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Correcting for the Inconveniences of Cultivation: Foraging as a Food Source in Southwestern Burkina Faso

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Source: Author

Parkia biglobosa* (fruit)** ***Parkia biglobosa* (seeds)** ***Adansonia digitata ***Cirina butyrospermi***

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Introduction

Thousands of years ago, the world's population sustained themselves entirely on hunting and gathering wild fauna and flora that lived in their surrounding habitat. Many of our history and geography classes teach us that this method of food production was all but lost once agriculture was discovered. Quickly, people switched from a nomadic lifestyle to settle in one area year-round which later on allowed for the creation of large cities, governments and the rest of the modern world we live in today. Without agriculture, we are told, we would simply starve. This, however, is a grave misunderstanding as foraging did not stop at the advent of agriculture (Diamond, 1987; Weisdorf, 2005). To this day, many communities around the world still practice foraging either alone or to supplement their agricultural production (Vincetti et al, 2013).

Foraging occurs worldwide, but is particularly important in many rural African regions where subsistence farmers live close to areas rich in edible plants. However, many of these areas also experience high rates of food insecurity and malnutrition. Foraged foods are important here as they can serve as a source of food for the poorest members of society who may not be able to access food through other means. For many marginalized communities foraged foods represent a food source outside of the greater capitalist system from which they are excluded. Thus, the importance of foraging worldwide cannot be underestimated in its ability to mitigate malnutrition in the face of food crises (Vincetti et al, 2013). In fact, in Southwestern Madagascar, foraging has even been shown to decrease the risk of food insecurity in the face of extreme drought exemplifying the resilience of wild plants and animals to aberrant weather (Tucker et al, 2010). Even for those who are not in dire need of

food, foraged foods are still consumed and enjoyed as they can contain health benefits, be culturally significant, or simply delicious.

While it has been shown several times that agriculture and foraging can peacefully coexist, the nature of agriculture in our globalized world is rapidly changing. Farmers are often encouraged by outside forces to devote more of their attention, land and resources to agricultural activities in order to increase their yields (Collier, 2008; Moseley, 2017). This often means other household tasks, such as foraging, may be replaced. Other trends such as the widespread use of herbicides, pesticides and expansion of agricultural land can also impact the natural environment and thus the availability of edible wild plants and animals (Pimentel and Edwards, 1982).

These so called 'improved' agricultural methods are celebrated by governments and development organizations worldwide which hope to use them to end world hunger. Africa is currently at the center of this conversation as it is the continent where malnutrition is the most prevalent and severe (Collier, 2008). After the success of the first Green Revolution that occurred mainly in Asia and Latin America, policy and development groups are advocating for a New Green Revolution for Africa (GR4A) to help alleviate hunger on the continent. Economic policies along with direct intervention in rural areas are designed to steer subsistence farmers towards producing and selling more of their yields. This, in turn, will grant farmers higher incomes which will allow them to purchase more food for their households. While this is certainly an admirable goal, it is also important to ask ourselves how these interventions are truly impacting people's food access and what true motivations may be lurking behind the highly publicized goal to end hunger (Moseley, 2017).

This involves understanding agricultural communities and food systems not simply as a machine in which one can put things in (such as improved seeds, fertilizer, and other agricultural technologies) and receive diffuse nutritional benefits, but as an infinitely complex organism that is highly influenced by power and gender imbalances and cannot be perfectly predicted or fully understood. For example, it is important to note who has access to land and agricultural inputs and who does not; how resources are distributed within households and larger social structures; and, of course, where food comes from, who has access to food and why people eat what they eat. Each of these questions must be kept in mind before, after and during the implementation of projects and policies intended to improve community nutrition (Foran et al, 2014).

Unfortunately, that is not always the case. Projects are frequently carried out without considering how these characteristics may vary in each particular locale. Most notably, non-agricultural sources of food are often ignored despite making up a significant portion of the diet in many of the target communities (Padoch and Sunderland, 2013). Foraged foods, in particular, provide an important source of fresh fruits and vegetables to families who may otherwise be unable to grow or afford such products. Further, many of these plants are native to the area and thus, may be better adapted to the environment and more resilient to extreme weather patterns than typical crops (Johns et al, 2013; Vincetti et al, 2013). Many of these products, such as *Parkia biglobosa* (African locust bean), *Corchorus olitorius* (West African sorrel) and *Adansonia digitata* (African baobab) are rich in nutrients and available during the hungry season in Southwestern Burkina Faso and thus offer an alternative source of nutrition that may be more accessible than agriculturally produced foods. They also play an important cultural role as they are foods that have been eaten for generations (Mertz et al, 2001; Lykke

et al, 2002). With this in mind, it is important to address how the GR4A's agricultural interventions may be impacting foraging practices and, in turn, nutrition.

To investigate this interaction, my academic advisor, Professor Bill Moseley, another undergraduate researcher (Millie Varley) and I went to Southwestern Burkina Faso where such agricultural interventions are already underway. One organization that is working towards this goal is the Project for the Commercialization of Rice in Burkina Faso (BRICOP), which is funded by the Alliance for a Green Revolution in Africa, a larger organization which funds projects working under the GR4A framework. Similar organizations work with cotton which is the main cash crop of the region, but we chose to look at rice production as women participate alongside men and are more involved in household food preparation. Choosing to focus on women gave us clearer insight into the nuances of food availability and consumption in communities impacted by the GR4A. Additionally, men often lie at the center of these project's attentions so focusing on women's voices gives us a new perspective.

Though we focused only on women, BRICOP works with both male and female farmers in the Hauts-Bassins region of Burkina Faso to increase access to improved rice seeds, farming techniques, and markets (Associated Press, 2014). The methods that have been introduced by BRICOP for intensive rice cultivation (SRI, *Système de Riziculture Intensive*) are more time intensive than previous farming methods which may take away from other important household activities (Traoré, 2016). While farmers appear hesitant to employ the full gamut of SRI methods, there does seem to be a trend of intensifying rice cultivation in villages where BRICOP is working which can take time that would otherwise be occupied

with other tasks. This is particularly notable for women who have many more household tasks than men and are responsible for the majority of foraging that occurs in the household.

To investigate the impacts of BRICOP's program on nutrition and foraging, we worked in five different villages, three of which participate in BRICOP's project. Over the course of two six week periods spanning two years we conducted nearly 200 interviews aimed at understanding the nutritional situation and foraging practices of female rice farmers. This thesis is a presentation of the findings from these interviews with the goal of answering three main questions:

1. Are foraged foods associated with improved nutritional outcomes and how commonly are they consumed in our study community?
2. Is agricultural intensification driven by BRICOP impacting nutrition outcomes and foraging practices?
3. Are there any other sociodemographic factors that have an effect on the extent to which people participate in foraging activities?

To answer these questions I will first be discussing the current state of the literature as it concerns the relationship between foraging, agricultural intensification and nutrition. I will go on to describe the methods I used during interviews, data analysis and the literature review. Finally, I will present the findings of this research in three main sections that address each of the questions listed above resulting in a series of policy recommendations and avenues for future research.

In the discussion of these results I will employ a feminist political ecology perspective to understand the various factors impacting these female farmers. This will be helpful for exploring the origins of the commercial agricultural movement in Africa as well

as the dismissal of foraging as a food source, as these have a largely political origin. These larger political structures impact women more severely in this specific case because foraging and rice cultivation are both tasks largely dominated by women. Additionally, women are at an economic disadvantage compared to men which means that anything that disrupts their methods of income and food production could have a more severe impact women's nutrition. This framework allows me to fuse the larger schemes going on at a global and national scale with everyday lived experiences of women in these communities to capture the complexity of changing local food systems (Foran, 2014).

Ultimately, I find that the agricultural improvement project has little impact on nutrition and no impact on foraging when compared with non-project control villages in this specific context. However, geography and land access (by proxy) do have a significant relationship with foraging practices. Finally, foraged foods are extremely important to the local diet and contain a wide array of nutrients that are beneficial to human health. As such, I suggest that access to these plants be both protected and expanded, especially during times of scarcity and for poorer households. I also argue that knowledge of healthy foraged foods could be leveraged to improve women's incomes, though given their importance such a project should be carefully planned and regulated. Further, due to the limited impact of BRICOP's initiative, I believe that they should slow their progression and consider women's concerns about project function before expanding.

Chapter 1: Context in the Literature

Study Area

Four of the five villages lie within the region of Hauts-Bassins, while one is further south in the region of Cascades. These two regions are quite similar in their climate and agricultural production and, thus, are agglomerated into a single zone as designated by the Famine Early Warning Systems (FEWS) report on livelihood zoning and profiling for Burkina Faso created by the United States Agency for International Development. This zone is characterized by the cultivation of cotton, cereals and fruits (usually mangoes). The region receives a fairly high amount of yearly precipitation at 900-1100 mm, however most of this rain falls during the months of June-September, limiting rain fed agricultural production to a single season. Additionally, this zone is characterized by the presence of *bas-fonds* which are seasonal wetlands. These can be used for the cultivation of vegetable gardens, but more importantly for the subject of this study, rice. This is notable, because other regions of the country do not have these areas and thus cannot cultivate rice due to the prolonged dry season. This means rice production in Burkina Faso relies first and foremost on cultivation in the Southwest (USAID, 2010).

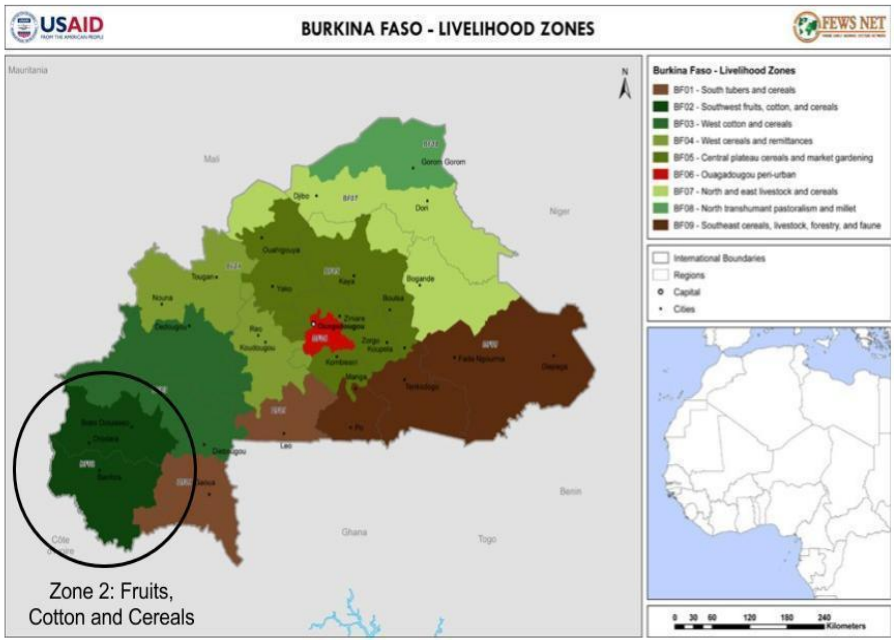

Figure 1. Map of Burkina Faso created by FEWS delineating livelihood zones. Zone 2, the topic of this research is highlighted in black and shaded dark green. Source: USAID, 2010.

A variety of cash and subsistence crops are grown in this zone. Main subsistence crops in the region include maize, sorghum, millet, rice and black-eyed peas. Cotton is the main cash crop and cultivated almost entirely by men, with the rare exception of households without a male head. According to FEWS, even the poorest households tend to own some forms of livestock, though larger animals such as cows and donkeys are typically only owned by those who are more well off. Wealthier households also occasionally own some forms of larger agricultural equipment such as plows, and many also own planted fruit trees (typically mangoes and/or cashews). However, the majority (>50%) of households in this region fall into the 'very poor' and 'poor' categories designated by the FEWS report (USAID, 2010). These trends are also reflected in the findings of the present study.

Crops can account for 40-80% of food consumed by the household, depending on the amount of land cultivated with wealthier households producing a greater percentage of what they consume. This means subsistence agriculture is the norm, even for wealthier

households. The remaining amount can be purchased for those who have the means, but poorer households tend to rely more heavily on loans and gifts from other members of the community. While other research clearly shows that foraged foods make up a fairly large portion of the diet in this region (Lykke, 2002, Pouliot and Treue, 2013, Zizka, 2004), the FEWS reports neglect their contribution to the diet directly. Instead, they focus on the collection of similar products for income generation, which they show can constitute nearly 40% of all income for the poorest residents in the region. Cash crops are a much more important source of income for the wealthier, while the poor rely more on the sale of agricultural labor than selling of crops (USAID, 2010). This is probably because poorer households only own enough land to produce enough for subsistence and do not have a surplus available to sell.

