interviews and regression analysis in combination with qualitative data.

I have organized my results into three sections. The first explores the relationship between food security and commercialization in the aggregate. The

second, and most pivotal, section looks at how a horticulture operation's source of water affects the relationship between food security and commercialization. The final component of my results focuses on the importance of food aid and a woman's attitude toward gardening in determining a backyard gardener's success. Lastly, I offer some recommendations for policymakers and contributions to the discourse on the intersection of gender, food security and resource access.

II. Context in the Literature

In this section, I first outline how the discourse on food security, and the way in which it is defined, has changed over time. The second body of literature that I review is concerned with the gender dynamics of agricultural production and access to water. Lastly, I give an overview of the debate over horticulture's merit as a livelihood strategy.

i. The Evolution of Food Security Discourse

The first large-scale multilateral discussion on food security took place at the 1974 United Nations World Food Conference (Alcock, 2009). Food security quickly became a key international issue in part due to the 1970-72 global food crisis, in which developing countries were squeezed by the combination of cereal prices that skyrocketed by as much as 225 percent and reduced food aid from the United States (Heady and Fan, 2010). The International Undertaking on World Food Security (IUWFS), which was written during the conference, clearly demonstrates the Malthusian mindset of this period. The first clause of the IUWFS blames natural disasters, crop failures and rising populations in developing countries for the crises of the preceding two years (FAO, 1974). This explanation completely ignores the larger forces at play, such as rising oil prices due to OPEC supply cuts and the enormous surge in grain demand by the USSR. The crisis is effectively stripped of its political dimensions and portrayed as a purely natural phenomenon. The resulting policy recommendations, namely to increase national production and grain reserves, are similarly oversimplified.

In 1981, Amartya Sen published *Poverty and Famines,* which has become one of the most cited works in the food security literature. *Poverty and Famines* marks a distinct departure from the preceding food security discourse from its very first line: "Starvation is the characteristic of some people not *having* enough food to eat. It is not the characteristic of there *being* not enough food to eat" (Sen, 1981, p. 1) (emphasis in original). Sen calls for a move away from the focus on aggregate food production statistics, and increased attention to economic access.

Sen proposes what he calls the entitlement approach to evaluating the causes of food insecurity. He defines a person's "endowment set" as consisting of all legally-obtained resources belonging to that individual, including land, the value of his labor, the food he grows himself, and his knowledge or skills. That individual's "entitlement set" includes all possible combinations of goods and services (including food) that he could purchase given his endowment set. The "exchange entitlement mapping", which is essentially the function that determines how a person's endowment set is related to their entitlement set, depends on that individual's legal, socioeconomic and political position within their society and on the market prices of that food (Sen, 1981, p. 46).

In this model, the individual will become food insecure through a reduction in his endowment (a loss of land or the productivity of that land, reduction in his ability to work, the failure of his crops etc.) or with a change in his exchange entitlement mapping (a fall in status, meaning that the individual can now obtain less food with a given level of wealth, or an increase in the price of

commodities). If either of these changes occur for many individuals in a population, widespread famine may develop without any original change in food production (Sen, 1981).

Sen's entitlement approach is the topic of much debate, even decades after its publication. Sen himself brings up several limitations of his model including its assumption that food is obtained legally, its ambiguous definition of entitlements, and incidences of people consuming less food than the maximum amount their endowment set can procure (1981, p. 48). Alcock (2009) argues that the entitlement approach also ignores the possibility of famines intentionally caused by human intervention. He uses the Ethiopian government's discriminatory distribution of food aid during the 1980s as an example of famine being used for political goals (Alcock, 2009). Devereux (2001) criticizes Sen for ignoring the linkages between famine and disease, which may bias his data since disease is often the ultimate cause of mortality for those who suffered from starvation. The entitlement approach also assumes that everyone in a household receives an equal portion of the food, and ignores intra-household power dynamics (Devereux, 2001). This assumption is particularly limiting when studying the intersection of gender and food security. Despite these limitations, the wealth of literature published in the last thirty years in direct response to Sen's *Poverty and Famines* shows the continued relevance of this work.

One of the best indicators of the tenor of contemporary food security discourse is the 1996 Rome Declaration (Alcock, 2009). In a decisive move

toward recognizing the importance of economic access to food, rather than simply focusing on national production or supply, the Declaration defined food security as existing when "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). This definition includes all three pillars of food security: adequate production and supply ("physical access"), equitable distribution and access at the household level ("economic access") and, for the first time, dietary diversity and quality ("nutritious food").

The Rome Declaration also drastically widens the scope of its policy recommendations, as compared with the IUWFS. While boosting national food production is still among the FAO's goals in 1996, measures such as poverty eradication, environmental protection, the promotion of democracy, and the strengthening of women's rights have also been added (FAO, 1996). The Rome Declaration maintains the Malthusian bent of the food policy discourse that preceded it, however; it actually out-does the IUWFS by explicitly endorsing family planning and ominously-vague "population policies" (FAO, 1996).

In recent years the discourse on food security has returned to an emphasis on food production, at the expense of economics access and distribution of food. The New Green Revolution for Africa is the best example of this shift. This initiative focuses on boosting agricultural yields through increased use of pesticides, fertilizers and GMO and hybrid seeds (Gates Foundation, 2016).

Nutritional security is the most understudied aspect of food security, but has gained increasing attention in recent years. An individual is nutritionally secure when they have "secure access to a nutritionally adequate diet and the food consumed is biologically utilized such that adequate performance is maintained in growth, resisting or recovering from disease, pregnancy, lactation and physical work" (Frankenberger, et. al, 1997). Nutritional security depends not only on the food consumed by an individual, but also on the individual's health and "care" (most relevant to children and the elderly) in terms of the time, energy and support given by the household or community. Health is an important determinant of nutritional security because illness can suppress appetite and prevent proper nutrient absorption (Smith et. al, 2000). This relationship also works the other direction, since nutritional deficits can harm the immune system and lengthen recovery time. Sanitation and access to sources of clean drinking water are also key components of nutritional security (Brown, 1995).

In addition to national food production, supply and distribution, scholars have identified various indirect drivers of food insecurity. Poverty is the leading factor, as it limits a household's economic access to food and the nutritional quality of the food obtained (Misselhorn, 2005). Environmental stressors, such as drought and climate change, can also exacerbate food insecurity by limiting food production possibilities across entire countries (Misselhorn, 2005). While food security depends on disease prevalence and health standards generally, HIV and AIDS specifically can have a significant impact on production, economic access,

and nutritional security. HIV/AIDS is particularly relevant in Botswana, as adult HIV prevalence is the second-highest in the world at 23 percent (United Nations, 2014). There are too many other determinants of food security to list in full, but among them are property rights, market access, and issues of gender equality. Since food and nutritional security depend on the interaction between all of the above factors and several others, it is often a challenge to trace the direct effects of each influence.

ii. The Role of Women in Discourse on Water Access and Food Security

Until the 1990s, most scholars ignored the gender dynamics inherent to water access or misrepresented the ways that women use water. The conventional wisdom held that women mostly required water for domestic purposes, such as cooking and cleaning, and women's production needs were not considered (Zwarteveen, 1997). Zwarteveen (1997) argues that, prior to her work, policymakers and researchers had focused too heavily on how women gain access to water through informal means, and on the differences between men's and women's water needs. This mindset led government agencies to leave women's need out of their plans for irrigation management policies. Crow and Sultana (2002) corroborate Zwarteveen's findings through their case study in Bangladesh. Crow and Sultana find that gendered power dynamics are key in determining who has access to water, and that water access in turn determines women's status in society (2002).

A growing body of evidence suggests that if gender inequalities in water access were reduced, agricultural production would improve greatly in developing countries, benefiting not only women but the entire population (Brown, 1995). Sub-Saharan African countries would likely experience the largest production gains with improved women's rights, since women account for up to three quarters of the agricultural labor in the region (Brown, 1995). A study by the World Bank in 1989 found that African women provide 90 percent of the labor needed to process crops, obtain water and fuelwood and do 60 percent of the harvesting. In the intervening years, women have taken on an even greater proportion of work in agriculture, even while facing serious structural constraints due to gender-based discrimination.

Weak land rights for women is one such constraint that has limited agricultural production and, thus, intensified food insecurity in many countries (Brown, 1995). The productive potential of women in developing countries, and their resulting food security status, is further constrained by inadequate education relative to men of similar socioeconomic status (Brown, 1995). Farmers with higher levels of education are more likely to adopt new technology if they determine that it will increase their productivity. Thus, a lack of education compounds the problems that women already face in obtaining physical capital. A woman with little education is also less likely to have a strong relationship with agricultural extension agents, and will therefore receive less help than the average male farmer, who is better-educated (Brown, 1995).

Empowering women might even improve food security beyond the gains expected from making half of the population more productive if, as several studies suggest, women actually contribute more to food security than men when given equal opportunities. For example, women have been shown to out-produce men with the same size plot and equal access to inputs (World Bank, 1994). Udry (1996) also finds that inputs, particularly land, are not distributed efficiently between different agricultural plots within many households. He finds that plots controlled by women are farmed less intensively because more resources are devoted to men's production activities. If these inputs were distributed more equitably between the men and women of the household, overall production could increase by as much as 6 percent.

Women also tend to spend their money differently from men, and when women gain decisionmaking power the welfare of the household often improves. Such discussions of bargaining power within households have come to be widely-accepted in recent years, even though they challenge conventional economic models of the household as a unified decision-making entity with a single set of preferences (Agarwal, 1997). Working in Senegal, Lepine (2013) finds that when a woman gains bargaining power within her household, her children's nutrition improves. In Kenya, Kennedy (1991) finds that the higher the share of household income that was controlled by a woman, the higher the family's calorie consumption. The same study shows a negative relationship between the share of household income controlled by a man and the household's

calorie consumption. Similar results have been found in Rwanda (Von Braun, 1991), Cote d'Ivoire (Hoddinott, 1995), the Philippines (Garcia, 1991), Taiwan (Thomas and Chen, 1994), Guatemala (Katz, 1992), and Brazil (Thomas, 1990). This body of research suggests that commercialized agriculture may have different impacts depending on a farmer's gender.

Theories to explain the different patterns of expenditure between women and men are mostly conjecture at this point. Hamilton (1984) posited that societal expectations in most cultures assign women the role of caretaker, making them responsible for ensuring that every family member receives sufficient food. He also suggested that women care more for children than men do, or at least are more aware of children's needs, since mothers typically spend more time with children than their fathers do (Hamilton, 1984). Another possible explanation Hamilton puts forth is that women spend the income that they control on more expensive food that takes less time to prepare, since cooking usually falls within the realm of a woman's duties. The final possibility is that women tend to spend their income on relatively inexpensive daily expenditures like food because their income comes more frequently than men, but in smaller increments. Thus, men's income is more likely to be used on large one-time payments (Hamilton, 1984).

Several of these studies have come under criticism for equating income earned by a woman to her control over those resources or her intra-household bargaining power (Engle, 1999; Nsamaneng, 1992). These critics point out that men may appropriate their wives' incomes and that husbands typically have

subtle and indirect influences on their wives' decisions. Despite these issues, the bulk of the evidence suggests that developing countries could make significant strides toward becoming food secure by securing women's rights to land ownership, improving their access to physical and social capital, sharing the burden of care work more equally between the sexes, and by opening more educational opportunities to women.

iii. The Impacts of Horticulture on Food Security

There are several questions that run throughout the literature on horticulture: is backyard gardening an innovative adaptation to gender-based constraints and climate change, or is it a marginal activity that is only used as a last resort? If there is a benefit to cultivating vegetables, is there a greater impact on food security and nutrition when horticulture is subsistence- or commercially-oriented?

Kirsten et. al (1998) found in South Africa that small-scale agriculture is only effective as a tool to alleviate poverty and ensure food security in regions where the environment is conducive to growing crops. These results prompted greater questioning of the viability of small-scale horticulture in water-scarce environments like Botswana (Averbeke and Khosa, 2007).

In 1995, Schmidt and Vorster also took a highly skeptical stance on the benefits of small-scale vegetable production. Their study in South Africa revealed only small differences in vegetable consumption between households that participated in horticulture and those who did not. Schmidt and Vorster found no

difference in height and weight for children in gardening families and those in the control group. In fact, the only significant difference between the two groups is that households involved in the gardening project had *higher* cholesterol levels than those in the control group (1995). Although the cause of this surprising result is uncertain, the authors speculate that those who grow their own vegetables use the money that they save by consuming their harvest or earn by selling it to purchase "convenience foods", which tend to be higher in fats and oils than some of the cheaper foods that the control group might rely on (Schmidt and Vorster, 1995).

Battersby (2013) has also critiqued the discourse surrounding gardening because she finds that urban South Africans would rather distance themselves from "their rural selves", as represented by agricultural activity, and view gardening as a last resort in times of crisis. However, she also found nutritional benefits for those who garden, prompting consideration of the balance between people's preferences about the sources of their livelihoods and their nutritional security (Battersby, 2013).

Scholars have also sought to determine whether there is a difference between the health and nutrition benefits of indigenous vegetables as compared to exotic vegetables. Horticulture in Botswana has often been framed as a low-productivity activity that people only turn to in times of drought or famine (Averbeke and Khosa, 2007). Others have argued that indigenous vegetables are only cultivated as a coping strategy, but that exotic vegetables are grown

regardless of ecological or economic conditions (Averbeke and Khosa, 2007). Indigenous vegetables are often not intentionally cultivated, and instead grow wild in maize and sorghum fields, and are only harvested by women and children in times of crisis. Exotic vegetables such as cabbage and carrots, on the other hand, can be bought and sold in commercial markets and are grown year-round, in good times and bad (Averbeke and Khosa, 2007).

Horticulture differs significantly from other types of agriculture when examined through a gendered perspective, as small backyard gardens allow women to work toward being food secure without directly challenging the social and cultural forces that keep women close to home. Unlike rain-fed crops, which are typically grown in large fields at a fair distance from residences, backyard gardens can be tended to in conjunction with women's domestic duties such as care of children and ill or elderly household members. The tools needed for horticulture are generally less expensive and more easily operated with the typical women's physical strength, partly because of the smaller scale of the average vegetable plot as compared to arable agriculture fields (Botswana MOA, 2008).

The main divide in the literature is over whether the facts outlined above indicate that women's involvement in small-scale horticulture is an example of their oppression or of their creative negotiation of gender-based constraints. Alice Hovorka (2004, 2005, 2006) takes the former stance, arguing that women turn to urban horticulture as a last resort, or in contexts where it is the only option available to them due to structural constraints. Hovorka qualifies this argument,

however, saying that over the long term small-scale agriculture may enable women to challenge the same constraints that forced them into horticulture in the first place (2006).

The onset of global climate change has brought an important new dimension to the debate over the viability of horticulture as a livelihood strategy, particularly in regions like Botswana where climate change is causing worsening water scarcity. Most vegetables require less water than cereal crops, and horticulture does not depend heavily on rainfall irrigation as maize or sorghum do since vegetables can more easily be watered by hand or using drip irrigation. Arable agriculture, on the other hand, fails one out of every three consecutive years in Botswana due to insufficient rainfall (Legwaila et. al, 2011).

However, if decreasing rainfall gives horticulture an advantage over arable agriculture, it still puts horticulture at a disadvantage to livelihood strategies that depend even less on rainfall, such as raising livestock. Faber (2010) questions the promotion of gardening to combat food insecurity since many gardens are inoperable due to drought. Faber did find, however, that the productive gardens had a positive impact on nutrition not only for its owners but for the entire community, as the highly-visible garden plots prompted others to think about their nutritional requirements (2010).

iv. The Debate over Commercialized Agriculture

The question of whether the commercialization of agriculture increases or decreases levels of nutrition and food security is a highly contentious one. On one

hand are those arguing that the extra income from cash cropping works to improve farmers' welfare, or that any negative effects will be corrected in the long-run (Kennedy, 1988; Von Braun 1995; Kennedy and Von Braun, 1986). In opposition to this view are those who say that cash crops are in competition with staple food crops, and that the growth of commercialization will reduce the amount of land and energy given to producing food for subsistence (Fleuret and Fleuret, 1980a and 1980b).

Fleuret and Fleuret (1980a 1980b) are forefront among those that frame commercialization as a problematic phenomenon. They question the assumption that commercialization necessarily leads to an increase in real income, or that such an increase would even result in food security improvements. They bring up the concept of "transitional malnutrition", wherein farmers who switch from subsistence agriculture to cash cropping experience a temporary decline in their nutrition (Fleuret and Fleuret, 1980b). This phenomenon is most commonly associated with cash crops that take several years of cultivation before profit can be made, such as fruit trees and coffee. Fleuret and Fleuret argue that malnutrition following commercialization is permanent far more often it is transitory, however, and that "transitional malnutrition" has too often been used to dismiss concerns about farmers' welfare (1980b).

Von Braun (1995) uses a global study done by the International Food Policy Research Institute (IFPRI) to argue that in most contexts, commercialization leads to improvements in nutrition. The IFPRI study found that

increased production of cash crops led to increased income for farmers in every country surveyed, except for Sierra Leone (Von Braun, 1995). The nutrition results were mixed, however; in Guatemala, Kenya and Malawi there was no difference between the nutrition of children in families of commercial farmers and those in families of subsistence farmers. In Rwanda, Zambia and the Gambia, child malnutrition fell with commercialization. In the Philippines and in Sierra Leone, children's health and nutrition were actually significantly *worse* in commercial families than in subsistence families (Von Braun, 1995).

Von Braun (1995) argues that the IFPRI study sites where child nutrition or health suffered after commercialization do not necessarily show a direct relationship between commercialization and the adverse health outcomes. In Sierra Leone, for example, the farmers were growing fruit trees and would not see any significant profit for about five years (Von Braun, 1995). This line of argument originates from Von Braun's earlier work with Kennedy (1986), in which the authors write that cash cropping influences many of the critical determinants of food security and nutrition, making it nearly impossible to trace a direct causal relationship between commercialization and health outcomes. The end result of this complicated process depends on a variety of factors, such as changes in real income, changes in intra-household power dynamics, effects on the allocation of time (especially for mothers), and nutritional knowledge (Von Braun and Kennedy, 1986). Thus, any adverse outcomes could be due to other structural factors, rather than the move toward commercialization per se.

In contradiction to scholars who argue that commercialization reduces the amount of land and resources given to cultivating food crops, Von Braun finds that farmers maintain their subsistence plots just as before, but simply add plots of cash crops (1995). These results are in line with earlier findings that farmers at various levels of commercial orientation use the same amount of land for food crop production (Kennedy, 1988). Most farmers who make the transition from subsistence agriculture to cash cropping are well aware of the risks of commercialization. Thus, to mitigate the risk of growing new crops or of monocropping, these farmers view their subsistence plots as a sort of insurance policy that ensures their households a baseline level of food security (Von Braun, 1995).

In their 1986 article Von Braun and Kennedy critique cross-sectional studies of the food security outcomes of cash cropping for ignoring farmers' initial food security and nutritional statuses (1986). They also point out that many of these studies find negative impacts of commercialization only because they work off of the unproven assumption that cash cropping is, by nature, in direct competition with staple crop production. When this assumption is relaxed, Von Braun and Kennedy find that commercialization most often has positive (but small) effects on food security and nutrition, and that these effects are most dramatic when cash cropping results in women gaining economic and social power (1986). In the cases where they do find negative effects, the authors prompt readers to ask: are adverse impacts of cash cropping going to be a long term

problem, or are they more of a short term phenomenon, indicative of creative destruction? Some scholars, such as Pingali and Rosegrant (1995) have argued that commercialization cannot be a frictionless process, and that "equity consequences" are likely to last only for the short or medium term. As mentioned above, Fleuret and Fleuret (1980b) caution that any negative effects of commercialization are likely to last much longer than policymakers might suggest.

In contemporary development discourse, it is still widely assumed that commercialized agriculture will improve farmer welfare. The New Green Revolution for Africa, headed by the Bill and Melinda Gates foundation, focuses on increasing access to commercial inputs such as fertilizer, pesticides and improved seed varieties. This approach requires farmers to make enough profit each season to purchase these inputs for the next year. There have been critiques of the New Green Revolution, such as Bezner Kerr's assertion that there is considerable danger of the initiative benefitting large-scale commercial farmers and international agrobusiness at the expense of the rural poor (2010).

The global development community has also increasingly focused on building value chains in recent years (World Bank, 2015; United Nations Economic Commission for Africa, 2015). This initiative involves integrating the developing country agricultural sectors into the global economy and adding value to raw materials through manufacturing (World Bank, 2015). These trends all

signal the continuing dominance of commercially-oriented agricultural development over more subsistence-oriented approaches.

This wider debate over the commercialization of agriculture has not often been investigated in relation to horticulture specifically, and the gendered component of this question is typically addressed only as a footnote. Further, the existing body of research on the connections between commercialized agriculture and food security have not considered the impacts of water access on this relationship. This study aims to fill the void in the literature by looking at these three factors (commercial orientation, food security and water) and by focusing on women and on horticulture specifically.

III. Conceptual Framework

My research is informed by feminist political ecology, as detailed by Rocheleau (1995, 2008, 2013). Political ecology emerged out of cultural ecology in the 1980s and 1990s, with the work of Blaikie (1995) and Bassett (1988). Political ecology seeks to challenge analyses of environmental change that focus only on proximate, or local, causes without fully considering the broader structural forces at play. Political ecologists use chains of explanation to untangle the forces working at various scales to influence human-environmental relationships. This approach results in explanations of environmental change that are based on localized systems of production constrained by the global political landscape (Blaikie and Brookfield, 1987). Examining horticulture and food security at different geographic scales is a key part of this research; I will be analyzing the local (individual gardeners and power dynamics within communities), national (Ministry of Agriculture policies and priorities) and the global (international development discourse) contexts, and how these scales interact.

Another key theme in political ecology is the connection between social, economic and environmental marginalization. In Botswana the marginalization of women, and in particular low-income women, has resulted in their relegation to their backyards and restricted access to so-called communal land. However, many of these women prefer to garden close to home to make their caretaking duties easier. These women are marginalized, but also exert power within those societal

constraints. This kind of tension is a key area of study for political ecologists, as they seek to recognize individual agency even while focusing on broader forces.

Marginalization is also evident in relation to water access in Botswana. There are very few communal sources of water; most gardeners either drill a borehole or simply use tap water. Political ecology holds that, because of such inequalities in access to environmental resources, environmental change affects people differently depending on their standing in political power structures. Thus, environmental change may either reinforce or break down economic and social inequalities. The disparate impacts of environmental change may be absent from the prevailing environmental and development discourses because discourse is most often controlled by those who gain from such inequalities.

Political ecologists also critique the narrative of a natural world that is separate from society and from livelihood strategies (Rocheleau, 2013). Instead, political ecology holds that the environment is inextricably linked with human survival and that in reality there are no areas of the world that exist outside of political and economic power structures. This link cannot be ignored in the case of horticulture in Botswana, since many households in my survey rely heavily on their garden for survival.

Another key concept in political ecology is dualism, which occurs when there are two related groups or areas, and one is developing at the expense of the other (Moseley, 2016). This is evident in Botswana at different scales. At the very broadest level, which I conceptualize through World Systems Theory, Botswana

is on the periphery (Wallerstein, 1987). Thus, the country as a whole has been exploited by core countries both during colonialism and in the intervening years. At the national level, dualism is present in the expansion of diamond mining at the expense of all forms of agriculture. Within agriculture the cattle industry has developed at the expense of crop agriculture generally, and rainfed agriculture in turn has historically been privileged over horticulture. Thus, horticulturalists are placed at the bottom of a long chain of exploitation, which may partially explain the mixed results of programs such as the MOA backyard gardening initiative.