While more arid regions of Burkina Faso experience more severe malnutrition, researchers have noted that indicators of food insecurity remain high even in these wealthy cotton-producing regions (Moseley, 2017; Ruiz, Maugerard, 2015). Within this region, even those who produce high amounts of cotton face the same rates of childhood malnutrition as those who produce very little, suggesting that increased incomes from cotton production do not go to improving household nutrition (Ruiz, Maugerard. 2015). This has been dubbed The Hauts-Bassins Paradox after the Sikasso Paradox named for a neighboring region in Mali. Similarly, in Sikasso, cotton production has skyrocketed, while childhood malnutrition has only increased leading some researchers to argue that the promotion of cotton as a cash crop in this area is actually detrimental to nutritional outcomes (Cooper, 2017). Because of this trend for cotton, I investigate whether this could be the same for rice production in Southwestern Burkina Faso as its intensive methods could negatively impact foraging

activities necessary for providing families with a balanced diet.

Despite these findings, multiple organizations in the region have attempted to implement agricultural improvement projects for several different crops in order to address the region's food insecurity. The most notable is an organization called SOFITEX. They help provide cotton farmers with necessary supplies and connect them to local production markets. The rice project examined in this study also works in villages impacted by SOFITEX to do similar work for rice farmers and is planning to expand these projects to new villages in the coming years. Unlike SOFITEX, however, BRICOP's project addresses the needs of women, as well, because they have traditionally cultivated rice, whereas cotton is typically cultivated by men. This is important to highlight because it has been shown that as a woman's financial situation improves, so does the nutrition of her family. The same has not been found to be true among men (Ashraf, 2009; Gengenbach, et al, 2017). This could mean rice projects are more likely to improve household nutrition, however past experiences have also shown us that altering women's busy schedules can cause intra-household labour issues, specifically in the case of rice cultivation which is why it is important to follow up on BRICOP's work and see how it is working for the farmers involved (Carney, 1988; Moseley, Carney & Becker, 2010)

A farmer's cotton field on the drive between Seguere and Medina Coura. Source: Author

BRICOP is a multi-stage project that focuses both on increasing output from rice cultivation and increasing sale of surplus grain. They have worked in the project villages for 2-3 years. BRICOP works with other organizations that level and organize the *bas-fonds*, in

theory making them more suitable for rice production, the success of which has varied by village. BRICOP then redistributes the land and sells improved seed and fertilizer to those who own parcels while also providing them with access to merchants who will buy their rice. BRICOP essentially acts as a match maker for farmers and merchants allowing farmers access to the best price for their surplus rice. In some cases, BRICOP also provided tractors to help with land management for the first year of production. This system is aimed at increasing both production and sale of rice for male and female rice farmers alike. This, hopefully, will increase incomes allowing households to buy more food.

Foraged Food for Rural Farmers

As discussed in the introduction, foraged food is an incredibly important component used to supplement agricultural production for many rural populations. While the definition of what is foraged and what is not can be highly debated, for the purposes of this paper I include all plants and animals that are not intentionally planted and cared for, but are still consumed for nutritional (rather than medicinal) purposes. On a global and continental scale, there have been many articles published that examine the importance of wild foods in rural diets. Bharucha and Pretty (2010), Grivetti and Ogle (2000), Johns et al (2013), Pimentel et al (1997), and Vincetti et al (2013) all show that wild foods play an extremely important role in rural diets worldwide. Not only are wild foods commonly consumed, but they have been shown to contain important macro- and micronutrients that may not be available otherwise (Grivetti and Ogle, 2000). Further, these food sources offer an extremely inexpensive option for the poorest members of the community.

In Africa, in particular, many wild foods have been disparaged by colonial governments while colonial crops have been elevated as the ideal form of nutrition. While

this was done decades ago during colonialism to promote production of crops that were economically beneficial to the colonial government, the effects still remain. Economic policies still exist that promote production of cash crops that benefit those in urban and more developed areas of the world, while the cultural impact of discrediting wild foods still remains and impacts people's food choices (NRC, 2006; Lykke et al, 2002). BRICOP's design could be construed as such a policy because it focuses on rice production, a grain that is most popular among the urban population (Moseley et al, 2010).

In Burkina Faso, Lykke (2002), Mertz (2001), Pouliot and Treue (2013), and Zizka (2015) et al have carried out surveys and analyses of wild plant use and consumption in Burkina Faso. These indicate that wild food consumption is fairly widespread. It is also an activity carried out almost exclusively by women in non-forest landscapes, though some products do come from forested environments. Wild food consumption can be used for vulnerable members of the population and during times of food scarcity, particularly during the rainy season when they are an important source of fruits and vegetables (Mertz et al, 2001; Vincetti et al, 2013). Despite their widespread use, Lykke (2002) found that wild food consumption is declining while reliance on market products is increasing. These market products, she explains, are less nutritious than wild food substitutes and thus more attention should be paid to promoting nutritious wild foods. She attributed this trend to the general assumption that market products indicate higher social and economic status (Lykke, et al, 2002).

Outside of these observations, most of the studies investigating wild food consumption have focused on describing the characteristics of foraged foods, rather than who forages. Those studies that do focus on population characteristics tend to look at differences

between ethnicities and genders which are quite pronounced (Smith et al, 1996; Vincetti et al, 2013; Zizka, 2015). However, these communities are not homogenous and the same should be assumed of foraging practices. It is important to understand who does and does not have access to these foods as this can determine who has food and who does not. Even within the same ethnic and gender groupings foraging could be impacted by other factors including wealth, land holdings, family size and much more.

Environmental threats to foraged foods are also present and growing. Green et al (2005), a group of experts on ecological health, identified agriculture as one of the greatest threats to the survival of wild plants and animals. In a 2005 publication, they argue that the global push to increase farmland and modernize farming techniques will severely degrade the environment. This is not an entirely novel argument as research has shown the detrimental effects of agricultural inputs on the natural environment for several decades (Pimentel and Edwards, 1982). Despite this knowledge, governments and aid organizations worldwide are still focused on increasing agricultural production in any way possible because, as Green et al point out, the world food demand is rapidly increasing and policy makers are panicking to find a solution (Green, 2005). However, destruction of the natural landscape caused by agricultural intensification may be doing more harm than good by limiting access to wild foods that clearly make up a significant portion of rural diets.

The combined pressure of social/economic and environmental pressures on wild foods may, in part, be responsible for the malnutrition seen in the study area despite the concerted effort made to improve nutrition. First, the implementation of a cash crop focused system may influence people to choose purchased foods over wild foods even if the former are less nutritious. Secondly, the methods used to cultivate these crops (such as herbicides

and pesticides) may also be harming the environment making it more difficult to access wild foods. While BRICOP does not necessarily expand agricultural land, they do support the use of potentially toxic agricultural inputs. Unfortunately, little research has been done to investigate these relationships making it difficult to know exactly why such high rates of malnutrition are present despite high agricultural output.

The Green Revolution: Past and Future

The GR4A is one of the largest forces exerting pressure on African farmers to intensify their agricultural methods with the goal of increasing agricultural food production to end hunger. While this goal is admirable, the political history behind the methods used by the GR4A is important for understanding the motivations behind the movement and the potential ramifications it could have on subsistence farmers. The Green Revolution began in Asia during the 1950s-60s. This was a US-supported effort to increase agricultural production and thus improve nutrition in developing countries of Asia, South and Latin America. While the Green Revolution was largely marketed as a philanthropic endeavor, the name alone 'Green Revolution' juxtaposed itself against the red communist revolution occurring in Eastern Europe, and parts of the developing areas targeted by the Green Revolution. While this was not particularly advertised, government officials were known to present the revolution as an alternative to communism. This was not only evident in the political rhetoric employed by proponents of the Green Revolution, but in its clearly capitalist practices which encouraged free market exchange. Further, the explicitly capitalist means employed in the Green Revolution fostered support of capitalism as it improved lives and livelihoods through promoting open markets and increasing sale of fertilizers and improved seeds. This saw great success in the rapid increase of food production, notably rice

in Asia, that followed implementation of these techniques. It is likely that the well-publicized success of the Green Revolution helped squash procommunist sentiment in the areas where it was used (Moseley, 2017).

While Africa was largely overlooked during this period, the New Green Revolution for Africa is now taking off as people move for the same tactics to be used across this largely impoverished continent. While the movement has many proponents, others are not so sure it is the best fit for the African context. One problematic assumption involved in this work is that food insecurity is a supply-side issue, meaning increasing production will necessarily improve poor people's access to food. However, this ignores issues of unequal access due to poor infrastructure and power differentials that are often present due to the damage done by colonial imposition. Further, the green revolution relies on increasing the use of agricultural inputs that must be purchased, this often excludes women (who typically have less disposable income than men) and the very poor as they are unable to buy their way into participation (Moseley, 2017). It has also been noted that in some areas where agricultural production has increased (including our study area) malnutrition has persisted, suggesting that the supply-side issue that is framed by the green revolution is not always accurate (Ruiz, Maugerard. 2015).

It is also important to note who gains from these policies and initiatives. Many of the seeds and fertilizers used in both past and present green revolutions are produced in Western countries, and now China, as well. This considerably increases the market size for countries trying to sell agricultural inputs. Many of the crops chosen as the focus of these programs are also of benefit to the urban, Western world, rather than crops that may be the most ideal for rural farmers (Moseley, Carney & Becker, 2010). This practice is all too reminiscent of

colonial era policies that forced many rural African eras to convert to producing popular Western crops, such as maize, for the benefit of the colonizer, despite such crops being less than ideal in this context (Moseley, 2017). Rice, as a grain popular in urban areas, falls into this category (Moseley et al, 2010).

Benefits within rural areas are also not distributed equally. Women and the very poor are often marginalized within these systems due to the high costs of inputs required to participate in this new form of agriculture, ultimately excluding them from the benefits. Further, suddenly increasing economic value of certain crops or land areas can cause more powerful members of society to take over areas that were once controlled by others, further marginalizing those who are already poor (Moseley, Carney & Becker, 2010; Moseley, 2017).

One of the largest faults of this frame of thought is the ignorance of alternative food production systems. While many authors have shown that food, especially for the very poor, can come from many avenues other than agricultural production, this notion is completely dismissed by green revolution advocates by focusing solely on agricultural production. In this thesis, I will be focusing on the importance of foraged foods in food security and dietary diversity, but gifts and loans are also extremely important aspects of rural food systems. Excluding this from any analysis of food production, consumption and security is inattentive and could even be hazardous if resulting policy does not consider its potential impacts on these pre-existing food-ways (Moseley, 2017).

I would like to make it clear, however, that the involvement in the capitalist system promoted by the GR4A is not what concerns me about this approach. While capitalism is a system that certainly has many drawbacks, I do not believe that it is the place of Western

researchers (who often enjoy many of the benefits of capitalism themselves) to say whether or not developing nations should take part in the system or not. My main concern with the GR4A is that the political agenda behind it (which, yes does happen to promote capitalism) will take precedence over the lived experiences of those it is claiming to help. At the same time, I do not wish to perpetuate the white savior narrative suggesting that poor rural farmers in developing nations should be shielded from the evils of capitalism and kept in their 'natural' state, a notion all too associated with cultural ecology. Instead, I believe it is important to accept the reality of capitalism for rural farmers moving forward. While farmers may have to work within capitalism, their local knowledge and livelihoods can still be used and respected when considering how to improve their economic situation within this system. This is in contrast to the method employed by the GR4A which suggests implementing the same agricultural system found in developed countries in African environments which are vastly different. I hope that these points are kept in mind while reading what follows as they help elucidate why the acknowledgement of foraged foods as a key component of the food system could help alleviate malnutrition in Burkina Faso.

Commercial Agriculture and Nutrition: Does it Work?

The impact of commercial agriculture on the nutrition of rural farmers is a long-held debate within development studies. While some argue that increased agricultural production and market access will increase incomes and improve farmer's ability to purchase nutritious food, others claim these tactics can be destructive to local economies and community nutrition. Many things can go wrong, but the main concern here is that increased participation in global markets and larger incomes will influence farmers to purchase less nutritious food, even if they purchase more of it. In this scenario caloric needs may be met,

but the diet would be lacking in vital micronutrients (Moseley, 2017). Governments and non-governmental organizations (NGOs) alike tend to follow the dominant narrative that commercialization improves rural livelihoods and nutrition outcomes and thus have structured policy and projects to encourage farmers to produce and sell more of particularly profitable crops (often cotton, coffee, chocolate and rice). Groups such as AGRA hope to provide African farmers with inputs and connect them to regional and global markets to ease sale of crops (AGRA, 2015).