The subfield of feminist political ecology is concerned with all of the concepts outlined above, but focuses explicitly on gender and on critiquing the assumption that households have homogenous preferences and a shared set of interests (Rocheleau, 2007). Feminist political ecology seeks to determine how gender-based power inequalities shape the way people interact with the environment (Rocheleau, 2013). This does not mean that gender is simply added as a variable similar to income or race, but that inequalities based on economic or political characteristics are viewed through the lens of gender first and foremost. Further, feminist political ecology views the differences between how men and women interact with their environments as a result of socially-constructed ideas of gender rather than biological differences.

The gendered division of labor in many countries is a clear example of such socially-constructed gender roles and their influence on human-environment relationships. Traditionally in Botswana, work is divided by gender within every

livelihood strategy. In arable agriculture, men are in charge of plowing and maintaining fields, while women weed and sow seeds. Men are more likely to own livestock, particularly cattle but also goats and donkeys, whereas women more often raise poultry (Norton, Alwang, and Masters, 2013). Vegetable cultivation is a fairly new activity in Botswana, but before it gained in popularity it was strictly women and children who gathered wild greens and squash that grow in fields and in the bush. These gendered systems of labor division lead men and women to relate to the environment in different ways. Thus, men and women have survival skills that are based on different sets of knowledge of environmental processes.

IV. Methodology and Data Issues

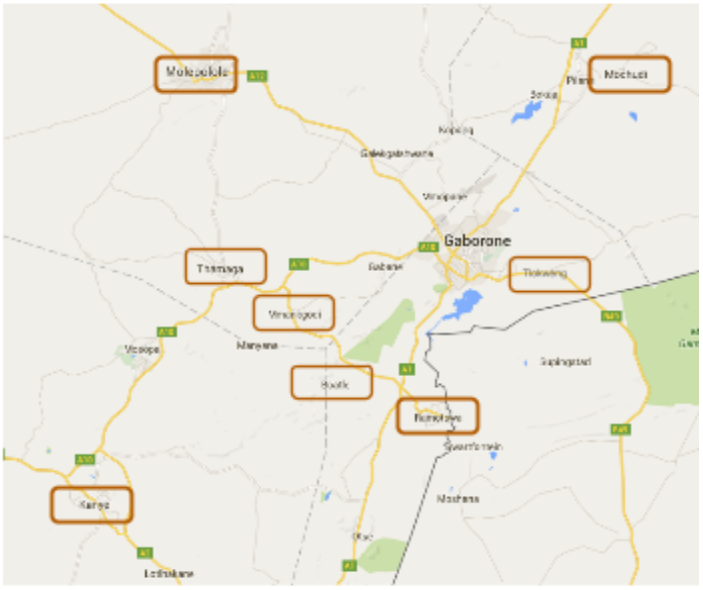
In this section, I explain how I conducted my fieldwork, and how I collected and analyzed my data. I also evaluate the potential issues with this data, and explain how I mitigate these issues.

I conducted 100 surveys within roughly 60 kilometers of Gaborone [see Figure 1]. This sample included 25 women who garden primarily for commercial purposes (those that sell more than 70 percent of their monthly harvest), 25 women who are in between commercial and subsistence (those that sell between 30 and 70 percent of their harvest), and 24 women who are primarily subsistence gardeners (those that sell less than 30 percent of their harvest). I also included 26 control cases. These were mainly women who had applied to programs that provide credit to cover the start-up costs of a commercial garden or women who had contacted the Ministry of Agriculture about the backyard garden program, but who had not yet established their gardens. I also included women who have already planted vegetables but have not yet harvested anything, since they will not yet have seen any food security benefits from their gardens. A sample survey form is available in Appendix 1.

Data were collected over a period of six weeks (May-June, 2015), so that this is functionally a cross-sectional dataset rather than panel. Panel data, which would include data on respondents in multiple years, would be ideal so that I could compare the relationship between horticulture and food security across both space and time. Cross-sectional data, rather than panel, is particularly limiting in

this case since Botswana experienced a drought not only at the time of data collection but also for several previous years. This may limit the comparability of my results with regards to historical data, but as droughts are expected to worsen with the onset of climate change this may not be a major issue in comparing with future trends. Additional problems arise from the fact that the question "how much of each vegetable did you harvest in the past month" refers to a different period of time for those surveyed in the beginning versus the end of the study period. This is not likely to be a serious issue, however, as most gardeners stagger the planting of new seedlings so that something is ready for harvest at all times. Further, commercial farmers adjust the amounts of each vegetable that they plant so that the market value of their harvest is roughly the same each month, giving them a stable source of income. Thus, the volume of a gardener's harvest is not likely to fluctuate by much from month to month (within a given season).

Figure 1: Main Villages where Interviews were Conducted



Map Data: Google, AfriGIS

I employed a research assistant who acted as a translator for 35 of the 100 surveys. For the survey questions

dealing with straightforward measures such as age and plot size, my research assistant wrote answers on the survey form in English, but without translating verbally. When collecting the less structured qualitative data, my assistant did translate aloud as we went along so I could ask follow-up questions and direct the conversation. However, the qualitative data is much more extensive for women who speak English, since some of the subtleties may be lost in translation and because conversations flow more easily when both parties speak the same language. This is particularly problematic because the respondents who speak only Setswana were among the poorest and most food-insecure women I surveyed.

All of the interviews with backyard gardeners took place in their yards, often with a Ministry of Agriculture official checking out the garden's condition while I talked to the gardener. Most of the interviews with commercial farmers took place in their fields, which are typically in a different location than the owner's home. I conducted a few interviews at coffee shops in Gaborone, with women who do not frequently travel out to their fields and instead live in Gaborone or the suburb of Phakalane. All of the interviews lasted between 15 and 30 minutes.

A random sample (within each commercialization category) would have been ideal, so that the data are representative of the population as a whole. Our sample was far from random, however, as we relied on Ministry of Agriculture data and snowball sampling techniques. At times we also drove through

residential areas looking for gardens and simply walked into the yard and introduced ourselves. As haphazard as this method may sound, we were never turned down for an interview request. However, our sample is weighted toward women who are easier to contact, whose garden plots are easy to reach, and who have more frequent contact with the Ministry of Agriculture. Thus, our sample is biased toward more educated and wealthier women.

We measured food security through the household food insecurity access scale (HFIAS) developed by the Food and Agriculture Organization (FAO) (USAID, 2007). The HFIAS is series of questions on the quality and quantity of a household's food supply. This scale also considers anxiety or uncertainty about a household's future food supply, and asks how people deal with a lack of sufficient food. The HFIAS questions leave considerable room for misinterpretation. For example, the first question asks "in the past four weeks, have you worried that you would not have enough food?" "Worry" can be interpreted in many ways, and it is likely that each woman has a unique threshold of anxiety necessary to answer this question in the affirmative. The HFIAS also asks how often each symptom of food insecurity occurs. It is often difficult for respondents to pinpoint exactly how many times they had to "eat a limited variety of foods due to a lack of resources", for example. This measure also does not capture women's struggles with relying on government food aid. Women who receive food baskets are often relatively food secure, but face shame and discrimination for depending on welfare.

The typical 0-27 Food Insecurity Access Scale does not weight each component question by its severity; thus, a response that indicates "worry" about household food supply has the same weight as a response indicating that a woman has gone a day without eating. The FAO does have a system that weights each question by its severity, but this scale only ranges from 0 to 4. Ideally, the dependent variable in a regression model will exhibit substantial variation; this scale is too coarse to provide statistically significant results since there are only five possible outcomes. I developed an alternative scale that assigns a score from 0 (perfect food security) to 100 by weighting each of the nine HFIAS questions "one step" more heavily than the last. Using either the 0-4 or the 0-100 weighted scales does not significantly change this study's results, which indicates that in this case a weighted scale adds little nuance to the results I find using the unweighted 0-27 scale.

We used the women's dietary diversity scale, which was also developed by the FAO, as a proxy for nutrition (FAO, 2010). The dietary diversity index is calculated by recording all food items consumed by the woman in the previous 24 hours and tallying counts of different food groups according to standardized FAO food type classifications. I prompted respondents to answer with as much detail as possible, but it is likely that there were errors due to imperfect recall.

Ideally I would have data on the income or wealth of all household members, so that I could control for wealth that does not come from producing vegetables. However, it is considered impolite to ask directly about income or

wealth in Batswana culture, and many women do not actually know how much their husbands make, let alone the incomes of every other household member. Instead, we used expenditures on electricity per household member as a proxy, following the precedent of using expenditure data to approximate household wealth (Morris et al., 2000). This is far from a perfect measure of wealth; the correlation coefficient between electricity expenditures per person and total food expenditures[2] is .58 (whereas a perfect positive correlation would yield a coefficient of 1). The expenditure estimates may be inaccurate, as we asked about a "typical" month and budgets can vary dramatically throughout the year. Additionally, some of the respondents are not the primary bill-payers in their household, and thus may not have a perfectly accurate view of expenditures.

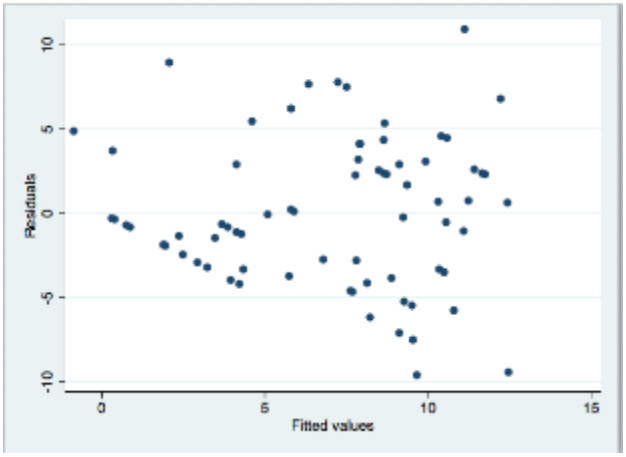
I measure "level of commercialization" as the percentage of the respondent's monthly harvest that they sell. To calculate this figure, I first converted the monthly harvest, consumption and sale into market values, since original answers were given in a variety of units, including market value, number of vegetables, weight and garden area. Monetary value is the best way to measure output, since this standardizes values across all different types of vegetables. Market value is a relevant concern to both commercial farmers (in terms of making a profit) and subsistence farmers (in terms of the money they save on their food budget by eating what they grow).

[2] Total food expenditure is the sum of food purchased and the market value of food grown and consumed. This is a good measure of wealth but cannot be used due to the high degree of collinearity between food security and food expenditures.

I triangulate my results along a variety of different dimensions, as is common practice in qualitative research (Patton, 1990). The qualitative data was collected during semi-structured interviews with gardeners, but also through less formal conversations with officials at the Ministry of Agriculture, which gives an idea of how opinions may differ at different levels of power, and according to the different interests that these actors hold in terms of the backyard gardening program. I also include gardeners at different levels of commercialization, those who rely on different water sources and those who garden in different locations as a way to triangulate; since I find that the food security benefits of horticulture are different for each group, the key question is what causes these differences. The final form of triangulation comes from comparing my quantitative and qualitative results, as each method of analysis can capture aspects of the relationship between horticulture and food security that the other method cannot.

This paper's main quantitative results were found through regression analysis conducted using the statistical software program Stata. There are several potential issues that could bias the results of these regressions. The first is multicollinearity, in which two of the explanatory variables are highly correlated with each other whereas

Figure 2: Residuals vs. Fitted Values of HFIAS Index



they would ideally only be correlated with the dependent variable. A correlation matrix shows that this is unlikely to be a significant problem in this study; the strongest correlation is between commercial orientation and plot size, with a correlation coefficient of only .51.

Heteroskedasticity, which occurs when the standard deviation of a variable is not constant across the range of that variable, does not appear to be a significant issue in this study. A residual-vs-fitted values plot (see Figure 2) shows fairly random residuals. There is certain to be a good deal of endogeneity in this model. Feedback loops are not likely to cause much endogeneity since, while a woman's food security status may have some power to predict her horticulture operation's commercial orientation, there is a much stronger causal relationship in the other direction. Endogeneity does arise, however, from omitted variables. There are many determinants of food security that this model does not capture, which causes the error term to be correlated with the independent variables.

V. Case Study Background

Botswana provides a uniquely appropriate case study for examining the intersection of food security, water access, gender and commercial orientation. This section will include a brief overview of each of these issues in the Botswana in order to contextualize this study's results and justify the choice of Botswana as a case study.

Despite the Botswana's status as a middle income country and an African development success story, there are stark inequalities in food security across the country (Hilbom, 2008). Botswana has a Gini coefficient of 60.5, which is one of the highest degrees of inequality in the world (Human Development Reports, 2016). It is necessary to delve into Botswana's history to understand the unequal access to food and resources that exists in the country today.

Figure 3: Botswana

Map Data: Google, AfriGIS

Most of the area that is now Botswana was included in the British Protectorate of Bechuanaland from 1885 until independence in 1966. Botswana was essentially a backwater colony, and received few settlers and little investment from Britain. At independence, Botswana was one of the poorest African

countries with only five kilometers of paved roads and 23 college graduates (Samatar, 1999).

Fortunately, since British colonizers did not consider Botswana to contain many valuable resources, the territory was exploited far less than other British colonies. Britain was sorely mistaken in ignoring Botswana as, shortly after independence, massive reserves of diamonds were discovered. Sir Seretse Khama, the leader of Botswana's independence movement and the country's first President, established a government that was focused on using its natural resources wisely. Khama, along with other government officials, instituted strong measures to control corruption and invested diamond wealth in education, infrastructure and health care. These investments, combined with a relatively small national population allowed the country to become one of Sub-Saharan Africa's wealthiest (Samatar, 1999).

Despite all of its success, Botswana still has segments of its population that suffer from the interlinked phenomena of persistent poverty and food insecurity (Lado, 2001; Crush and Frayne, 2010). Botswana's citizens depend heavily on imported food, which has reached 90 percent in recent years (Makepe et. al, 2008). This heavy import dependence means that Botswana is extremely vulnerable to volatile global food prices.

The backyard gardening program implemented by the Botswana Ministry of Agriculture and the Poverty Eradication office is one example of efforts to address the country's stark inequalities and dependence on imported food. Many

of the gardens established through this program failed to produce food or were unsustainable due to high costs for water, and the program was discontinued in 2015. Several scathing newspaper editorials accuse the government of implementing the program without fully considering how appropriate gardening is in this context (Kebadiretse, 2011; Sunday Standard, 2011). An anonymously-written editorial stated the author's opinion in no uncertain terms: "Ten years from now, when we look back and assess some of the brilliant ideas of our republic and some of the most deplorable ones, backyard gardens will stare us in the face as the lowest level of thinking that the nation has ever reached – a sore toe, in the national step" (Sunday Standard, 2011). The same author argued that the program was doomed from the start: "To think that we can defeat poverty by carrots and cabbages in the desert terrain is to demonstrate a poor understanding of our climatic conditions, our work ethic and the extent of our national poverty" (Sunday Standard, 2011).

Access to water is inextricably tied to food security, and Botswana's shifting rainfall patterns and worsening droughts present a distinct challenge to productive agriculture. Botswana has always been water-constrained, with 70 percent of land covered by the Kalahari Desert and with less than 5 percent of agriculture sustainable by rainfall alone. The situation has only worsened over the last decades, with average rainfall in the Gaborone area declining from 530 mm per annum in the 20th century to 450mm in more recent years. Six out of the last ten years have been drought years, and residents of Gaborone and surrounding

cities have been subject to water rationing (Manthe-Tsuaneng, 2014). Understanding the dynamics of water access and its effect on food security is key, since water will only become scarcer in the coming decades due to climate change (Zhou et al., 2012).

There is a considerable disjuncture between water policy in Botswana and the practical reality of water access (Swatuk 2004, 2006). Although water is of key importance to Botswana's entire economy, sustainable solutions to the country's water constraints have been dealt with in rhetoric alone and have not yet come to fruition. Swatuk (2004) says that this failure is due in part to the cultural belief that the country's water will never completely run dry, and that the government will ultimately be able to provide for its citizens indefinitely. Additionally, the disproportionate economic power held cattle interests mean that any actions that increase the costs of water to this group are politically infeasible, and that cattle owners typically priority access to water sources (Swatuk, 2004). In 2000, about 23 percent of Botswana's water was used in tending livestock (Swatuk, 2006). Because the vast majority of cattle owners are men, this has resulted in water policy that is seriously biased toward men's interests and leaves the voices of women unheard.

Since this study focuses exclusively on women, it is important to examine the particular challenges that women face in Botswana. Women could not legally own land until 1996 as they were considered to be "minors" under the law (Botswana Ministry of Agriculture, 2008). Even after the law was changed,

cultural norms in Botswana relegate female farmers to smaller plots or to marginal land (Brown, 1995). This limits the productive capacity of women, and thus constrains food security for the population as a whole.

Being excluded from land ownership also limits a woman's financial capital. In many contexts, it is nearly impossible to get a loan for starting an agricultural enterprise without proof of land ownership (Botswana Ministry of Agriculture, 2008). Thus, women are often left without means to drill boreholes, or to buy fencing or seedlings (Botswana Ministry of Agriculture, 2008). Women have inadequate access to physical capital, and the limited technology that is available is often ergonomically inappropriate for use by women (Brown, 1995).

The burden of care work also negatively affects agricultural production by keeping women tied to their homes, and taking up time that would otherwise be spent on cultivation (Brown, 1995). In Botswana, HIV/AIDS in particular has increased the care burden on many women, and effectively imprisoned them within a small distance of their homes due to the constant demands of caring for the infected (Botswana MOA, 2008). This limits the opportunities for women to participate in commercial agriculture, which requires large tracts of land that are often located far from home (Botswana MOA, 2008). Care work also takes up a woman's valuable time, and has been shown to push women toward readymade, store-bought "convenience foods", which typically have a lower nutritional value than homemade meals (Brown, 1995).

Finally, Botswana is also a suitable case study for researching commercialization because of the wide variation in commercial orientation among horticulturalists. While there are still significant power inequalities between commercial and subsistence farmers, the barriers to commercialization are lower in Botswana than in many other countries because of numerous government branches (Poverty Eradication, Youth Fund, Gender Affairs) and private organizations (ISPAAD, CEDA) that offer subsidized loans for agricultural operations.

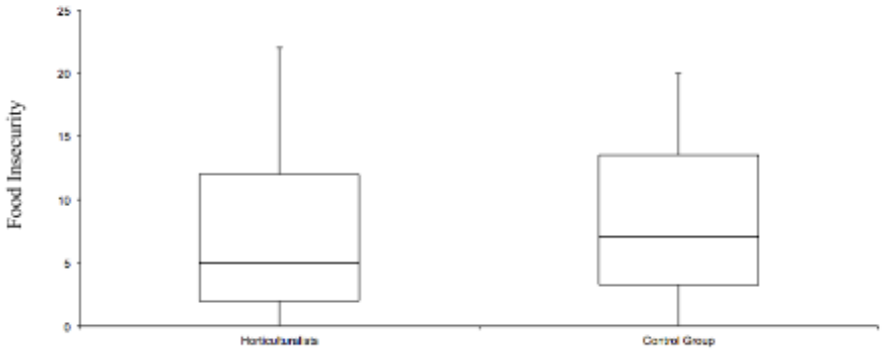
VI. Results

This section is divided into three parts, based on three groups of statistical tests and categories of qualitative interview data. The first section will examine the relationship between commercial orientation and food security, as well as outlining how my control variables (age, education, gardening experience, wealth, and market access) affect a woman's food security. The second section complicates and refines the first section's results by accounting for different sources of water used for cultivation. The final results section critiquing the narrative that women who receive government food aid put forth less effort toward their gardens, and examines the importance of a woman's attitude toward gardening.

Before looking into what types of horticulture operations lead to the greatest food security benefits, it is important to first establish that there *are* benefits to horticulture. While I cannot by any means answer this question definitively, my control group can provide some insight. The control group includes both women who are likely to become backyard gardeners (those who had contacted the MOA about the Poverty Eradication program) and those who are likely to cultivate larger-scale plots (women who had applied for loans to establish a commercial operation) in similar proportions to the group of respondents who already garden. The distribution of wealth levels, education and age is also fairly similar between the control group and the group of current horticulturalists. Thus, these groups are comparable, and an exploratory t-test

determines that women who cultivate vegetables have significantly better food security than women who are similar but have not yet started to garden (see Figure 4). This difference is relatively small, however; the control group has an average HFIAS score of 8.27 and the horticulturalists have an average score of 6.85.

Figure 4: Median Food Insecurity



To further investigate whether there is a difference in food security status between horticulturalists and my control group, I conducted a regression with a dummy variable for the control group. I find that the coefficient on the control group dummy is positive and statistically significant, indicating that respondents in my control group are less food secure than the current horticulturalists [see Table 1].

i. Level of Commercialization

I find that the more commercially-oriented a horticulture project is, the better the food security status of the gardener [see Table 2].[3] This relationship holds even when controlling for market access, plot size, years of gardening experience, age, household wealth and the number of people who contribute to the

[3] I measure commercial orientation through the percent of last month's harvest that was sold.

household food budget. More specifically, a 10 percent increase in commercial orientation leads to a 3.75% improvement in food security. Further, the percent-sold variable is the most statistically-significant determinant of food security out of all the variables included in this regression.

Figure 5: Commercial Orientation vs. Food Insecurity

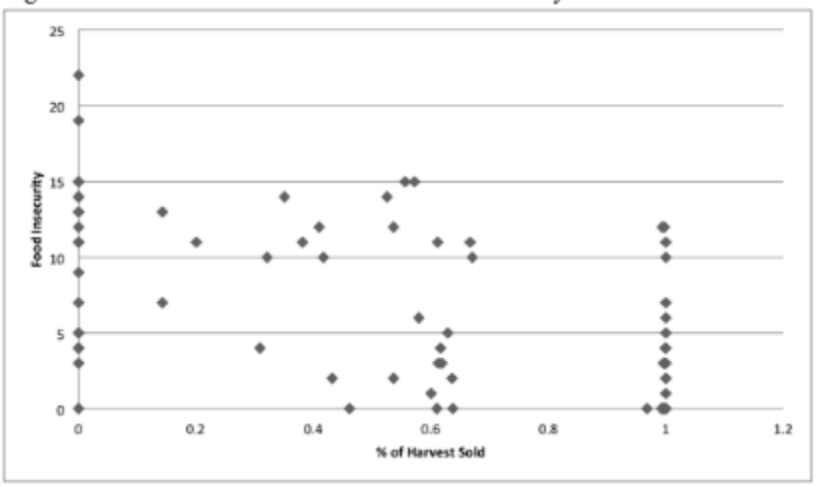
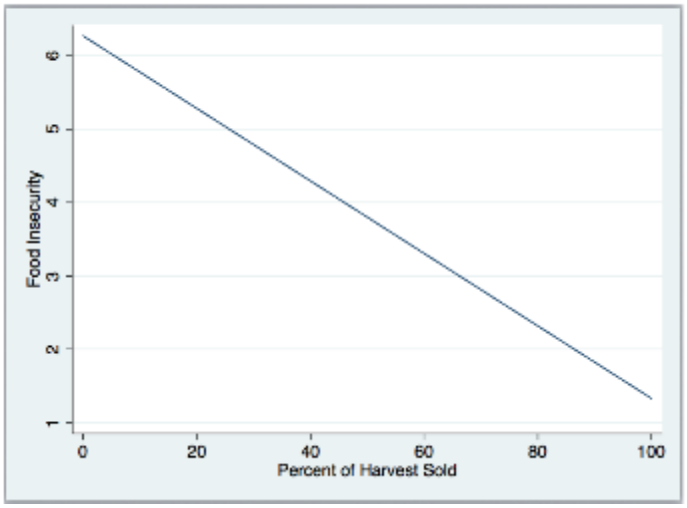


Figure 6: Commercial Orientation vs. Food Insecurity



Figures 5 and 6 show this relationship between food insecurity and commercial orientation. There a disproportionate number of horticulturalists who

sell either all of their produce or none of it (see Figure 5). In between these two extremes, there are several horticulturalists who have similar commercial orientations but different food security statuses. Overall, food security improves (and the index value, shown on the Y-axis decreases) with greater commercialization (see Figure 6).