Many researchers agree with these practices as a tactic for improving rural nutrition. For example, one study uses a mathematical model to show that export cropping would improve nutrition in Cote d'Ivoire over time (Sahn, 1990). Others, such as Mehra and Rojas (2008), and Spring (2000) argue that it is especially important to involve women in commercial agriculture because they have the most to benefit from it as underprivileged members of society. Increasing women's income, they say, will benefit household nutrition as women are more likely to use their income to purchase healthy food for the family (Ashraf 2009; Gengenbach et al, 2017; Ruiz, Maugerard, 2015).

Von Braun (1988) offers a case study from the Gambia in which increased production of rice, led by commercialization projects, resulted in increased calorie consumption, most notably for children during the hungry season. He takes a strong stance on this divisive topic, stating that whether increased production is for subsistence or commercial gain does not matter, as long as agricultural yields have increased, food consumption will increase as well. In this and another article published in 1995, Von Braun does acknowledge the limitations of commercialization in benefitting marginalized members of the community (women and the very poor), however he argues that with the proper political and economic climate

commercialized agriculture can be an extremely important tool for alleviating poverty-associated malnutrition.

While the optimism expressed in these papers is enticing for a 'quick fix' development strategy, many other scholars note that such confidence may be misplaced and commercialization could result in negative nutritional outcomes. Longhurst (1988) compares several case studies involving the implementation of commercialized techniques in agricultural communities with varying results. Half of the 18 cases discussed had negative to neutral nutritional outcomes. He notes that certain factors such as women's involvement, the potential for the commercialized crop to be used for subsistence and the manner in which the program acknowledges existing local practices may be involved in determining the success of the program in improving community nutrition (Longhurst, 1988).

More current reviews of the literature have shown more conservative outcomes. For example, a similar study published in 2004 took investment in various kinds of capital (human, social, physical, etc.) into account. They suggested that investing in social capital (specifically, nutrition education and women's role in society) is the most important indicator of success, but found, even then, that improved health and nutrition outcomes are limited even with increased agricultural output (Berti, 2004). Another review compliments the previous two, though the author takes a bolder stance by arguing that we *cannot* assume that increasing income will improve nutrition. Other factors, particularly who controls the flow of capital at a household, community, state and national level are more important determinants in understanding how to improve rural nutrition and livelihoods (Dewalt, 1993). Lastly, a recent case study from neighboring Ghana showed that the implementation of cash crops (cacao and palm oil) actually lead to worse food security (Anderman, 2014).

The latter studies all call for caution in the use of agricultural commercialization to improve nutrition, showing the importance of focusing on specific local contexts and economies. However, none of them address the role of alternative food production chains outside of agriculture (whether subsistence or commercial) leaving a significant gap in the literature.

Commercial Agriculture and Wild Food Consumption

Some of the negative nutritional outcomes observed after implementation of agricultural commercialization programs could be due to a decrease in consumption of foraged foods. Unfortunately, this connection has been given little attention in the literature for this region. Wild foods represent such a large source of nutritious and nearly free food that anything that causes farmers to decrease their consumption of these foods could have negative effects on nutrition. The only article found to address this connection is authored by Broegaard, et al (2017) and focused on Laos. They found that agricultural commercialization was associated with decreased nutrition and wild food consumption in a rural area of Laos. To accompany survey data that provided information on foraging practices and nutrition indicators, aerial photographs were also used to ascertain the presence of non-agricultural land for foraging which indicated that increased commercialization is associated with loss of foraging areas.

The applications of this article to the region of West Africa, however, are limited. Broegaard et al's findings contradict some of the regional literature that explored foraging practices in Nigeria. Here, researchers found that increases in agricultural land actually promoted the growth of certain commonly foraged plant species (Harris, Mohammed, 2003). This is because many foraged species are used in agroforestry such as *Adansonia digitata*

(African baobab) and *Vitellaria paradoxa* (shea nut tree). This makes sense in light of Pouliot and Treue's (2013) finding that most wild foods for this region do not come from forest landscapes, and thus are not in direct competition with agricultural land. Additionally, findings from an agricultural study in the Hauts-Bassins region of Burkina Faso noted that increased income from agricultural commercialization was not associated with improved nutrition, but the diversity of tree species (from which farmers forage) on agricultural fields was associated with improved dietary diversity (Lourme-Ruiz, et al, 2016). Still, Lourme-Ruiz et al's findings do not indicate that agricultural commercialization harms dietary diversity, just that it has no significant impact. The findings in Broegaard's study may not be entirely applicable to communities in Burkina Faso, but it should be noted that Laos underwent a similar 'Green Revolution' as the one that is now being pursued in Africa and may show what the future holds for the African continent, should the GR4A be realized (Moseley, 2017). Combined with other literature on the potential negative effects of commercialized agriculture on nutrition in the West African context and the shifting food consumption patterns in Burkina Faso, it is very possible that GR4A programs such as BRICOP could be unintentionally encouraging farmers to decrease their consumption of foraged foods.

Chapter 2: Methods

Selection of Study Villages

For this study, we chose to perform surveys in five different villages surrounding the city of Bobo-Dioulasso. Three of these villages were involved in BRICOP's project, whereas two had no official involvement in BRICOP's or any other rice cultivation project. Within the project villages we further stratified samples to include women who were involved in the project as well as those who were not. This was done to understand how the project's presence in a village may impact those who are not technically involved. Two of these villages (Medina Coura and Seguere) were located to the North of Bobo-Dioulasso and had a population that was majority Mossi (migrants from the central plateau) whereas the three villages to the South contained a mixture of ethnicities (Dioula, Toussian, Mossi, etc.). One village furthest South (Siniena) was majority Gouen, a smaller ethnicity localized to Southern Burkina Faso. It is important to note the demographic differences between these villages as they could contribute to some of the differences we see in foraging, project involvement and status of women. Additionally, their relative location to Bobo-Dioulasso, Banfora and other larger cities and towns is important to note because it alters market access which may alter both commercialization and foraging.

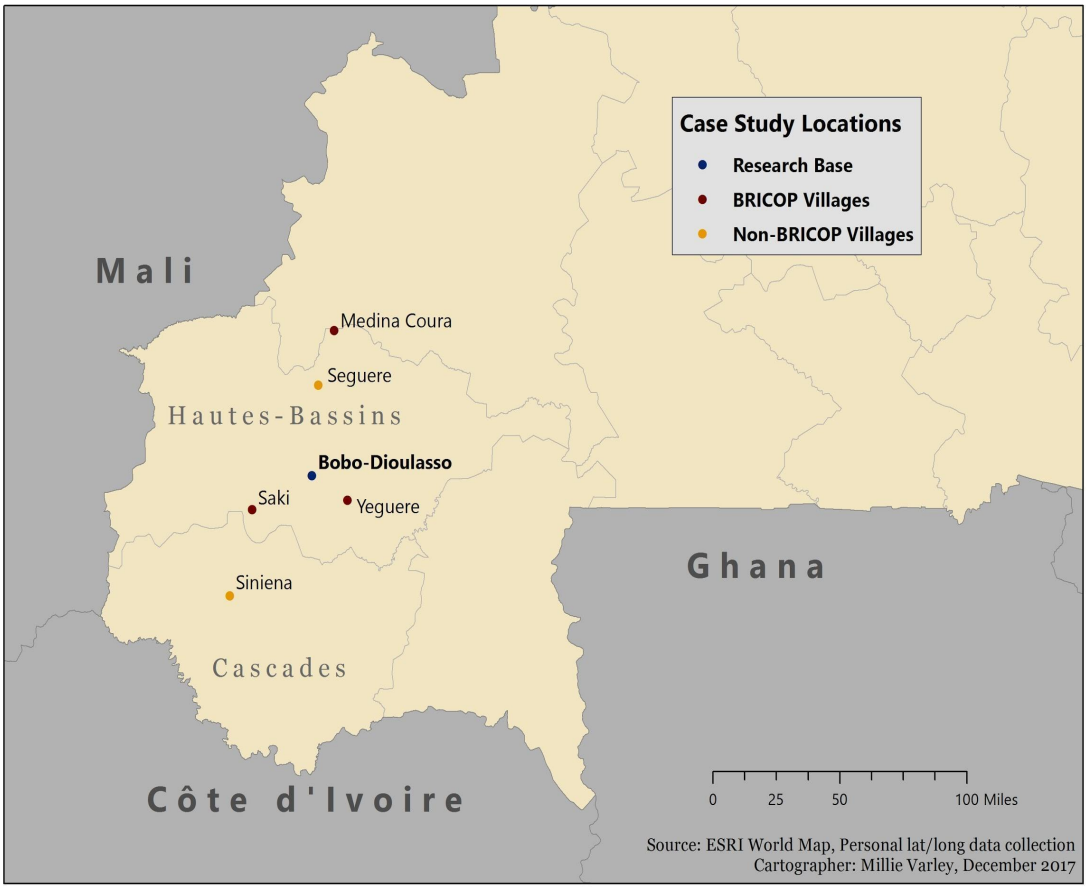

Figure 2. Map of study area detailing the five study villages and their project involvement.

Surveys

Surveys were conducted by a research team working with multiple research assistants from urban areas near each village. The initial round of surveys took place June-August 2016, while the second round took place June-August 2017. While the majority of baseline surveys took place during the first round, one village, Yeguere, was added during the second phase and baseline surveys were done in tandem with follow-up surveys.

Baseline – Baseline surveys were constructed to obtain basic household information on age, marital status, family size and other demographic information. Participants were also asked

about their overall agricultural activity and sale of crops. More specific information was gathered on rice production to ascertain the extent to which participants used techniques and inputs (fertilizer, insecticide, etc.) encouraged by the project. Finally, participants were asked about the large goods that they owned individually and within the household including various forms of livestock, agricultural equipment and home goods. This information was used to create an approximation of household and individual women's wealth in West African Francs based on market prices for these goods then converted to USD to allow for greater understanding among a Western audience. The survey instrument can be found in appendix A for exact questions.

Dietary Diversity and Food Security – To estimate household and individual dietary diversity, we used the United Nations Food and Agriculture Organization's (FAO) designated survey instrument which has been shown to be a useful indicator of nutrition among similar populations in Burkina Faso (Savy et al, 2005). This survey asks participants to recall all foods consumed over the course of the previous day, noting all ingredients used in each meal. Presence or absence of foods within certain food groups (also designated by the FAO) are then used to create an index for dietary diversity. This measure counts the number of food groups from which ingredients were eaten, not the quantity that was eaten. Precise explanations of the survey instrument and analysis can be found on the FAO website (Kennedy, et al, 2011). Participants were then asked about their own perceptions of their level of food security over the previous four weeks using a standardized set of questions developed by USAID. Questions are aimed at gathering information on anxiety and uncertainty about food supply, poor quality of food and insufficient consumption and the associated physical discomfort. This survey can also be found online, consult Coates, et al,

2007.

Foraged Food – Lastly, a survey on foraged foods was used to ascertain the level of involvement in foraging and use of foraged foods within the household. To follow up on the dietary diversity survey, it was noted whether participants had consumed any foraged food the previous day. Additionally, participants were asked which foraged foods they gathered during a normal year, the frequency they consumed these products per week when available and whether or not they ever sold the products they gathered. These three questions were each used to create indices which serve as a set of quantitative variables that measure the level of involvement in the collection, consumption and sale of foraged foods. If participants paid for the foraged foods or the rights to harvest them, they were not counted as foraged foods. This provided information only on the foods the household foraged for, indicating a cash free (though potentially time intensive) source of food. Finally, participants were asked whether or not foraging was necessary in order to have enough food to feed the family.

Scientific names of foraged foods were found by matching names with local languages or in some cases matching physical characteristics with those in the literature and online databases (Brunken, et al, 2008; UNESCO, 2004). A multi-database search was then used based on scientific names to find the nutrient composition of each product. Searches were conducted in both English and French. The plants or animals whose scientific name could not be ascertained were excluded from this search.

It should be noted that some information on types of foraged foods was gathered during group interviews, however, due to time limits at the beginning of the survey period, most of the species of foraged foods were collected over the course of the surveying process.

Due to this method the number of foraged foods found may be limited by factors such as seasonally related recall bias. However, using this method ensured that the products mentioned have significant value in the daily lives of participants. Each time a new foraged product was mentioned the interviewee was asked about its general properties including what was eaten, how it was prepared and when it was in season. For more detailed information on the foraging survey instrument see appendix B.