This result cannot be fully understood without some broader context on the differences between women who are primarily subsistence gardeners and those that are more commercially oriented. To be clear, commercial and subsistence are not binary categories; this is why I included the percent of harvest that is sold as a continuous variable rather than separating respondents into discrete categories. However, respondents can be categorized into "backyard gardeners" and "commercial gardeners". Within each of these groups there are various degrees of success, various scales, and a range of commercial orientations.

I will refer to vegetable plots that are located away from the owner's home as "commercial horticulture operations", although there is a range of commercial orientation among these horticulturalists. Most of the women who own this type of plot sell their entire harvest, or have plots that are so large that their household can only consume a small portion of the total harvest; for example, many women eat only the damaged produce that is not suitable for commercial sale. Women who cultivate commercial plots consume, on average, only 13.25 percent of their harvest, which is roughly a value of $8.18 per month.

However, I surveyed nine women who cultivate “commercial operations”, but who sell less than 75 percent of their harvest. These women are much more likely to be renting their plots. Their plots tend to be smaller than those with a more commercial orientation; the average plot size for this group of nine women was 3,912.33 square meters, compared to 11,754.36 sq.m for women who sell more than 75 percent of their produce. These nine women have significantly worse food security, on average, than the women with more commercialized operations (a HFIAS index score of 6.78 compared with 3.96).

Some of the women who own “commercial horticulture operations” are highly engaged in the day-to-day operations, commuting from their homes every day to do upkeep or to oversee workers. 11 of the owners of commercial horticulture operations did not employ any workers, and instead took on full responsibility for growing their produce. Other women view their garden more like an investment; they hire a manager and hand over all responsibility for daily operations to him. Such women are typically much more involved in the business side of horticulture than the actual cultivation, and often own several gardens in different locations; I surveyed six women who owned more than one plot.

My sample of backyard gardeners also includes various degrees of commercial orientation. Many backyard gardeners dedicate their entire harvest to household consumption or only sell a small portion to friends and neighbors, but there are also some who are successful enough to sell a significant portion of their harvest. What these women have in common is that their plots are smaller than

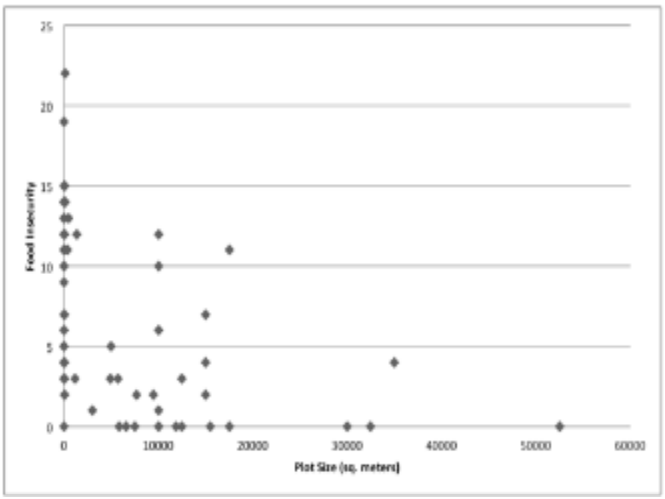
commercial gardens (an average size of 102.6 sq.m compared to 27,421.05) and are located on their residential property.

Another commonality, for 37 out of the 40 backyard gardeners, is that they received their gardens through the Ministry of Agriculture Backyard Gardening program. The Ministry of Agriculture's backyard gardening initiative was implemented under the assumption that commercialization is inherently beneficial, and the gardens provided through the program are intended first and foremost to generate income. This focus is so pronounced that both respondents and Ministry officials most often refer to the backyard gardens as "poverty eradication gardens" or "PE gardens" for short. The responsibility for the program falls under the jurisdiction of Poverty Eradication officers as well as the horticulture department, and is thought of within the government as a form of welfare. In fact, the criteria for eligibility is not based on food security status but rather on income; only women who make less than $1.25 per day can receive assistance through the program. The gardens are intended to provide food directly to households, but the program's architects view this goal as secondary to generating income. Food security is not even explicitly addressed in the plans for this program, although most officials consider food security to be tied so closely to wealth that there is no need to separate the two issues.

If we rely on the findings in this section alone, it might appear that the Ministry of Agriculture is justified in encouraging commercialization; however, the results outlined here only show part of the picture. The adjusted R-squared

value for this regression is fairly low, at .335. This indicates that only 33.5 percent of the variation in food security status can be explained by variation in the variables I included. As I will explain in the next section, much of the nuance in the relationship between commercialization and food security is lost in aggregated tests like this one; when women's different sources of water are taken into account, many dynamics that are hidden here become visible.

Figure 7: Cultivated Area vs. Food Security



The coefficients on the other explanatory variables can also give some insight into the relative importance of the different factors influencing food security among female gardeners. I would have predicted that years of gardening experience and the number of people contributing to the food budget would be significant determinants of a woman's food security, but both of these variables are statistically-insignificant. Interestingly, the number of people who contribute to the food budget *does* have a significant effect on a woman's nutrition (as measured through the dietary diversity scale); I find that nutrition improves by

10.76 percent with one additional contributor. However, this is the only variable that has a statistically significant effect on dietary diversity.[4]

Plot size is of borderline significance (P=.15) but as the coefficient is essentially zero anyway, it does not appear to be an important determinant of food security. This result is likely due to the significant clustering of observations on the very low end of the range of plot sizes (see Figure 7). Since women in my sample who cultivate small plots have a wide variety of different food security statuses, we cannot discern a clear relationship between plot size and food security. Figure 7 also shows that most respondents cultivate less than 20,000 square meters but that there are four women who have plots larger than 30,000 sqm. I ran a test with dummy variables for these four observations and the results did not change by much, indicating that these outliers are not causing significant bias [see Table 3].

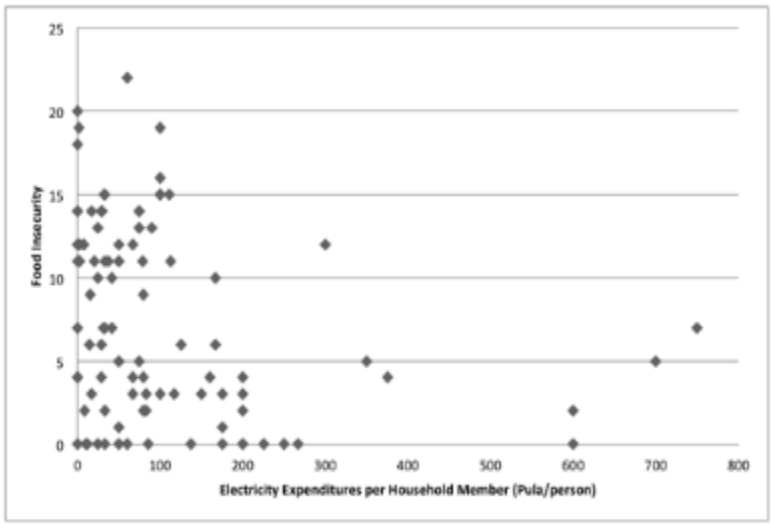
The respondent's age has the largest effect on her food security status out of all the explanatory variables; a woman who is ten percent older than another will have 4.78% worse food security. Age is a particularly important factor in Botswana because the agricultural labor force is disproportionately older and female (Botswana Ministry of Agriculture, 2008). While there is a considerable body of research on the link between nutrition and age, there have been relatively few studies on the link between age and food security and even fewer that

[4] I ran the regressions with both the food security and the nutrition indices as the dependent variables with the same explanatory variables. None of the coefficients in the WDDS (nutrition) regression were statistically significant except number of contributors, probably because the index only ranges from 0 to 9, so I have focused on the HFIAS index.

specifically focus on women or on developing country contexts (Barrett, 2002; Tucker and Baranapin, 2001). Thus, I cannot turn to the literature for answers about why older women have worse food security. This relationship can be explained in part by the fact that older women in my study tend to have fewer people contributing to their food budget and they typically live further from markets. From informal observation and conversation with these women, however, it became clear that a more important determinant of older women's food security is whether they are caring for children or not.

There are roughly 67,000 AIDS orphans in Botswana, and these children often fall under the care of their grandmothers (UNAIDS, 2014). Even children whose parents are alive are often primarily cared for by their grandmothers; older women often take on child care responsibilities when younger parents are at work.

Figure 8: Wealth vs. Food Insecurity



In many cases in the villages around Gaborone, where this study was conducted, parents live in the capital city during the week to work and return to the village only on weekends. Many of the older women in my study explained that when

food is scarce, they sacrifice their portion to the children in their care. Of course, mothers and caretakers of any age would be equally likely to make this decision. However, older women in my study were actually likely to be caring for more children than younger women; the correlation between age and the number of children in a women's care is equal to .5 (whereas a perfect correlation would be 1 and no correlation would be 0). This makes sense when one considers that an older woman may be caring for her grandchildren from multiple parents.

The variable with the third largest effect on food security, after age and commercial orientation, is market access. Women who must travel further to get to the place that they buy their food have worse food security than women with better market access. A ten percent increase in travel time leads to a 2.57% drop in their food security status.

Wealth has the smallest effect out of the statistically-significant determinants of food security; a ten percent increase in wealth only results in a 1.2 percent improvement in food security (see Figure 8). This is a puzzling result, as it is clearly established in the literature that an increase in wealth leads to improvements in food security (Misselhorn, 2005). It could be that outliers on the high end of wealth spectrum are causing these surprising results. The two households with the highest levels of electricity expenditures have relatively poor food security (see Figure 8). To investigate this possibility, I omitted the four households whose expenditures are greater than P500 per person but my results did not change significantly, indicating that these outliers are not causing

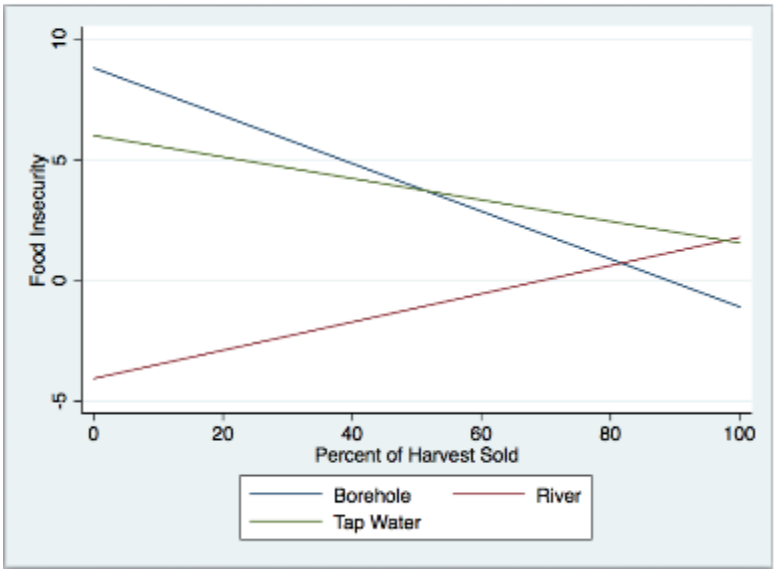
significant bias.Thus, rather than indicating that wealth truly has no effect on food security, these results more likely show that electricity expenditures per household member is not a good measure of wealth in this case.

ii. Water Access

The relationship between commercial orientation and food security among female horticulturalists gives only a partial picture of the forces at play in this context; water access is also a key determinant of food security [see Table 4]. When water source dummy variables and interaction terms are added into my original regression, I can explain roughly 11 percent more of the variation in food security.[5] This improvement is as expected, since water is a critical resource in Botswana and there are huge disparities in access to cost-effective sources of water. Adding a dummy variable and an interaction term for each water source allows me to model a different relationship between commercial orientation and food security for each of these three groups. I find that commercialization improves food security for women who use tap water or borehole water, but for those who rely on river water commercialization will lead to worsening food security (see Figure 9).