Sample - A total of 145 participants were used in the analyses, 73 of whom were involved in the project. Participants were invited to participate in the study through communication with local leaders who held different roles in each particular case. All were informed that participation was completely voluntary and they were able to withdraw from the study or deny answers at any point, should they wish to do so. Data was missing for certain participants in certain variables, for analyses using these variables those participants with missing data were excluded, however they were included in other analyses for which their data was not missing. Most notably, the variable showing the proportion of rice sold was impacted by low success in rice production, which was more prevalent in certain villages (Medina Coura and Yeguere), than others. See appendix C for a table showing the number of people per village who reported low rice production (<2 100kg sacks).

Data Processing and Analysis

An index was created for dietary diversity based on the indicated FAO methodology. The food insecurity index was created using a method first demonstrated by Fehr & Moseley to further differentiate levels of insecurity (2017). Questions were weighted according to their severity to create an index scaled 0-120 with higher scores representing greater food insecurity. Additionally, a count of the foraged foods collected during a normal year was

created by adding the self-reported collection of a certain subset of foraged wild foods (African baobab, African locust bean (both fruit and seed), shea butter, Senegal saba, mango, sickle senna, hunting, fishing and termites) that were present in all five villages with a maximum total of 11. I chose to include only plants that were present in all villages so that I could better understand farmer decision-making about which plants to forage. Further, geographic differences in available foraged foods could make associations with project involvement difficult to interpret. The same foraged foods were used to create counts for the frequency of consumption (per week when available) and the number of foraged foods sold during a regular year.

The index for program participation accounts for the use of various agricultural techniques to prepare land in the way that BRICOP has encouraged in order to maximize production (e.g. sowing seed in rows, use of fertilizer, etc). However, the use of BRICOP's market was not included in this index because data was missing for this variable for nearly half of participants. The use of these technologies were counted to create the index with a total maximum of six.

Linear regressions were used to compare the relationship between continuous variables including food insecurity, frequency of foraged food consumption and percent of rice sold, while ordinal regression was used for ordinal variables such as the other foraging and project indices as well as dietary diversity. Difference of means tests were used to compare all binary variables such as marital status, project land cultivated, and more. Descriptive statistics were also gathered to give basic population information. ANOVA analysis coupled with Tukey post-hoc analysis was used to test for between village differences as each village represents a unique social, economic and ecological environment.

All analyses were done using SPSS statistical software and R Studio.

Theoretical Framework: Feminist Political Ecology

To interpret and contextualize the results produced from my analyses I will use a framework of feminist political ecology (FPE). This is a modified form of political ecology, a framework which stems from cultural ecology, but focuses on the political nature of human-environment interactions. In other words, political ecology examines how larger political and economic forces impact how people interact with the natural and built environment around them, typically highlighting issues of environmental degradation and marginalization (Robbins, 2012). Rocheleau describes the importance of using gender as a lens through which to view these relationships, acknowledging that people of different genders play different roles and hold different stakes in human-environment interactions. Instead of assuming these differences are inherently biological or simply imagined as other frameworks have done in the past, FPE acknowledges the real power that socially constructed gender norms have on both men and women and their relationships to the natural environment (Carney, 2008; Hovorka, 2006; Rocheleau, 2013).

This framework has been shown to be particularly relevant for addressing the intricate nature of food systems. Foran et al (2004) explains the usefulness of political ecology in understanding complex food systems. She notes that political ecology has strengths in this area because it analyses situations with a bottom-up perspective ensuring that details particular to each situation are included along with overarching geopolitical influences. This is done in three main domains in which political and economic influences are intrinsically linked with farmers' everyday choices surrounding food consumption and production. I will discuss each of these domains and how they apply to the particular situation being discussed

in this paper in Southwestern Burkina Faso within the following three paragraphs.

Firstly, political ecology allows researchers to analyze the availability, resilience and persistence of food and food production systems. With its focus on social justice, political ecology leads us to investigate the inequalities that exist within food access networks both within and between communities. In the present case study, land ownership or tenure is imperative for producing either income or food via agriculture and foraging. Without access to land and the ability to manage it in some way (e.g. cultivating or collecting natural food products), people in this society will likely go hungry. Any outside force that impacts land access is, therefore, important to food access as well. Previous research in political ecology has also shown us to examine the vulnerability of livelihood systems as well, which enables us to understand the resilience and persistence of food access and production (Watts and Bohle, 1993). For example, due to climate change, agricultural production in this region has become increasingly more vulnerable to erratic weather patterns such as drought and flooding which both regularly impact the communities discussed in this paper. While weather cannot be drastically altered, measures should be taken to mitigate risk, or decrease vulnerability of food production systems. Methods of food production should be examined accounting for vulnerability in order to understand whether particular practices will further exacerbate the environmental changes faced by this community.

Secondly, political ecology helps us to understand how access to food can be changed by larger political and market forces. According to reports released by the FAO, cereal production for the past five years has consistently exceeded utilization indicating that the world's food supply is more than sufficient meaning production is not the issue. This is also true for Burkina Faso as the available amount of calories in the country has exceeded need

per capita (FAOSTAT, n.d.) Political ecologists tend to look outside of sheer availability, into understanding how politics and economics can impact an individual's access to food. The GR4A, for example, influences policy and development groups to push farmers to use expensive inputs that can leave farmers in serious debt if they do not produce enough surplus to pay back the loans needed for their inputs. In theory, this shouldn't happen as the inputs would pay for themselves in an ideal world, however, that is not the situation in which these farmers are living. Due to the environmental changes discussed above these policies can leave farmers even more vulnerable to the consequences of aberrant weather and ultimately leave them without food. Further, poor infrastructure and seasonal price fluctuations can make it difficult for food to get to the homes and villages where and when it is needed most. For example, many families in SW Burkina Faso have difficulty purchasing food once their own stores of grain have been depleted for the year. While all of these factors occur at a fairly large political scale and are not easily influenced by rural farmers, they have strong impacts on their daily lives and particularly on their food security.

Lastly, political ecology aids in considering how the consumption and utilization of food products can impact food security. On a small scale, individual preferences and cultural norms will dictate what is appropriate to eat and what is not. This seemed to be particularly true in the case of certain foraged foods in this study. For example, *Corchorus olitorius* (West African sorrel) appeared to be commonly consumed by Mossi women, while largely avoided by those of other ethnicities. It can be difficult to understand how such cultural differences may arise, but there are other trends that have developed more recently due to clear outside influences. Colonial governments, notably, disparaged the consumption of foraged foods claiming them to be primitive despite their being an invaluable source of

nutrients (NRC, 2006). Further, globalized markets are influencing the ingredients people choose. For example, the inexpensive bouillon cube, *Maggi,* has given households a low cost way to add rich flavors to their sauces, but it is also low in nutrients. Other food products such as bread, pasta and rice are gaining popularity. Once again, these foods are highly processed and may have fewer nutrients than their more traditional counterparts, but indicate a higher social status and may be chosen over corn or sorghum for this reason (Lykke et al, 2002).

It is also imperative that gender imbalances be considered throughout each of these areas. Women in this study area tend to have fewer advantages than men, and are particularly vulnerable to environmental and economic changes that could cause them to lose income. As they tend to have much less money to begin with, this loss would be even more devastating for women. In addition, household work is heavily segregated by gender which imparts women with both advantages and disadvantages in influencing household nutrition. Women are typically responsible for foraging and food preparation as well as acquiring ingredients for nutrient-rich sauces. This allows them greater power to alter what the family consumes. However, their other household duties also make it more difficult to devote time to income-earning activities which limits their ability to choose which ingredients to grow, forage or buy. In the discussion of my results I will be focusing specifically on women's role within the food system and how projects like BRICOP may be making their jobs easier or more difficult.

These three factors, along with a feminist perspective will be used in the analysis of my results to situate foraged food consumption in these five village communities within the greater context of global markets, political trends and the GR4A. Following in the footsteps

of previous FPE literature, I will aim to describe the specific environment I observed within these particular villages. I will then discuss how larger geopolitical powers come into play to create the patterns we see here and why this is occurring. Finally, I aim to show who is 'winning' and who is 'losing' in this particular situation. Based on this analysis, I will then offer recommendations for future policy, development initiatives and research occurring in this region with the hope that the weight of the difficulties these women are facing will soon be lessened.

Chapter 3: Foraging and Nutrition

Results

Survey participants listed a combined total of 25 different species of non-cultivated plants and insects that are collected and consumed as food in addition to hunting and fishing. Most of the products collected are fruits consumed raw, however there are also several plants whose leaves or nuts are processed and consumed as well. There were also two species of insects that were cooked and consumed. Several women said they participated in hunting and fishing, but specific species were difficult to ascertain, thus they were not included among the list of species. Still, they represent an important source of fat and protein. No fungi or tubers were cited in this study, however, other studies have found that these products are also consumed in this area. This discrepancy could have been due to the phrasing of the question or slight regional differences in availability or cultural preferences. It should also be noted that because this study encompassed a fairly wide region each product was not necessarily available or consumed throughout each of the five villages, certain products, such as the caterpillar *Cirina butyrospermi*, colloquially known as shitumu, were only available in Southern villages. Below in table 1 is a complete list of all plant and insect species reported by the survey participants, their common names in English, Dioula and Mooré and the type of product collected.

Scientific	Dioula	Mooré	English	Product
Adansonia digitata	Zirasun	Toeega	Baobab	Leaves
Bombax costatum	Boumbou yiri	Vuaka	Red-flowered silk cotton tree	Fruit
Ceiba pentandra	Bana yiri	Gounga	Kapok	Leaves
Ceratotheca sesamoides	Banougou	Boundou	False sesame	Leaves
Cirina butyrospermi	Shitumu	UK	Shea caterpillars	Insect
Corchorus olitorius	Fonongoh	Bulvaka	West African sorrel	Leaves
Detarium microcarpum	Tambacoumba	Kagèdga	Tallow tree	Fruit
Diospyros mespiliformis	Sunsun	Ganga	African Ebony	Fruit
Ficus gnaphalocarpa	UK	Kankanga	Fig	Fruit
Ficus thonningii	UK	Kounkouiga	Strangler fig	Fruit
Hibiscus asper	Kongo da	Bito	Wild hibiscus	Leaves
Landolphia dulcis	Pompony	Leila	N/A	Fruit
Lannea microcarpa	Pegun	Sambga	African grape	Fruit
Macrotermes bellicosa	Bibi	Yiwa	Termites	Insect
Mangifera indica	Mangue	Mangue	Mango	Fruit
Parkia biglobosa	Nèrè	Roânga	African locust bean	Fruit, Seeds
Saba senegalensis	Zaban	Wèdga	Gumvine	Fruit
Senna tora	Kri-kri	Sogoda	Sickle senna	Leaves
Tamarindus indica	Tomi	Pusga	Tamarind	Fruit, Leaves
Vitex doniana	Koto	Anda	Black plum	Fruit, Leaves
Vitellaria paradoxa	Shi	Taanga	Shea	Fruit, Seeds
UK	Farafin finsan	UK	UK	Fruit
UK	Kamsango	UK	UK	Fruit
UK	Botorobara	UK	UK	Fruit
UK	Limolimo	UK	UK	Fruit

Table 1. Shows the scientific and common names of the cited foraged food products as well as the type of product that is used from each species. Spellings were done phonetically for the Dioula and Mooré names and may differ slightly from those found in other studies. UK = Unkown

In table 2 you can find a calendar showing the seasonal availability of most of the foraged for which this data was available. This data was collected from survey participants each time a new product was mentioned. Many of the products are available between May-

August when food is most scarce indicating these plants and insects can be an important resource for families running low on food and cash during these months. A few other plants are also available during the dry season from December-February, though this is less common. Very few products are available March-April or September-October, indicating this may be a time of diminished dietary diversity for families that rely heavily on foraging. However, many of the leafy products such as those of *Adansonia digitata, Corchorus olitorius* and *Senna tora* can be dried and used throughout the year. While this appeared to be a common practice for leaves, dried fruits were far less common. Dried mangos could be found in the market, but according to the leader of the women's group in Saki, most people did not have the resources to do this themselves. Other products such as *soumbala,* the fermented seeds of *Parkia biglobosa,* or butter from the seeds of *Vitellaria paradoxa* are created specifically for the purpose of being saved and used for longer periods of time. This means the calendar gives an indication of when these products are most plentiful, but by no means delineates when they are unavailable.