[5] I ran a Breusch and Pagan Lagrangian multiplier test to confirm that these dummy variables and interaction terms should be included.

Figure 9: Commercial Orientation vs. Food Insecurity



The key to disentangling the complex explanations behind each of the above results is to recall the fundamental difference between each water source; whereas use of tap water and borehole water is divided along lines of wealth and power, river water is available to horticulturalist who own land along the river and can afford a pump and fuel to run it. Thus, the barriers to accessing water are much lower for women close to the river than for those who must use borehole or tap water. Viewed through this lens, my results indicate that when all women have access to low-cost water, there are greater food security benefits to consuming their harvest than to selling it.

Figure 10: Food Insecurity by Water Source

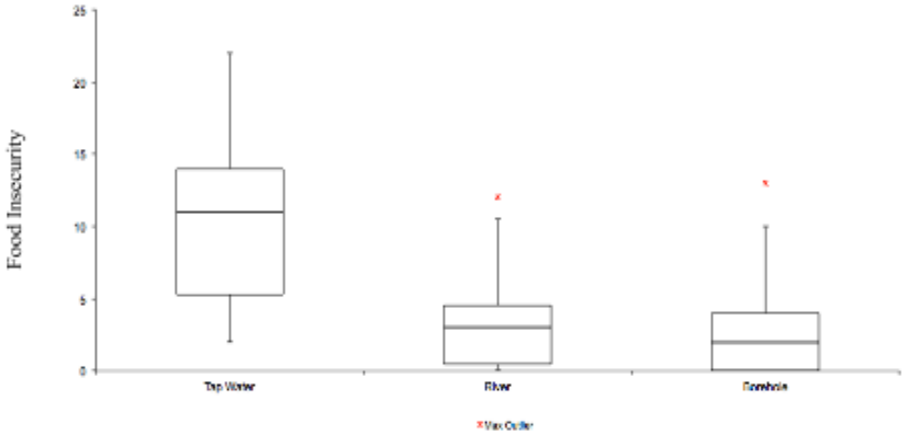


Figure 11: Commercial Orientation vs. Food Insecurity

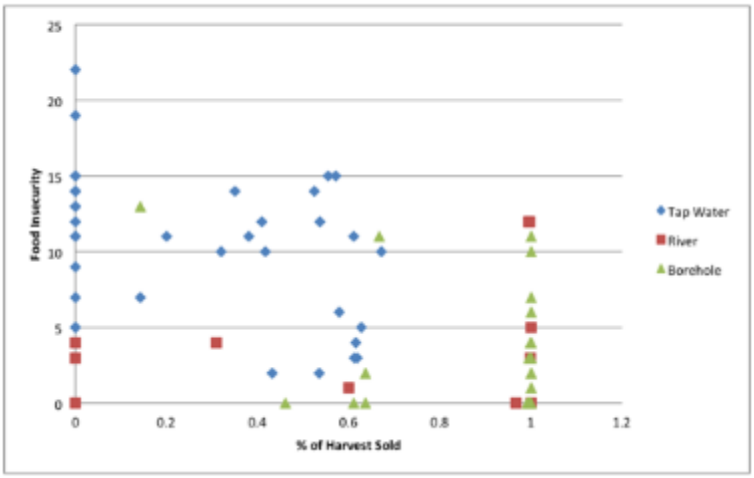
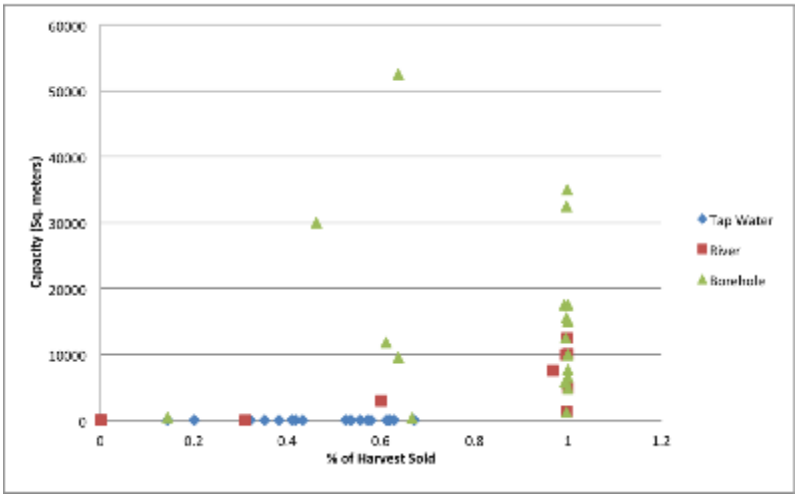


Figure 12: Commercial Orientation vs. Cultivated Area



There are three main options for obtaining water to irrigate vegetables; women can rely on tap water, they can drill a borehole, or they can pump in river water. River water is the cheapest option, the only significant operational costs are a pump and the electricity or diesel fuel to run it. This is only feasible within a few kilometers of a river, however, and many rivers dry up seasonally or contain polluted water. Additionally, land access is an issue; although land is relatively abundant and fairly cheap in Botswana, there are still considerable gendered inequalities in land ownership. Thus, there are many more male-owned horticulture operations along the river than female-owned.

The women who use river water have a median food security index value of 3, which is fairly close to perfect food security (see Figure 10). River water users are significantly more food secure than women who rely on tap water, but still slightly less food secure than borehole water users. Figures 11, 12 and 13 show that this group includes a wide variety of plot sizes and levels of

Figure 13: Horticulture plots along the Ngotwane River

Map Data: Google, AfriGIS

commercialization, as is expected based on the fact that river water is used by the a more diverse group of women than tap or borehole water. On average, river water users eat food from 3.08 different food groups per day, which is a greater level of dietary diversity than tap water users but slightly less diversity than borehole users.

The next most cost-effective irrigation method is pumping water from a borehole (see Figure 14). The only cost to operating a borehole after the initial construction is fuel to run the water pump. However, access to the starting capital to drill a borehole is hard to obtain; gardeners either have to have enough money to begin with, or they must apply for loans. To obtain a loan, including a subsidized loans from ISPAAD or the Youth Fund, the applicant must own the land where the horticulture project will be implemented. However, up until 1996, women were treated as minors under the law and not entitled to legally own land (Ministry of Agriculture, 2008). This severely limited

Figure 14: Borehole

Photo by William Moseley

women's access to water and their ability to support themselves through agriculture. Since the 1996 law change, women have seen improved access to boreholes, but access is still far from equal. Loans are only awarded to people who can cover other start-up costs such as fencing, and will not be awarded to those who plan to garden for subsistence, which excludes mostly low-income women. The women who own a borehole have the best median foods security, as compared to tap water and river water users (see Figure 10). Compared to the women who rely on tap or river water, borehole users are much more commercially-oriented and they typically own larger plots (see Figures 11 and 12). Borehole users have the most diversity in their diet of all three groups; they eat food from 3.68 different food groups in a given day.

The women who do not have the resources to drill a borehole and do not have access to river water are left with tap water as their only option. These women pay monthly for their water, which works out to be much more expensive than borehole water. Tap water is also a less reliable source than borehole water, since there are frequent and

Figure 15: Drip irrigation system hooked up to municipal water

Photo by William Moseley

unpredictable water stoppages. The increasing use of rationing for public water service in recent years has also made tap water an undesirable source, since there is a finite amount of water allocated to each household that must be used for cooking, washing and drinking. Most of the women who rely on tap water to irrigate their gardens also collect rainwater to mitigate these problems, but this is only a small contribution to their water supply during the dry season, particularly in drought years. These women have the worst food security status by far; the median index value for tap water users is 11, as compared to 3 and 2 for river water and borehole users respectively (see Figure 10). Figures 11 and 12 show that tap water users are typically subsistence-oriented and cultivate relatively small plots. These women also have the least diverse diets of all three water source groups, with an average of only 2.59 different food groups eaten per day.

Women who rely on tap water experience food security benefits from increased commercialization. With a 10 percent increase in their commercial orientation, their food security improves by 1.11 percent. This relationship is not statistically significant (P=.176), which is surprising since this is the group containing the most respondents (n = 35). However, the results for tap water users are still worth analyzing in combination with my qualitative data. Women who water their gardens using tap water have to pay for that water regardless of whether their crops are sold or consumed within their household. If water costs exceed the benefits of horticulture (in terms of revenue from selling their vegetables or the money saved by consuming them), a woman will actually be

worse off than if she did not have a garden. The food security benefits provided by increased commercialization may actually simply be reflecting these women's increased ability to pay their water bills, rather than any inherent value to commercialization.

The 25 horticulturalists who obtain their water from a borehole also see improvements in their food security with a higher degree of commercial orientation, but for much different reasons than tap water users. With a ten percent increase in commercial orientation, food security increases by 24.6 percent. On average, this group is more experienced in the commercial horticulture market than women who rely on tap water or river water. Thus, they are more likely to have an established customer base, loyal workers, business savvy, and means of transporting their produce to market; in short, all of the determinants of a horticulture operation's success and all of the things that are particular challenges for those who are relatively inexperienced in the commercial market.

In contrast to these first two groups, women who irrigate their plots with river water experience greater food security benefits from consuming what they grow rather than selling it. With a ten percent increase in commercial orientation, food security deteriorates by 9.12 percent. This result is highly statistically significant, even though this group has the smallest number of observations (n = 11). These results indicate that, once women already have access to low-cost water, commercialization will only lead to food security benefits if women can

overcome the challenges to entering the commercial market. In the case of the river water users in my study, these challenges and the extra costs of commercialization are too large for these women to make a profit or to see improvements in their food security.

In order to see improvements in food security from commercialized horticulture, a woman must be able to make a profit that is used to buy food. However, an increase in the percentage of the harvest that is sold guarantees an increase in revenue but also an increase in costs. In the case of tap water users, the costs may actually increase by as much as revenue, leaving them with only small profits or even losses if the costs exceed revenues. Much of the extra operating costs come from the expense of using tap water and the unreliability of tap water supply. Additionally, most of the tap water users in my study sell their vegetables for less than the market price, since they sell to friends and neighbors. This means their profits are impeded by lower revenues as well as higher input costs.

For river water users there is also some degree of uncertainty about their input costs, since river water supply and water quality changes seasonally, as well as from year to year. Several women explained that when they cannot obtain sufficient water from the river, they will have to incur the extra costs of using tap water as well. The data provides further evidence of this dynamic; I find a nearly perfect positive correlation ($r = .87$) between a river water user's level of commercialization and the costs of watering their plot. Borehole water users, on the other hand, have a reliable source of clean water and can count on increasing

returns to scale to boost their profits. This group actually sees water costs decrease with an increase in their commercial orientation (correlation coefficient = -.14), giving them a distinct advantage over tap and river water users in the commercial horticulture market.

Food price volatility is another challenge that commercial horticulturalists must deal with. They are essentially betting on future movements in food prices, since their profits will drop with prices and vice versa. Subsistence-oriented producers, on the other hand, are not so vulnerable to fluctuations in the global food market. This can be a distinct advantage, as food prices have reached unprecedented levels of volatility in the last ten years (United Nations, 2011).

There are additional issues that pose particular challenges to horticulturalists who are just starting to commercialize their operations, which may partially explain the negative food security effects of commercialization for river water users. There are costs to breaking into the horticulture market, including advertising, transportation and packaging costs. These start-up costs may make it impossible for horticulturalists to make a profit (and thus, to see improvements in food security) when they are starting to commercialize. Borehole users, on the other hand, are much more likely to be experienced horticulturalists, in part because they must demonstrate that they will be profitable in order to get a loan for the costs of drilling their borehole. Borehole users see food security benefits from increased commercialization because they have

already shouldered these start-up costs, and thus see a more direct correlation between increased commercial orientation and increased profits.

There are time costs to running a commercial horticulture operation as well. Many women who garden only for home consumption hold another job to bring in income. Cultivating a more commercialized operation takes up a great deal of time and energy, making it difficult to hold another job. Several of the women in my study said that when they started selling more of their produce, they had to give up their jobs to focus on the horticulture operation. This is particularly problematic if their horticulture operation is struggling to make a profit due to the factors outlined above. Thus, she may end up with a lower income than when she was more oriented toward subsistence, and her food security will deteriorate. One woman explained how her commercial horticulture operation was a serious drain on her economic resources. She established her operation using loans from the Citizen Entrepreneurial Development Agency (CEDA) but was struggling to pay them back. She had to ask her son for financial support, and even had to sell her house. Although the operation was doing quite well, the owner explained that all of the profit went to paying for wages and inputs, and that as a result she "does not live well".

Another challenge for newly-commercial horticulturalists is that they must move along a steep learning curve. Particularly for women with low levels of formal education, it can be difficult to master the business and marketing components of their operations. In the first few years, they are more likely to

make serious missteps that damage their profitability. Even if a horticulturalist learns quickly and makes no mistakes, their garden may still fail due to the risk inherent in horticulture. Particularly with smaller plots, the entire crop can be wiped out by pests, cold temperatures or goats and chickens. Goats and chickens were cited as the second most-common reason that backyard gardens fail, after water scarcity. Unlike commercial plots, backyard gardens are usually located in the middle of residential areas and livestock or chickens from neighboring homes wander freely through these areas. Shade nets help to keep animals out, but unless the opening is firmly secured and all holes in the net fixed immediately, there is still a risk.

Since horticulturalists who are just breaking into the commercial market tend to start with relatively small plots, they face additional challenges due to issues of scale. Most of the major grocery stores will only purchase vegetables in set quantities that are difficult for most backyard gardeners to produce. These women face a choice between growing a single type of vegetable, which allows them to produce the necessary quantity, or planting a more diverse mix of vegetables that is better-suited to home consumption. This observation reaffirms the findings of Fleuret and Fleuret that the expansion of commercialization can reduce the amount of land and energy given to producing food for subsistence (1980a 1980b). Many respondents expressed anxiety about how to make the tradeoff between profit and diversity of crops in the coming year. In many cases the decision comes down to whether the expected profit from monocropping is

certain enough that the household can count on buying the vegetables that they otherwise would have grown themselves and consumed directly. As mentioned above, however, there are great risks inherent to horticulture, and this uncertainty will only grow if the patterns of droughts seen in the last few years continue. This risk might make subsistence horticulture a more rational option for many women.

A third option, which allows women to grow a diverse mix of vegetables but also generates income, is to sell only to neighbors and friends. These less formal exchanges often come with an expectation to sell produce for less than its market value, however, or even to give it away for free. There were 14 respondents who went this route, typically selling out of their home. This has distinct advantages in cutting down on transportation costs, and in allowing women to stay close to home to more easily handle their caretaking and domestic work. In sum, there are a multitude of challenges impeding the success of newly-commercial or small-scale horticulturalists that may outweigh the benefits of commercialization for many women.

iii. Food Aid and Attitude Toward Gardening

While investigating why many backyard gardeners have struggled to be successful, I frequently heard the recipients of the Poverty Eradication program described as "too worried about losing their government food basket to put forth effort in their gardens." The logic behind this statement is that, if a gardener becomes "too successful," their caseworker will remove their status as destitute and their government aid will cease. However, I find that women who receive

government aid do not have significantly less successful gardens than women who do not receive food baskets.

The Government of Botswana is relatively wealthy and provides a wide range of services to its citizens. In particular, there are many welfare options available to those classified as “destitute”. Those who have less than four livestock and earn less than P120 without dependents or P150 with dependents fall into this category. A caseworker assessment determines whether destitutes are classified as permanent or temporary. Both types of destitutes are eligible to receive a monthly government food basket, along with a small cash transfer and exemption from paying publicly-provided services including water, electricity, medical and school expenses.

In Botswana, as in almost every state that provides welfare to its citizens, there is tension between those who think destitute households should be entitled to welfare and those that think recipients should have to work for their aid. The government food baskets are an entitlement, whereas the backyard gardening program is essentially a pay-for-work scheme, but without guaranteed income. Many government officials emphasized that the Poverty Eradication gardens were intended to reduce welfare dependency. Many of these officials viewed “lazy” women as the main reason for failing gardens, with one even arguing that women would rather be “sleeping around in the village” than working on their garden. These stereotypes are not isolated within the MOA but are evident throughout Batswana society; former Pandamatenga Commercial Farmers Association

chairman Tiene Kruger went on record saying “Government is making people lazy by generously giving them food hampers. Even the able bodied who should be working are living on government handouts” (Balise, 2013).

It is possible to qualify for the Poverty Eradication backyard gardening program without being classified as destitute (and therefore eligible for food baskets and service coverage). My sample includes 17 backyard gardeners who receive government food baskets, and 26 who do not. The average food security index score for the aid recipients is only slightly worse than non-recipients (9.14 compared with 8.24). The monthly garden yield for aid recipients is slightly lower than for non-recipients (P115.9 compared with P159.1). A t test determines that this is not a statistically significant difference (P=.18). Receiving food aid does not appear to lower monthly harvest, which I use here as a measure of garden success and gardener effort. Further, aid recipients actually have a higher degree of commercialization than non-recipients (29.29% of harvest sold on average compared with 23.72%). This indicates that their gardens are successful enough to sell a significant portion of their harvest, directly contradicting the claim that aid recipients are reluctant to increase their income in case this disqualifies them from receiving welfare.

A much more important determinant of a Poverty Eradication garden’s success than food aid is whether the backyard garden was the recipient’s first choice of government assistance. There are many other types of welfare that the Government of Botswana offers, including Ipelegeng (manual labor for wages),

provision of livestock or poultry, and assistance in establishing a tuck shop or laundry business. Many women prefer Ipelegeng because it provides a guaranteed income, or prefer the other forms of assistance for various reasons. However, the backyard gardens have been heavily promoted in the past few years, and the process for recipients is much easier and quicker than for any other type of welfare. Thus, many women ended up with backyard gardens because it was "better than nothing", or because a government official convinced them it would be worthwhile, even though gardening was not necessarily their first choice of a livelihood.

I find that women whose first choice of government assistance was a backyard garden have a higher average harvest than those who would have preferred another type of welfare (a monthly harvest worth P300.42 compared with P129.92). This is a statistically significant difference (P=.048). Women who enjoy gardening will obviously put forth more effort and see greater success, and the difference between women who prefer to garden and those who do not is obvious when meeting respondents. Some women had their own, self-made gardens before the program began and simply used the Poverty Eradication initiative to supplement their own efforts. Other women, who would rather have received some other form of assistance, have no interest in horticulture and may focus more on the activities they prefer, such as raising poultry or goats, at the expense of their garden's success.

The importance of attitude towards horticulture has been largely ignored in the implementation of the backyard gardening initiative. To be fair, it is a fine line to tread; government officials want to promote the new program and there may be women who do not think they would like to garden until they try it. On the other hand, if women are simply accepting the backyard gardening program because it is free and easily available, but have no intrinsic motivation to work at their garden, the program is practically destined to fail.

VII. Policy Recommendations

Many Ministry of Agriculture and Poverty Eradication officials were interested in this study's results as a sort of autopsy of what went wrong with the backyard gardening program. Every government employee that I spoke with, from the top official in charge of Poverty Eradication to the officials at the smallest village Ministry of Agriculture offices, said that the program is winding down. Although there has not been an official statement from the Ministry of Agriculture indicating a definite end to the program, several Ministry officials told me that they have started pushing people toward other forms of government assistance. The women in my control group who had contacted the Ministry about the program were told that there was no guarantee they would receive a backyard garden.

In short, it is unclear whether the gardening program is being scaled back temporarily or is being phased out completely. In either case, the Ministry of Agriculture is making a premature decision. The backyard gardening program is an innovative model of development in many ways; it specifically targets the poorest and most marginal members of society, encourages self-sufficiency and takes gender-based constraints into account. The program has the potential to improve quality of life for participants and to move these households toward food security. This potential is currently being wasted, however, due to inadequate consideration of the importance of water access.

The Botswana backyard gardening program is also limited by its definition of success, since the program places an undue weight on generating income and encouraging commercialization rather than improving food security. There are several possible goals of a horticulture program, including income generation, food security, nutrition, or reducing welfare dependence. The implications of this study's results for policymakers seeking to implement a horticulture program differ depending which goals are prioritized. There are a few general recommendations that apply to either type of program, however. The most important consideration in Botswana, and likely in other water-scarce environments, is to ensure that horticulturalists have reliable access to water. This could be done through an expansion of the existing water subsidy program. Water access must be the first priority not only because it determines whether gardening is viable, but also whether commercialization should be encouraged.

Age is another important consideration regardless of a gardening program's goals. I found that older women typically have worse food security than younger women, which is of serious concern considering the large proportion of gardeners who are elderly. Older horticulturalists may need extra support. A barrier to adequately addressing the additional challenges that older gardeners face is that official data may not accurately show how many elderly gardeners there are. The program applicant is not always the person who takes on primary responsibility for operating the garden; in many cases I studied, the applicant's elderly mother was in charge of the garden. In Botswana this issue is mitigated by

the requirement for MOA officials to check in on all horticulturalists several times a year. Because of these visits, most local officials are well-aware of who is actually doing the gardening in most cases, but currently the program does not provide extra support for elderly participants.

The final recommendation that is relevant to all programs, regardless of whether they are focused on income or food security, is to recognize individual agency. I find that women who preferred a garden over other types of government assistance had markedly more successful gardens than those who would have preferred another form of assistance. While no one should be "pressured" into joining a gardening program, in contexts where most people have not grown vegetables before it may be necessary to encourage reluctant or ambivalent people to give it a try. One way to do this is to offer a trial program, where participants are first given a small plot that is later expanded if they are interested. This is already done to some extent in Botswana's gardening program, but expansion is contingent upon a garden's profitability rather than the gardener's interest in continuing. Another option is to require that anyone who is interested in the program attend a free horticulture course where they can try out gardening before committing to their own plot.

If a government establishes a horticulture program with the primary goal of generating income, they must be very careful that do not assume that commercialization necessarily leads to profit. In order to generate income, horticulturalists must also incur costs, which may be a heavier burden when they

are first breaking into the commercial market. This type of horticulture program should assist participants in moving along the learning curve; this includes accessing a market, building a customer base, and finding the most cost-effective way to package and transport their harvest. In the case of small-scale horticulturalists, it is imperative that they find a market that will buy in small quantities, since most markets require a higher volume than small plots can provide.

If program directors are going to encourage commercialization, they should also make sure that participants are fully aware of the risks involved. When the MOA backyard gardening project was first introduced, Ministry officials assumed that the majority of gardens would be profitable enough for gardeners to purchase their own seedlings and pay their own water bills after the first year. The goal was for the government to cover the initial costs but that, aside from check-ins from local Ministry Officials a few times a year, gardeners would be self-sustaining after the first year. This only worked out in a few cases, and the Ministry of Agriculture often ended up paying for the upkeep of many gardens for years.