Product	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Adansonia digitata												
Bombax costatum												
Ceiba pentandra												
Ceratotheca sesamoides												
Cirina butyrospermi												
Corchorus olitorius												
Detarium microcarpum												
Diospyros mespiliformis												
Ficus gnaphalocarpa												
Ficus thonningii												
Hibiscus asper												
Landolphia dulcis												
Lannea microcarpa												
Macrotermes bellicosa												
Mangifera indica												
Parkia biglobosa												
Saba senegalensis												
Senna tora												
Tamarindus indica (fruit)												
Tamarindus indica (leaves)												
Vitex doniana (fruit)												
Vitex doniana (leaves)												
Vitellaria paradoxa												

Table 2. Is a representation of the availability of each foraged product throughout the year based on participant reported seasonal availability.

Not all products were used to the same extent throughout the population. Indeed, some were hardly used at all such as the fruit powder of *Parkia biglobosa,* hunting and fishing, both used by less than half of the population. However, others, most notably *Hibiscus asper, Vitellaria paradoxa* and *Cirina butyrospermi* were collected by nearly all who had access to them. Still, most products were used by the majority of the population, between 60-80%, adding to the evidence of their widespread use and importance to rural

farmers.

The percent of the population selling their foraged foods also varies by product, though instead of ranging in the over 50% category, most are sold by somewhere between 10-30% of the population showing that the sale of these is less common. Some products however, stick out such as *Cirina butyrospermi, Vitellaria paradoxa* and *Mangifera indica.* This indicates some potential among these products for their sale to be further commercialized, or their processing to be localized in order to give women more access to income-earning opportunities based on traditional livelihood practices.

Product	Foraged	Sold
Adansonia digitata	74.48%	22.07%
Cirina butyrospermi	86.81%	63.74%
Corchorus olitorius	68.28%	11.03%
Fishing	40.00%	17.24%
Hibiscus asper	97.80%	26.37%
Hunting	13.79%	2.76%
Macrotermes bellicosa	63.45%	8.97%
Mangifera indica	61.38%	35.17%
Parkia biglobosa (fruit)	35.86%	18.62%
Parkia biglobosa (seeds)	57.93%	26.21%
Saba senegalensis	77.06%	22.02%
Senna tora	70.34%	8.28%
Tamarindus indica	55.86%	17.24%
Vitellaria paradoxa	88.28%	45.52%

Table 3. Gives the percentage of the population that reported collecting and selling the listed foraged food. For certain species such as *Cirina butyrospermi* and *Hibiscus asper* that were not available throughout all five villages the total population was decreased to represent only those villages with access to foraged food.

The following two tables (4 & 5) show the macro and micronutrient content of a select number of foraged foods that participants listed. As you can see by this table there is an extensive range of nutrients found among these products proving their nutritional worth. Most of the products are particularly rich in certain micronutrients which is important

because most agricultural products are lacking. The insects offer a unique source of protein which can also be difficult for rural farmers to access.

Scientific	Product	Carbs (g/100g)	Protein (g/100g)	Fat (g/100g)	Kilocalories/ 100g
Adansonia digitata	Leaves	64.6	14	4.3	353
Bombax costatum	Fruit		78	0.025	
Ceiba pentandra	Leaves	52.06	12.97	4.35	150.8
Ceratotheca sesamoides	Leaves	47.15	29.35	4.6	
Cirina butyrospermi	Insect	12.63	62.74	14.34	432
Corchorus olitorius	Leaves	53.04	13.7	3.5	71
Detarium microcarpum	Fruit	58.77	2.93	1.57	
Ficus gnaphalocarpa	Fruit	18.83	10.36		
Hibiscus asper	Leaves	45.67	23.82	2.01	71
Landolphia dulcis	Fruit	30.3	17.7	36.6	
Lannea microcarpa	Fruit		41	0.255	
Macrotermes bellicosa	Insect		20.4	28.2	
Mangifera indica	Fruit	17	0.5	0.3	65
Parkia biglobosa	Seeds (proc.)	14.6	37.2	35.5	526
Parkia biglobosa	Powder	84.5	3.3	2.3	372
Saba senegalensis	Fruit	74.23	0.53	8.92	379
Senna tora	Leaves	36.6	11.63	2.02	
Tamarindus indica	Fruit	80.8	8.2	2.4	377
Tamarindus indica	Leaves	72.7	14	3.9	382
Vitex doniana	Fruit		22	0.15	
Vitex doniana	Leaves	12.92	5.85	1.1	
Vitillaria paradoxa	Butter	22.3		75	
Vitillaria paradoxa	Fruit		5.2	1.3	22.6

Table 4. Depicts the macronutrient content of the plant and insect products for which a scientific could be found and data was available. Blank cells indicate missing values. The values presented in this and Table 5 are an agglomeration of many sources which are presented in Appendix E.

Descending from left to right these pictures show *Corchorus olitorius, Senna tora, Cirina butyrospermi, Landolphia dulcis,* farafin finsan (unidentified), *Adansonia digitata, Parkia biglobosa.* Source: Author.

Scientific	Product	Iron (mg/100g)	Magnesium (mg/100g)	Zinc (mg/100g)	Calcium (mg/100g)	Potassium (mg/100g)	Sodium (mg/100g)	Vitamin A (Retinol Equivalents)	Vitamin C (mg/100g)
Adansonia digitata	Leaves	16.94	887	8.02	2168	2049	1.2	112	
Bombax costatum	Fruit	0.04	4.73	0.016	13.5		0.0422		
Ceiba pentandra	Leaves	2	35.5	11	7.66	419	0.38	0.73 mcg	4.91
Ceratotheca sesamoides	Leaves	43.4	2.45	0.03	2.62				
Cirina butyrospermi	Insect	12.97	169	1.88	210	1160			
Corchorus olitorius	Leaves	0.77	1.86	0.03					
Detarium microcarpum	Fruit	2.53	97.07	0.78	175				
Ficus gnaphalocarpa	Fruit	81.8	210	25.6	612	2330	28		487
Hibiscus asper	Leaves	0.334	1.032	0.169					
Landolphia dulcis	Fruit	50	20		780	134	70		112.5
Lannea microcarpa	Fruit	0.16	2.42	0	6.44		0		
Macrotermes bellicosa	Insect	27	0.15		21			2.89 mcg/100g	3.41
Mangifera indica	Fruit	0.1	9	0	10	156	2	765 (IU)	27.7
Parkia biglobosa	Seeds (proc.)	35	257	5.9	574			TR	
Parkia biglobosa	Powder	15	202	1.6	284			TR	
Saba senegalensis	Fruit								
Senna tora	Leaves	220	860	40	3520	960	100		
Tamarindus indica	Fruit	14		2.3	240			TR	
Tamarindus indica	Leaves	91		2.7	330			TR	
Vitex doniana	Fruit	0.019	1.24	0	1.39	0	0		
Vitex doniana	Leaves	17.29			51.7		1.29	3583 (IU)	32.98
Vitillaria paradoxa	Butter	0.8	4.5	4.2	9.6	2.2	4.2		
Vitillaria paradoxa	Fruit	8.5	57.2	2.1	117.6	830.3	19.3		196.1

Table 5. Micronutrient content of the plants and insects for which a scientific name was found and data was available. Blank cells indicate data could not be found for that particular value. TR indicates trace amounts were found. For vitamin A different articles used different measurements, mcg represents micrograms while IU represents international units (commonly used to measure fat soluble vitamins.

Among the entire population foraged foods were found to be extremely important with 92.0% (n=126) of participants reporting that foraging for food was necessary to fulfill the family's needs for food. During interviews, some women further specified that leaves were of particular importance because of their use in sauces consumed at every meal. Additionally, many women talked about the importance of drying and preserving these leaves so that they could be used once fresh products were no longer available during the dry season. Fruits, they said, were a nice snack for children, but did not make up a necessary part of the diet. Foraged foods were also found to be commonly consumed during this season as 91% (n=132) had eaten foraged food products in the previous 24 hours.

These data show that foraged foods are consumed frequently during the rainy season. This would be expected as many wild food plants were in season while surveys were taking place, as exemplified by Table 2. However, the high reporting of the necessity of foraged foods in the diet and the fact that leaves are commonly dried and saved indicates that this trend would likely be seen year round. See Table 6 for values indicating the average use of foraged foods in the community. In this table you can see that the number of foraged products, frequency of consumption and sale of foraged goods are all commonly practiced within these communities. The mean values for the number of foraged foods collected and frequency of their consumption are both near to half of the potential maximum value, which indicate both natural distribution of the data as well as high collection and consumption among this population of female rice cultivators.

	#FFs Eaten w/in 24h	#FFs Collected Year-round	Frequency of FF Consumption	#FFs Sold
Mean	2.03	5.63	23.03	2.01
CI	0.19	0.30	1.60	0.34

Table 6. This table shows the mean number of foraged foods (FFs) consumed during the previous day as well as means for each of the foraging indices. This includes the number of foraged foods (from a total of 11) collected throughout the year, the reported frequency of consumption of these foods when in season (max = 45) and the number of foraged foods sold during a typical year. Corresponding confidence intervals (CI) using a standard 95% confidence are presented as well.

Overall population nutrition values split by wealth group are given in table 7. The values here show that overall, dietary diversity is relatively high as compared to the previous results given by Savy et al (2006) which found an average score of 3.4 during the hungry season in Burkina Faso. Our values are nearly double this score, even for the poorest wealth group. While there are no set cut-off points for interpreting dietary diversity, the mean values are slightly greater than half of the potential maximum value indicating diets, on average, do include a decent variety of food groups. However, it should be noted that diets were quite monotonous. While each meal often contained multiple ingredients, it was common for the household to consume the same meal repeatedly. Many women mentioned this during the food insecurity survey saying that they did not like the food they ate and were frustrated by the fact that they had to eat it repeatedly. When asked what food they would prefer several women said that they would like to have better access to bread and pasta.

Individual women's dietary diversity (WDD) is nearly identical to household dietary diversity, though the confidence interval is slightly larger for WDD indicating slightly more variance within this variable. The mean food insecurity score, though much smaller than the maximum value of 120, was surprisingly high given the FEWS report's designation of this region as food secure. As mentioned before, this probably comes from women reporting dissatisfaction with the food they ate as that is also a key component to food security. Still, these responses indicate a low severity of food insecurity because fewer participants reported

actually missing meals or eating insufficient meals. This indicates that this population is somewhat food insecure in that people are unable to access culturally appropriate food or frequently worry about having enough to eat, but there is not such a severe lack of food such that many people are going hungry.

Means for HHDD and food insecurity show better nutritional outcomes as wealth improves with HHDD increasing and food insecurity decreasing. However, for WDD the mean increases very slightly from low-medium, but decreases between medium-high. However, ANOVA and Tukey HSD analyses showed no significant differences between wealth groups for HHDD and WDD meaning that the differences shown in this table are likely due to random error. There was one significant difference found between the low and medium group for food insecurity which is notable as these two means are quite different. This suggests that food security increases as wealth increases up to a certain point (medium income), while all wealth groups have the same level of dietary diversity.

		Wealth Level				
		Low	**Medium**	**High**	**Outliers**	**Total**
HHDD	**Mean**	6.37	6.49	6.88	7.5	6.51
	Std. Deviation	1.496	1.26	1.15	0.71	1.34
WDD	**Mean**	6.55	6.56	6.25	7.00	6.53
	Std. Deviation	1.68	1.46	1.342	0.00	1.51
Food Insecurity	**Mean**	50.55*	34.36*	34.25	20.5	39.96
	Std. Deviation	65.816	28.499	30.67	28.99	32.273
	N	51	73	16	2	142

Table 7. Shows mean household dietary diversity score (HHDD), individual women's dietary diversity score (WDD) where the total maximum value is 12 with higher scores indicating more diverse diets. Mean food insecurity index (FiS) is also shown with a range from 0-120 indicate greater food insecurity with higher values. Means are split by wealth level to indicate how they differ across wealth groups along with standard deviations indicating variance within the data. The * indicates a significant difference between these two means.

Linear regressions were used to analyze the relationship between foraging indices and nutritional outcomes. The results displayed indicate the effect that foraging practices have as independent variables on the dependent nutrition variables of food insecurity and household

dietary diversity. For food insecurity there is a significant negative relationship with the number of foraged foods collected year round. This means that as food insecurity decreases (as people become more food secure) the number of foraged foods collected increases at the scale of -3.5 for each additional foraged food collected. While this is a relatively small change, it is still an important change in food security. The association with the frequency of foraged food consumption is not statistically significant at the level of 0.05, but is very close at 0.06 suggesting that there could be an association here and further investigation of this association should be done to better understand this. Exact figures are shown for these tests in Table 8.

The relationships between HHDD and the foraging indicators are more significant than they were for food insecurity. This makes sense given that foraged foods are typically used to supplement agriculturally produced grains. These grains usually account for the bulk of caloric intake, largely determining food insecurity, while foraged foods typically provide an array of micronutrients determining diet diversity. The relationships between HHDD and foraging indices are all positive, though somewhat weak, with the weakest relationship being between HHDD and the frequency of foraged food consumption at 0.044. This indicates that higher collection and sale of foraged foods helps to contribute to higher dietary diversity scores. However, the frequency of foraged food consumption has only a very minor effect on dietary diversity. Due to the way dietary diversity is measured this makes sense as the quantity of foods in different food groups is not measured and the survey accounts for only one day of consumption, therefore the frequency of consumption shouldn't have a great impact on this variable. This does not mean that consuming foraged foods more frequently does not contribute to a more nutritious diet, only that frequency of consumption does not

factor into this particular nutrition variable.

	Food Insecurity			Household Dietary Diversity		
	Coefficient	**Sig.**	**R Squared**	**Coefficient**	**Sig.**	**R Squared**
#FFs Collected	-3.534*	0.023	0.1	0.191*	0.019	0.07
Freq. FF Consumption	-0.468	0.063	0.09	0.044*	0.004	0.07
# FFs Sold	-0.514	0.366	0.07	0.244*	0.001	0.1

Table 8. Gives the regression results explaining the relationship between nutrition indicators and foraging indices. All regressions were done while correcting for household wealth. * indicates significant coefficients where p<0.05

Discussion

This analysis has strengthened the current regional literature showing that foraged foods play an extremely important role in rural agricultural communities in West Africa. Not only are the foods frequently consumed, but their collection, consumption and sale are correlated with higher dietary diversity, and their collection is associated with higher food security. Further, the macro and micronutrient contents displayed in Tables 4 & 5 show that foraged foods do offer a wide array of vital nutrients resulting in real world health benefits for those who consume them. Moreover, these benefits can be accessed freely in the natural environment. It is important to note here that these can be time consuming activities for some products that may be difficult to access or require lengthy preparation such as boiling, peeling or chopping. Further, these responsibilities fall largely on women who also must tend to their agricultural fields, watch over children, prepare meals and much more. Thus, while I refer to

A woman shelling African locust beans in Saki, a common sight during the rainy season. Source: Author

many of these products as a free source of nutrition, I mean only that they do not require an exchange of money or other goods. Because of the time commitment required to harvest these items they are not truly free.

The selection of edible plants and animals cited by the women in our study were found to contain a vast array of different macro and micronutrients. These prove particularly useful as supplements to a diet that is typically heavy in micronutrient deficient carbohydrates. The calendar of availability also indicates most of these products are in season during the hungry season when food is most scarce providing an alternative food source for families who have depleted their stores of grain. Insect products, particularly *Cirina butyrospermi,* which are commonly collected and sold, also provide an important source of protein. Iron, though not common throughout all products, was found in high amounts once again in the leaves of *Senna tora* as well as the leaves of *Ceratotheca sesamoides* and the fruit of *Ficus gnaphalocarpa*. Iron deficiency is one of the largest nutrient-related health problems in Burkina Faso with 92% of children under five found to have iron deficiencies. The same statistic is at 40% for pregnant women, 13% of whom have severe anemia (UNICEF, 2010). Many products also contained large amounts of calcium, most notably the leaves of *Senna tora* which are also widely consumed. In fact, this was one of the most visible products as it grows on the sides of roads and fields and many participants pointed it out and attested to eating it on a regular basis in the form of sauce. Several products also contained very high amounts of potassium. Overall, this selection of edible plant species contains high amounts of many different kinds of micronutrients that are vital for maintaining human health. Improving access to and consumption of these products would greatly improve nutrition in Burkina Faso.

Despite the influence of colonial governments and modern media which disparage the use of wild foods in the diet, foraging seems to be alive and well. Not only do people consume these foods on a regular basis, but most seem to do so happily. Even one of our research assistants who was by no means desperate for food enthused about the taste of one of the leafy vegetables (*Corchorus olitorius*) and was shocked to hear that it did not exist in the United States. Much of the research on foraging frames it as a last resort effort to find food, but in this case, foraging is a normal way of accessing foods that are both nutritious and delicious. More importantly, they are cheap. While imported foods purchased in the market seem to be gaining in popularity (Lykke, 2002), foraged foods give women a source of food that does not require them to participate in the capitalist system in which they are inherently marginalized due to their gender and this, in my opinion, is invaluable. Because of this, the potential for foraged foods to improve women's nutrition and reverse some of their economic marginalization is great.

Not only is the collection and consumption of wild foods notable in this community, but their sale also appears to be related to higher wealth (see values in Table 8) and improved nutritional outcomes. It is difficult, given this data, to determine the causation between these variables, but their relationship is significant and should be considered in future research and policy. Their sale allows women to earn income during the hungry season (as this is when most of the products are available) which is also corresponds to the planting season when farmers are in need of agricultural inputs. This can help them to feed their families in the short term by purchasing other foods and in the long term by allowing them to purchase agricultural inputs that could potentially increase their yields in the coming years. Alternatively, it may be easier for wealthier women to gain market access which could be

responsible for the relationship we see. However, these two scenarios are not mutually exclusive and they could be working in tandem to cause this association.

Future projects could focus on nutritional education around foraged foods and supporting equal access to these products. Nutrition education programs have been noted in past literature as defining aspects of successful development projects for improving nutritional outcomes (Berti, 2004). Incorporating the current findings on the dietary importance of foraged foods into this education could be a culturally appropriate means of reaching the population by supporting foods that are already familiar and well-liked. Improving access to products is another important aspect of this. If access is unequal, education will do little to improve things for the most marginalized. Creating common spaces where land can be lightly maintained for the growth of wild food products could aid in increasing access for those who may not have access to valuable tree products. The details of access will be discussed in greater detail later on in Chapter 4.

Many researchers have explored the idea of commercializing local knowledge of foraged foods to improve women's economic status (Tieguhong et al, 2012; Leakey, 1999; Shiundu, Oniang'o, 2007; Ayanwale, et al, 2011). They argue that this could have a profound effect on women and other marginalized members of the community who often already partake in foraging and may not have access to income through other means. Creation and promotion of such a market would have to be carefully managed, however, to avoid harming these exact members of the community by damaging pre-existing food systems on which they rely. Researchers Shiundu and Oniang'o (2007), in particular, discuss the potential for takeover of this sector by those with greater social capital (i.e. men) as the value of the industry begins to increase. Further, overexploitation of these resources could cause greater

food insecurity for those who rely on foraging for sustenance. However, given the use and importance of foraged foods in this community and the clear demonstration of their nutritive value seen in previous research, it seems that this could be a potential avenue for further research and policy to explore.

My analysis shows that commercializing foraged foods could be an extremely profitable endeavor for women in our study villages if done correctly. Given the positive association between the sale of foraged foods, nutrition and wealth I believe a commercialization project would have great potential. It's important that any project that intends to exploit wild foods also have a plan of action for increasing access to avoid depleting natural supply and causing a shortage of nutritious foraged foods for consumption. This could be done by simply reserving a particular space to become overgrown with forest. Alternatively, certain species could be planted specifically for the purpose of selling their products. While this second option requires more money and labor, I think it would be the best option as it would allow for the commercialization of only one or a few products which would help mitigate the risk to other foraged foods should something go wrong. Further, ongoing project impact assessments should take place to ensure that the project is achieving its desired goals within the community, not just earning money. Most importantly, local ideas and perspectives should be at the forefront of such a project as the women involved are both the most knowledgeable and the most invested contributors.

Similar projects have already begun in other locations operating on quite a large scale and the evidence is as close as your nearest health foods store. Products ranging from nutritional supplements and drink mixes to shampoos and lotions use ingredients commonly found in the West African Sahel. Most commonly, these products employ shea butter

(produced from the seeds of *Vitellaria paradoxa*) which is used in beauty products, and baobab fruit (*Adansonia digitata*) used for its nutritional benefits and good taste. Given that there is already a market and seeing the extensive list of nutrients contained in Burkina Faso's foraged foods, it seems that similar products could be manufactured for international sale.

Figures 3-5. Various health food and environmentally conscious body care products produced using ingredients commonly foraged in Burkina Faso. From left to right it depicts: Alaffia Baobab Powder which is hand-processed in Togo and advertised as a great source of vitamin C; Powbab, a fruit chew that is capable of satisfying 100% of your daily antioxidant needs and slowing aging and (Powbab, n.d.); Alaffia bath products which contain shea butter as well as several other West African plant products that are also harvested and processed in Togo. These are just some of the products in the extensive market of African-sourced health and beauty products that use foraged plants (History, n.d.). Source: Author.

One company, in particular, that has created an extensive line of products using ingredients sourced from Togo, a neighboring country in West Africa, is Alaffia. The company was started by a former Peace Corps volunteer from rural Washington and a man she met during her two year stay in Togo. They created the company in the hopes of improving lives and livelihoods of rural farmers in Togo while celebrating their appreciation for the natural environment and human health. Alaffia supports Togolese women by purchasing their raw ingredients at or above Fair Trade certified pricing. The raw ingredients are then processed in Olympia, Washington and sold in the United States. Company profits are then put back into community empowerment initiatives focused on a variety of social, economic and environmental issues (History, n.d.).

Based on the information exhibited in this thesis, I suggest that a similar project be undertaken in Burkina Faso, which supports women in a task they already partake in. By selling the products abroad the project would ensure that they claim a higher price than they would were they sold locally. Additionally, following Fair Trade practices and promising to recommit earnings to societal improvement ensures that women and the resources they rely on will not be unfairly exploited. I would also suggest that a processing plant be built in-country to provide jobs and increase the amount of money that could be earned by women in Burkina Faso. A similar tactic was employed by the co-operative start-up Madécasse which works with Malagasy (from Madagascar) farmers to fairly produce chocolate at the source. As they mention, 70% of cacao is grown in Africa, while only 1% of chocolate is manufactured there (Made at the Source, n.d.). They argue that in order for African nations to improve their economies so that they are competitive with those of Western countries, it is important that investment be put into creating African-based manufacturing operations. By following this model, I believe that women's livelihoods could be improved while honoring their knowledge of wild edible plants and bringing worldwide respect to the practice of foraging. To be clear, I am not suggesting a complete commercialization of foraged foods, rather a selective and careful program that utilizes the surge in the health foods market to alleviate some of the economic pressure on rural women while celebrating local knowledge of foraged foods. Unfortunately, such a plan relies on significant economic investment that is difficult for most African farmers to access, meaning the future of such a project relies on foreign investment from those who are interested in working with African farmers to improve their situation.

Shea nuts being roasted over a wood fire to be turned into butter in Yeguere. Source: Author.

Which product or products are appropriate for such a project should be heavily considered. Shea butter is an obvious option as its export already earns Burkina Faso 90-200 million USD and employs nearly 3 million women across West Africa (Chen, 2017). Unfortunately, shea trees take a long time to develop and mature which means that any results from this project would be a long way off. The leaves of *Senna tora* could also be used as they grow much more quickly and contain a plethora of different micronutrients which could be used to market them to those interested in good nutrition. However, this decision should rely mainly on local input as there may be certain products that they do not want to be commercialized.

The government, though weak can also play a role in the promotion and management of foraged foods. Primarily, they should encourage land use strategies that support the growth of foraged foods. Once again, it is important to note that this is not necessarily forest environment (Pouliot and Treue, 2013). Unused agricultural land is more important for foraged food growth and the government can support policy that protects it from land grabbing (large companies cheaply purchasing large tracts of supposedly unowned land) or other destructive practices. This has become a serious issue for many African farmers because the system of land tenure in countries with such newly developed governments can be chaotic. This leaves farmers at risk of losing their tenure if governments are offered a profitable investment in exchange for large swaths of land. This has been reported throughout Africa, notably inciting a coup in Madagascar. While there haven't been any particularly

scandalous cases reported in Burkina Faso, the government should make an effort to prevent it from happening in the future. Even the sale of 'unused' land could have disastrous effects on foraging and nutrition (von Braun & Meinzen-Dick, 2013).

Lastly, more research examining foraged foods should take place, both in this area and in other areas of West Africa to better understand their use. More generally, the nutritional properties of wild foods should be more carefully explored and catalogued so that nutrition issues can be solved using natural, local ingredients. Current literature does have a great deal of information on these properties already, but is particularly lacking in information on various vitamins found in wild foods. Additionally, regional and seasonal differences in nutrient properties could prove useful in planning for better nutrition. Lastly, the creation of a publicly available repository for this data in an easy to understand format would give students, other researchers and the public access to this valuable information inspiring more in depth research on this topic. I also hope that all future research can be done, at the very least in partnership, with local researchers, rather than foreigners. While a foreign perspective can be valuable, and I am incredibly grateful for the experience I've had in collecting and analyzing the data presented in this thesis, I believe that such culturally sensitive research could always benefit from local knowledge and input.