Even when a gardener was not able to make a profit due to events entirely outside of their control, Ministry officials placed the blame on their shoulders. “These people take their money and spend it on other things, when they are supposed to be buying seedlings and fertilizer for the next year,” one official said. Gardeners were often criticized for spending irresponsibly even if the “other

things" they bought were food, clothes or school fees. Likewise, many respondents in my study mistakenly expected immediate profitability from their gardens. Participants should be informed that their gardens may not be profitable for the first few years, and that they should maintain their other forms of employment if possible. Program leaders must recognize this risk themselves, as well, and plan for the possibility that continual financial support may be necessary. Particularly in the first few years of operation, a gardener may need assistance for purchasing inputs and for garden upkeep.

This study's final recommendation for programs intended to generate income is to establish Horticulturalist Associations for backyard gardeners. There are already several Associations of horticulturalists operating in Botswana. The vast majority of the members of these groups own relatively large, commercial operations, however. There is a pressing need for groups that focus on small-scale horticulturalists. These types of groups could be instrumental in establishing a system that makes it easy for small-scale producers to pool their harvests and reach the quantities required to sell to grocery store chains and other large venues. Alternatively, community gardening, which is not widely-practiced in Botswana, could allow women to share the risks of commercial cultivation. These groups could allow women to receive the highest possible prices for their produce, as well as facilitating unity among small-scale producers to ensure that their voices are heard by those developing agricultural policy.

If a horticulture program is intended to replace entitlement forms of welfare, my results prompt additional words of caution. Program leaders should make no assumptions about the work ethic of those on food aid or other types of government assistance; in this study, those who received food baskets were actually more commercially-oriented and had roughly the same average harvest as those who did not rely on food aid.

The optimal way to run a horticulture program will differ depending on the environmental, social and economic context. Future research should investigate whether similar dynamics between commercialization and food security exist in places where water is not a significant problem. Comparison between countries would also help inform the discourse on horticulture and food security, as this study's findings may be unique to Botswana and have less applicability in different countries.

While the results presented in this paper apply primarily to female horticulturalists in the area around Gaborone, they can also provide insight on how commercialization and water access affect food security in other agricultural sectors and in other countries. My key finding is that access to water determines whether it is feasible for a woman to cultivate vegetables for subsistence purposes. In different geographic contexts another resource might take on the role that water plays in Botswana; in a densely-populated country, for example, land ownership might be a key factor. The link between agricultural commercialization

and food security cannot be fully analyzed without recognizing inequalities in resource access.

Recognition of the importance of resource access is particularly crucial because, in recent years, the international development community has been focused on improving food security through commercial agriculture through initiatives such as the New Green Revolution for Africa (Gates Foundation, 2016). These programs will not be successful if they operate on the assumption that commercialization necessarily leads to welfare improvements; instead, development workers must be fully aware the power dynamics involved in water access and how these inequalities determine what impact commercialization will have.

Policymakers and development officials must also recognize the particular challenges that arise when transitioning from subsistence to commercial agriculture. Farmers and horticulturalists without much experience in commercial agriculture face a much higher degree of risk and lower profitability than those who are more experienced. If these inexperienced people are simply thrown into the commercial market without any support, they are likely to see substantial deterioration in their levels of food security.

The Ministry of Agriculture program could have much larger positive impact on participants welfare if it was redesigned to take the above recommendations into account. The program would improve dramatically if it

focused first and foremost on ensuring access to cheap sources of water and measured success in terms of impacts on food security rather than profit.

Even if the program maintains its focus on income generation, there is room for improvement through more fully informing participants that commercialization is risky and may not result in immediate profit. Many times throughout the course of my fieldwork, respondents emphasized that horticulture takes patience; if Botswana's government listened to these horticulturalists and continued trying to improve the backyard gardening program, it is possible that the program could serve as an example for other countries to follow in improving food security through horticulture.

VIII. Conclusion

I find that, in the aggregate, increased commercialization improves food security for female horticulturalists in Botswana. However, this relationship becomes more complex when we consider the influence of a horticulturalist's water source. For women who water their vegetables with river water, which is relatively cheap and open to most people whose plots are along the river, commercialization leads to a deterioration in their food security. This result comes mainly from the struggles of women who are inexperienced in the commercial horticulture market; for these women, the costs of commercialization (loss of time, the costs of finding a customer base, advertising, packaging, transportation, increased costs of water etc.) outweigh the benefits (a stream of revenue that is subject to high levels of risk).

Women that have to rely on tap water, which is the most expensive source of water, experience food security benefits with increased commercialization. These women are even more likely than those in the river water group to be inexperienced, and thus face the same challenges to commercialization. The difference between tap and river water users is that tap water users must pay high water costs to produce vegetables, regardless of whether they are cultivated for consumption or sale. Thus, the revenues from the sale of their produce help cover water expenses, which leaves tap water users better off, despite the costs of commercialization they also face.

The last group consists of women who own a borehole, which requires the ability to cover high upfront costs but is cheaper over time than tap water. These women tend to have larger plots, more wealth, and more business experience. Thus, they are much more likely than the first two groups to make a profit from their commercial horticulture operations. Increased commercialization leads to improvements in this group's food security, since most of these women are already established in the commercial market.

My findings indicate that for poorer horticulturalists, commercialization may not be inherently valuable, but instead is beneficial only in that it allows these women to pay their water expenses. When women have access to a reliable source of inexpensive water (as the river water users do), they can sustainably pursue subsistence-oriented horticulture and may in fact see greater food security benefits from consuming what they grow than from selling it.

There is great potential for the discourse on the MOA backyard gardening program to be informed by political ecology. An analysis of horticulture in Botswana that relies only on proximate causes of different levels of garden success and food security is inherently limited. Within Botswana, much of the discourse on why so many backyard gardeners have struggled to keep their gardens going relies only on the most localized explanations; such explanations hold that gardeners are lazy, or they squander their garden's profits on frivolous goods instead of investing in its future productive capacity. When we expand the scope of our analysis, it becomes clear that broader systems of water access and

gendered power inequalities are integral in explaining the current issues that horticulturalists face.

Along with the structural forces that create disparities in water access along lines of socioeconomic status, there is a gendered component that leaves all women at a disadvantage relative to men. The historical significance of the cattle industry, which is dominated by men, has led to a national water system that gives first priority to male livelihoods and forces horticulturalists to either find creative ways to negotiate these constraints or to see their gardens fail. The fact that so many female gardeners have found ways to succeed in horticulture despite their social, economic and environmental marginality, underscores the importance of individual agency. For example, many of the backyard gardeners in my study, who are marginalized because of both gender and low economic status, have experimented with different types of crops and found the mix of vegetables that is most water-efficient. Other small-scale producers have found ways to succeed in commercial horticulture despite being far from markets and having no support in covering the costs of commercializing; many of them sell out of their home or package their products in recycled material to lower their costs of operation.

Such creative solutions to resource constraints will become more difficult to implement as climate change escalates. It is important to recognize that climate change, and the resulting shifts in rain patterns and weather volatility, will not have equal effects on all groups but are likely to reinforce existing inequalities. Boreholes are a fairly sustainable source of water and horticulturalists who own

them will have a greater capacity for resiliency in the face of climate change. Tap water users, on the other hand, will likely face increasing water rationing and rising prices for water use. Even those who use river water are vulnerable to climate change, as continuing droughts may reduce the supply of river water. In short, the issue of unequal water access will only become more pressing the longer that we fail to address it.

The final takeaway from this study is that many Ministry of Agriculture officials are seriously misguided in arguing that women receiving food aid will be lazy about working in their garden because if they make too much profit they will lose their aid. I find that this line of logic, in addition to being intrinsically problematic, is invalid; there is no significant difference between harvest volumes for women who receive food baskets and those who do not. A woman's attitude towards gardening is actually a much more important determinant of a garden's success than welfare dependency. Women whose first choice of government assistance was a backyard garden produced significantly larger harvests than women who would have preferred a different program.

These results fill a gap in the existing body of literature on the welfare impacts of transitioning from subsistence to commercial agriculture by considering water access, and by focusing on women and on horticulturalists specifically. It is clear that water access is too important of a variable to ignore, as I find that a horticulturalist's source of water is key in determining whether

increased commercialization will improve her food security or leave her worse off than she was originally.

My findings that women were not adequately prepared for entry into the commercial market corroborate the results of other research on the pitfalls of commercial agriculture, such as Moseley's (2007) findings that efforts by the South African government to encourage blacks to participate in commercial agriculture were impeded by a failure to prepare these targeted groups for the intense competition in the commercial market. My results are also in line with Fleuret and Fleuret (1980b) who find that increased commercialization does not necessarily lead to increases in real income.

The key question to answer next is whether the challenges of moving into commercialized horticulture described by many of my respondents, including a deterioration in household food security for those who use river water, are short-term or long-term issues. While several studies have found commercialized agriculture to have negative impacts on farmers, there is continual debate over whether these effects are temporary or permanent (Pingali and Rosegrant, 1995; Fleuret and Fleuret,1980b). Answering this question should be a priority for future research, along with an increased focus on the intersection between resource access and commercialized agriculture.

Another important direction for future research is to examine these variables using larger groups of observations. Although my results are statistically

significant for river water and borehole water users, the small samples from each of these groups mean that these results may have limited applicability.

Even though there are questions left to be answered, is is already clear that the impacts of commercialization cannot be fully understood without considering the often inequitable systems of water access in countries like Botswana. Since resource access in every context is tied closely to gendered social and economic power dynamics, there will always be crucial caveats to the idea that commercialization should be encouraged; in this case, subsistence horticulture is actually more appropriate for those who already have a source of cheap water. If these lessons are ignored, agricultural policy and efforts to improve food security are likely to fail to help those who need it most as they are pushed into the commercial market without a safety net.

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Table 1. Dependent Variable: Food Insecurity

Independent Variables	Coefficient	t statistic
Control Group	1.29*	2.55
Travel Time to Market	.037	.69
Number of Contributors to Food Budget	-.398	-.72
Electricity Expenditures per Person	-.017***	-4.21
Age	.070*	1.91
Constant	5.56**	2.29

Observations: 100
R-squared: .2043

*** significant at the 1 percent level
** significant at the 5 percent level
* significant at the 10 percent level

Table 2. Dependent Variable: Food Insecurity

Independent Variables	Coefficient	t statistic
Commercial Orientation	-4.936***	-2.97
Travel Time to Market	.093*	1.81
Plot Size	0	-1.45
Gardening Experience	.062	.41
Number of Contributors to Food Budget	-.369	-.72
Electricity Expenditures per Person	-.007*	-1.76
Age	.069*	1.83
Constant	6.279**	2.60

Observations: 75
R-squared: .3993

*** significant at the 1 percent level
** significant at the 5 percent level
* significant at the 10 percent level

Table 3. Dependent Variable: Food Insecurity

Independent Variables	Coefficient	t statistic
Commercial Orientation	-5.202***	-2.65
Travel Time to Market	.093*	1.75
Plot Size	0	-.3
Gardening Experience	.067	.42
Number of Contributors to Food Budget	-.379	-.71
Electricity Expenditures per Person	-.009	-1.00
Age	.069*	1.76
Harvest outliers	-.189	-.04
Wealth outliers	.553	.11
Plot size outliers	-2.11	-.4
Constant	6.279**	2.60

Observations: 75
R-squared: .4010

*** significant at the 1 percent level
** significant at the 5 percent level
* significant at the 10 percent level

Table 4. Dependent Variable: Food Insecurity

Independent Variables	Coefficient	t statistic
Commercial Orientation	-9.907***	-3.12
Potable	-2.887	-.93
Potable*Com. Orientation	5.486	1.37
River	-12.872***	-3.23
River*Com. Orientation	15.746***	3.33
Travel Time to Market	.067	1.38
Plot Size	0	-1.35
Gardening Experience	.118	.82
Number of Contributors to Food Budget	-.236	-.49
Electricity Expenditures per Person	-.004	-1.07
Age	.087**	-1.07
Constant	8.836**	2.32

Observations: 75
R-squared: .5221

*** significant at the 1 percent level
** significant at the 5 percent level
* significant at the 10 percent level