Chapter 4: The Intersection of AGRA, Nutrition and Foraging

Results

One of the improved rice growing areas in Saki, small rice plants can be seen pushing up through the dirt in their organized rows while a bull wanders away from his field after a hard day of plowing. Source: Author.

Quantitative Analyses

To measure project involvement, I used two different variables: percent of rice sold, as a measure of commercialization of rice (an activity promoted by BRICOP) and a project index which shows the number of 'improved' agricultural techniques used by each woman for cultivating her rice field (max=6). Table 9 shows the means for each indicator as well as the number of people included in the analysis because some participants were removed due to lack of rice production. This is notable in the percentage of rice sold as 47 participants had to be excluded due to lack of data. Percentage of rice sold is somewhat low at 35.9%. However,

taking into account the kernel density plot it is clear that there is a bimodal distribution for this variable where most participants sold no rice at all, while another large group sold over 50% suggesting a divide in rice selling tendencies within these communities of women. The fairly wide confidence interval for this mean further indicates this division. The mean project index is nearly four out of a total of six suggesting high participation as measured by the techniques surveyed. No significant differences were found between wealth groups for either the project index or the percent of rice sold. These variables were found to be good indicators of project involvement based on a difference of means test between project participants and non-participants. See appendix D.

		Wealth Level				
		Low	**Medium**	**High**	**Outliers**	**Total**
Project Index	**Mean**	4.00	4.11	4.00	5.50	4.09
	Std. Deviation	1.85	1.37	1.76	0.71	1.59
	N	32	45	10	2	89
% Rice Sold	**Mean**	36.00%	35.00%	33.00%	67.00%	35.00%
	Std. Deviation	28.00%	30.00%	38.30%	N/A	30.40%
	N	31	50	14	1	96

Table 9. Mean values for indicators of project involvement and commercialization by wealth group along with corresponding standard deviation values and population sizes (N).

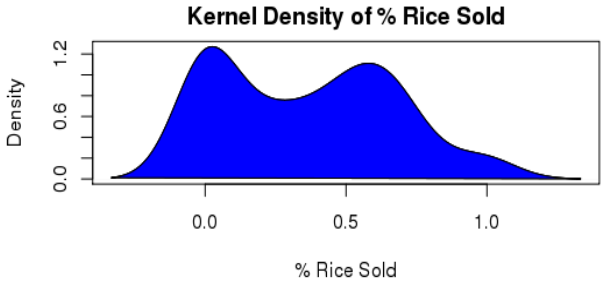

Figure 3. The proportion of the population having sold a certain proportion of their rice. A bimodal distribution is clearly visible where most participants sell 0% of rice, while another significant group sells >50%

In order to explain the trends of nutritional outcomes, I used individual linear regression analysis for foraging and project involvement indicators. Unfortunately, it was not possible to use multilinear regression as the project indicators were too highly correlated with

one another for this to be feasible. Linear regressions were used to calculate the relationships for food insecurity because the index had an extensive range (0-120) where higher scores indicate greater food insecurity. Results are displayed below in Table 10 and show that relationships vary between food insecurity and HHDD.

For food insecurity there is a significant negative relationship with the level of project involvement gauged by the project index. This means that as project involvement increases by one point (based on the construction of the index this would mean with each additional agricultural activity promoted by BRICOP), food insecurity decreases by about 3.5. This is not an extremely large change given that food insecurity is measured on a scale that ranges from 0-120, so a difference of 3.5 is somewhat small relative to this measurement. However, this result still indicates that participation in the activities that BRICOP aims to encourage is associated with improved food security. Because the surveys took place in July and early August, this time period corresponds to the hungry season for this region when farmers are planting crops and awaiting harvests which adds to the importance of this result. This suggests that if participation in BRICOP's project is causing improved nutritional outcomes, this improvement lasts through the hungry season.

For HHDD the pattern is somewhat different. No significant relationships were found between project involvement and HHDD. While this does not indicate that the project is improving dietary diversity in this population, it also does not mean that it is harming dietary diversity. Rather, project involvement and agricultural commercialization simply have no impact on the diversity of farmer's diets as measured by this study. Further, the relationship between the number of foraged foods collected and HHDD goes away when the project index and wealth are both factored in suggesting that other variables may play a role in determining

HHDD than foraging.

	Food Insecurity			Household Dietary Diversity		
	Coefficient	**Sig.**	**R Squared**	**Coefficient**	**Sig.**	**R Squared**
Project Index	-3.711*	0.09	0.13	0.001	0.955	0.06
# FFs Collected	-3.528*	0.06		0.096	0.364	

Table 10. Regression results explaining the relationship between nutrition indicators, foraging and measures of project involvement while correcting for wealth.

An independent difference of means test was also used to understand how foraging and nutrition outcomes are different based on project participation. In table 11 means are shown for each of the foraging and nutrition variables for participants and non-participants of BRICOP's project with significance values. You can see that there are no significant differences in means for any variable other than the number of foraged foods sold. In this case project participants, on average, sell fewer of their foraged foods than do non-participants. However, after closer examination of the data, it is likely that this is due more to geographical differences between villages than influence from the project. This will be discussed more thoroughly in a later section on the role of geography in foraging practices, but in sum one of the non-project villages seems to have greater access to a market making sale of foraged foods more accessible and skewing the mean for the non-participant group.

	# FFs		Frequency		# FFs Sold		HHDD		FS Index	
	P	**NP**	**P**	**NP**	**P**	**NP**	**P**	**NP**	**P**	**NP**
Mean	5.7	5.5	22.7	23.4	1.5*	2.6*	6.3	6.8	38.12	42.37
P-value		0.4		0.7		0.002		0.06		0.4

Table 11. Results of the mean difference tests done based on project status dichotomized as in the project (P) and not in the project (NP). Means for each variable are given by project status and the significance as indicated by the p-value is shown with a * for p<0.05.

Finally, linear and ordinal regressions were also used to explain the effect of the project on foraging practices. Linear regression was used only for the frequency of foraged food consumption because it had a greater range than the two other variables. The results of

these regressions are in line with what the mean difference tests showed as well. No significant relationships were found between any of the variables except for the number of foraged foods sold and the project index and percent of rice sold. Here, we see negative relationships, though fairly weak in the case of the project index, which means as project involvement increases fewer foraged foods are sold. While it is possible that the project has some influence on farmer's decision to sell their foraged foods, it is more likely that the same difference in village geography is at work here because of the one non-project village where foraged foods are sold far more than in any other village.

	#FFs Collected		Frequency of FF Consumption				# FFs Sold	
	Estimate	**Sig.**	**Coefficient**	**Sig.**	**R**	**R Squared**	**Estimate**	**Sig.**
Project Index	0.098	0.279	0.521	0.301	0.09	0.008	-0.343*	0.000
% Rice Sold	0.431	0.215	1.46	0.436	0.095	0.009	-1.056*	0.004

Table 12. Regression results explaining the relationship between foraging practices and level of project involvement and commercialization. Linear regression was used to calculate the relationship for the frequency of foraged food consumption while ordinal regression was used for the number of foraged foods sold and collected. *is used to show significance where p<0.05.

Overall, these results mostly align with my predictions based on the previous literature surrounding agriculture, nutrition and foraging. The project seems to be exerting little influence on nutrition or foraging outcomes, though there is one relationship that indicates participation in the project could improve food security. Additionally, foraging appears to improve both food security and household dietary diversity. However, it is the number of foraged foods collected year round, not the frequency of consumption that appeared to have the greatest effect on both nutritional outcomes. Project participation does not seem to be impacting foraging practices, with the questionable exception of the number of foraged foods sold, which is more likely due to geography. To see exact figures which exclude our outlier village (Siniena) that is causing these associations, see Appendix F.

Qualitative Analyses

Over the course of our research period we performed several informational interviews with BRICOP officials and affiliates, as well as village leaders to better understand how BRICOP functioned on a structural level. However, some of the most relevant information also came out during our structured interviews as many participants hoped we would be able to relay their messages back to BRICOP. No matter who we talked to, we seemed to get roughly the same message: the project was not going as planned.

In the villages many participants were frustrated with the quality of the parcels they had received. Nearly one third of project participants (largely coming from Medina Coura and Yeguere) were producing fewer than two sacks of rice per year, far less than would be expected, particularly if participating in a project designed to increase rice production. In Medina Coura participants brought up concerns they had with the way in which the land had been improved, saying it had been poorly done and resulted in recurrent flooding in certain areas of the seasonal wetlands causing their rice to be destroyed. This also seemed to allow hippos from a nearby reserve to access the fields and destroy the crop long before harvest. In Yeguere there seemed to be the opposite problem with many people grappling with drought. These women did not attribute this to bad weather, as these were problems only faced by a subset of the group, while others had no problems with water, hippos or otherwise. We attempted to ascertain who these particular women were and understand why they received such poor producing parcels, but everyone seemed to have a different explanation. In our discussions with BRICOP itself, it was apparent that they already knew about these issues, but did not have the ability to address them, whether this was due to finances or plausibility

was unclear.

Even for those who were producing significant amounts of rice in their BRICOP parcels, participation in all of the project's agricultural and commercial activities was not a priority. This came both from participants and BRICOP. This was particularly true in Saki where people felt that the new agricultural technologies and market place were unnecessary. The BRICOP officials corroborated this story and expressed some frustration with trying to convince people to change their ways. They seemed to feel that this was hindering participant's success in rice production, though Saki had the fewest number of participants with fewer than two sacks of rice. BRICOP was much more pleased with the rates of adoption seen in Medina Coura and Yeguere. Additionally, according to official BRICOP materials they promote the use of SRI. However, this does not appear to be happening at any level. BRICOP does not seem to actually be training farmers to use these methods outside of promotional billboards in each village explaining (in writing) how to use SRI. Unfortunately, this is not particularly useful for a larger illiterate population. Further, project participants never mentioned using SRI methods or having been trained to do so, further showing that BRICOP is much different on paper than in practice.

Still, across all villages, the use of BRICOP's market to sell rice was quite low. Some women explained that this was due to a lack of trust in the project's ability to return the profit they promised, but also because it could result in delayed payment. This, in particular, works counter to the way that women tend to sell their crops. Participants explained that they preferred to sell small quantities of their surplus grains in order to pay for agricultural inputs, school fees or medicine. Thus, it was important for them that they could have flexibility in when they sell their crops and an immediate reimbursement. BRICOP seemed to be trying to

improve some of the logistics of their market program, but again expressed frustration that people were not participating in the way they had hoped.

Finally, according to preliminary results from my fellow undergraduate researcher Millie Varley, women seem to have particular difficulty accessing agricultural inputs. While BRICOP does have its own market through which they are able to sell supplies such as fertilizer and improved seeds, given this result it seems female farmers would have a more difficult time finding the funds with which to purchase them as BRICOP does nothing to address gender differences in this respect. This means that women are just as marginalized within this marketplace as they would be in all others giving them no real benefit to participate in BRICOP's project if they are unable to buy the supplies needed.

Professor William Moseley lounging next to BRICOP's supply of fertilizer. Source: Author.

Discussion

Integral to the framework of Feminist Political Ecology is the identification of winners and losers in contentious situations. As discussed in the review of the literature, BRICOP and other projects working under AGRA and the GR4A are very controversial and many question their motives and the outcomes they produce. Several examples have indicated that market-focused agricultural projects can, indeed, have detrimental impacts on nutrition despite their goals for the opposite (Anderman, 2014; Berti, 2004; Longhurst, 1988). Thus, I seek to integrate my qualitative and quantitative data to help us understand

what is truly going on in BRICOP villages, who is benefitting from their work and who is not.

The result indicating that increased participation in BRICOP's project is associated with improved food security shows that project participation may be having a positive effect on nutrition. However, it is only marginally so and other factors, particularly foraging and wealth have stronger associations with nutritional outcomes. Still, it is important that BRICOP is not having a negative impact on nutrition or foraging as I had originally predicted at the outset of the study based on previous studies (Broegaard et al, 2017; Tucker et al, 2010). This means that the female project participants in our study, as a group, may be benefitting from participation in the project in terms of being able to produce and/or purchase greater quantities of food, though this food may not be more diverse, as there was no association with HHDD.

Considering the significant limitations in project success described previously which have been expressed both by participating women and BRICOP officials, it is understandable that the project has had such a limited impact on nutrition and no impact on foraging practices of participating women. If women are marginalized within the project due to poorly producing plots or an inability to purchase inputs, it is unlikely that they would then devote additional time to their rice production that could otherwise be used to supply their families with nutritious foods from foraging. Further this shows the resiliency of foraging practices in the face of agricultural commercialization. Everywhere we went people were excited to talk about foraging, rather than ashamed and many people in our daily lives, who were not struggling with food insecurity, also spoke to the cultural importance and appreciation of foraged foods. Foraging simply plays too important of a role in women's lives and household

diets to be impacted by a project like BRICOP's.

The lack of impact on foraging may also be because important trees used for foraging do not grow in the seasonal wetlands used for rice cultivation. Thus, rice might be unique in this relationship to foraging. Other crops may have more of an impact on foraging practices if their intensification interferes with agroforestry practices that provide important foraged foods.

Given previous findings on the potential hazards of agricultural commodification on nutrition, I do have some concerns about continuation of this project. First, BRICOP makes no clear attempt to support women's participation in their project. While they are permitted to be in the project, it seems that men still control most of the resources in this setting. Additionally, they don't pair their agricultural efforts with nutritional education or other social investments that could have a synergistic effect to improve nutrition along with improved production methods. These are all points mentioned in previous research that were associated with better nutritional outcomes for commercial agriculture projects in similar settings (Dewalt, 1993; Longhurst, 1988; Berti et al, 2004; Anderman, 2014)

Future research should continue to address the relationship between commercialization, nutrition and foraging in this region, particularly as green revolution projects continue to spread and intensify across the continent. It is important to assess how these situations change over time as rural communities become increasingly linked to regional and global markets that they did not have access to in the past. Further, examining how different crops result in different community impacts is important for understanding the nuances of each food system as the results found in this study may only be applicable to rice. Quantifiable data on the change in nutrition and foraging indicators is imperative to

understanding how these food systems are changing. The use of food loans and gifts (particularly among Muslim communities where this is common) should also be researched to understand whether commercialization has an impact on their use as well. This is especially important for understanding the situations of the poorest members of society.

Participatory research should also take place to address the needs and concerns of individuals in these communities especially considering the amount of frustration many participants expressed towards BRICOP's management. BRICOP has a responsibility to these communities to help them in the way that participants see fit and adjust the problems in the implementation of their project. Projects and researchers should use their influence to magnify the voices of the rural poor so that they can receive help for problems they find important in ways that fit with their current social, economic and environmental situation, of which they are the most knowledgeable about. Ignoring their voices is likely only to result in uninformed and useless interventions.

Chapter 5: Foraging and Society: Who does and who doesn't

Results

The population in this study represented women of multiple ethnicities and religions, however more women identified as Mossi (49.0%) than any other ethnicity. The vast majority were also Muslim (86.2%). Most women were married (91.7%), polygamous (72.9%) and had children (96.6%, mean number of children=4.9, SD=2.3). As seen below in Table 13, this community largely represented middle aged women who have multiple children and reside in large households. This indicates that a typical family in this study requires a significant amount of food and income in order to feed all members of the household. Mean household wealth was equivalent to $3223 in USD. While this is fairly little in a Western context, this is what one would expect to see in this population (USAID, 2010). Lastly, women reported cultivating an average of nearly two hectares indicating reasonable access to land. However, it should be noted that most women did not own their parcels meaning that while women do have some land rights, they are fairly tenuous and linked to relationships with male family members or others in the community.

Family Stat	%	Ethnicity	%	Religion	%	Demographic	Mean
Project	51.0%	**Mossi**	49.0%	**Muslim**	86.2%	**Age (years)**	39.6
Married	91.7%	**Dioula**	11.7%	**Christian**	8.3%	**# Children**	4.9
Polygamous	72.9%	**Gouen**	15.9%	**Animist**	5.5%	**HH Total**	15.9
Children	96.6%	**Toussian**	8.3%			**HH Wealth**	1800521
		Other	15.2%			**Land (ha)**	1.8

Table 13. Population characteristics by indicating the percentage of the population represented within a particular category of marital status, religion, ethnicity. Additionally, means are shown to give an understanding of overall population age, family size and wealth.

Geography of Foraging

Availability and culture are two of the most important influences on the extent of

foraging practices. Availability defines whether or not a population has access to the foraged products, if the plant or animal is not available within a reasonable distance of where people live, obviously they will not collect it. Culture defines what is acceptable to eat. In cases where a particular product is available, it still may not be appropriate to eat due to certain cultural norms or taboos. In our case study, both of these are heavily impacted by the geographical location of participants. This means that foraging practices are likely to differ greatly by village because the social and natural environments in each location can determine the availability and cultural acceptability of foraging. Further, the infrastructure surrounding each village is quite different which can impact whether or not foraged foods are sold or consumed. In this section we will explore the differences we see in foraging practices between villages and why this might be occurring. First, I will give a brief description of the geographical location of each village and how this could impact the collection, consumption and sale of foraged foods. This will be followed by the statistical differences in foraging practices found between the villages.

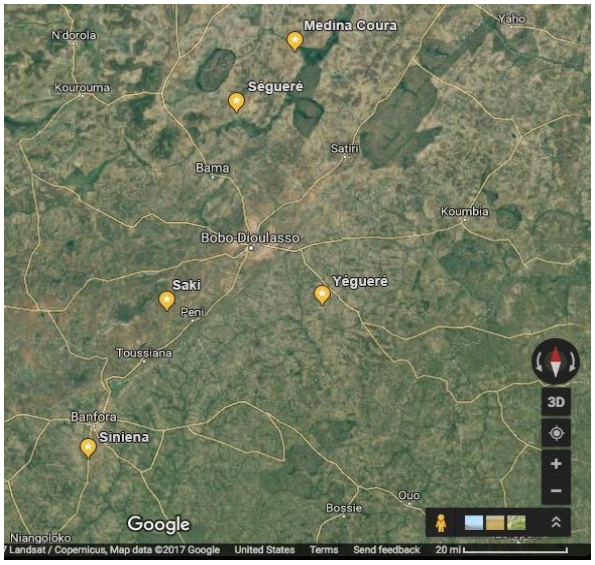

Figure 6. Map of the study region with participating villages, large cities nearby and major roads. Source: Google Maps.

Medina Coura (in project)

As the map above shows, Medina Coura is the village farthest to the North and farthest from any major city or road. It is located along a dirt road that is the only major road for four-wheeled vehicles that goes through the region. It also is located near to the Mouhoun River and hippo reserve which is a notably darker green spot just to the West of the village center. These two features have both caused notable issues for agricultural production in recent years. While villagers are allowed to enter the hippo reserve, they are not permitted to harm the hippos or other wildlife. Outside of the reserve most of the area is occupied by agricultural land and clear of forest. Some survey participants mentioned a forest in which they could access several edible wild plants but commented that it was too far to walk on a regular basis. However, many smaller plants and large tree species commonly used in agroforestry were visible in and around agricultural fields. House compounds were fairly dispersed, but mostly located along the large dirt road, with the center of the village revolving around the chief's house. There were also a couple of small businesses located nearby that sold prepared food and beverages. While our research team did not visit the nearest market that most farmers attended, we were told that it was further West along the main road. Presumably, this market serves other similar villages that subsist largely on agricultural production and foraging as well.

This Northern region is unique because it was previously infested with tsetse flies which rendered it uninhabitable as they transmitted trypanosomiasis (sleeping sickness) to humans and livestock. In the late 20th century, however, sleeping sickness was eradicated here due to a campaign of pesticide use that killed the tsetse fly vector. This also coincided with significant environmental changes in the region that reduced the amount of forested area

which also helped to eliminate tsetse flies. The opening of this land for agricultural use coincided with the migration of Mossi populations from the central plateau during a drought that occurred in the late 1970-80s (Sow, et al, 2010). Unlike Southern areas which were already inhabited with other ethnicities, the Mossi were able to become the dominant ethnicity in this area making it a fairly ethnically homogeneous village. Not only does this change the cultural environment of the area, but the extensive pesticide use targeted against tsetse flies may also have impacted the natural environment. Certain plant and insect species were not listed in this area, most notably, *Hibiscus asper* and *Cirina butyrospermi*. It is unclear, however, whether this is due to cultural differences between Northern villages and Southern villages, or if this is the result of tsetse fly eradication.

Seguere (not in project)

In terms of ethnicity and tsetse fly eradication Seguere is very similar to Medina Coura. Seguere is also in a very similar environment located near to the Mouhoun River with the exception of the hippo reserve. It also seemed that farmers in Seguere were closer to forest environments in which they could find wild fruits. There also appeared to be a slightly larger local economy with a more centralized market within village boundaries and more businesses offering food and drink, particularly on market days. There was also a nearby health center which may have brought more people to this area. Additionally, Seguere is much closer to the main paved road leading from Bobo-Dioulasso and is somewhat close to the large town of Bama. However, the compounds around Seguere were very spread out, though also mostly located directly along the main dirt road. The same edible species that were lacking in Medina Coura were also lacking in Seguere. Despite this, there seemed to be reasonable access to foraged foods in Seguere.

Saki (in project)

Of all of the villages Saki seemed to have the most forested landscape within a reasonable walking distance. Driving the few kilometers from the main road to the village we passed through large areas of natural landscape with a noticeable abundance of biodiversity. This suggests that access to edible wild foods was fairly easy for inhabitants of Saki. Unlike the villages to the north, Saki was not near to any natural body of water which was mentioned by some of its inhabitants as a source of concern. Ethnically, Saki is fairly heterogeneous containing a mix of Bobo, Dioula and Toussian ethnicities, all who are original inhabitants of the land. It was difficult to pinpoint the village center, and most house compounds were at least half a kilometer from one another. The main gathering point seemed to be in Péni, a larger town that stood along the main road where a market was held every five days that most women attended on a semi-regular basis. This is where we usually did interviews as it was the spot where we were most likely to encounter a large population of women from Saki, indicating its importance to village culture. Péni is just over 32km from Bobo-Dioulasso and lies on the route that many buses take from the city of Banfora, which is the other major city in Southern Burkina Faso. Buses and taxis could often be seen stopping at this market to purchase food and drink giving farmers from Saki access to an urban dwelling market population.

A woman from Saki prepares balls of *soumbala* to be sold in the market in Peni. Source: Author.

Siniena (not in project)

Siniena was the only village in our study that stood directly along the main paved

road. The difference was clear in the layout of the village as almost all buildings stood close to the road. Some people also owned shops or small restaurants which had customers due to the traffic coming through. A market was also held here, similarly to the one in Péni with significant access to the population in nearby Banfora which lies only 13 kilometers to the north. Siniena is also fairly close to the border with Côte d'Ivoire, only 56 kilometers, or an hour driving. Many participants mentioned having close family members working in Côte d'Ivoire who sent back remittances. As a result, town infrastructure seemed to much more developed than the other villages with some houses having cement walls or floors and many having access to electricity. There was even a large covered meeting space in the center of the village where people would be called to meet for various events. None of these amenities were seen in our other study villages.

Siniena seemed to have good access to forested areas containing a mix of wild food plants. However, we spent the least amount of time in this village because our research assistant was able to do many of the surveys on her own, thus, my observations are fairly limited in this regard. Siniena is also a majority Gouen village, another ethnicity native to Southern Burkina Faso and Côte d'Ivoire. There was also a far greater number of people who identified as animist in Siniena, which was a stark contrast from the other villages that were largely Muslim. In general, I got the impression that Siniena is culturally and economically different from the other four villages in our study, though it is still located within a similar natural environment with access to the same flora and fauna. Cultural and economic differences however, may alter how foraged foods are used, while access to them remains comparable to our other study locations.

Yeguere (in project)

Yeguere was added to our study during the second phase while doing nutrition and foraging surveys, unlike the other villages that had completed the base survey a year before. However, we still spent a significant amount of time conducting interviews there which allowed me to observe the general culture, economic and natural environment. Yeguere appeared to have a very well-developed town center with several businesses. They also had a school and were in the midst of constructing a new cement mosque. Weekly markets took place in the village center. While not far from a main paved road, approximately three miles, there was little outside traffic through Yeguere itself or the village on the main road because it did not lie between two major cities. House compounds spread out around the center and agricultural fields surrounded them. Large trees used in agroforestry and small edible plants could be seen on the edges of fields, however participants said that forest areas were very far away. While they mentioned visiting them to access different resources including edible wild foods, they said it was an activity that took a significant amount of time. However, they could not estimate the distance.

This was the only village in our study with a mix of late-comer and original land owners. This split was mostly defined by ethnicity where Mossi were the late-comers, while Dioula and Bobo were there originally. Land access and overall well-being seemed to differ along these lines where late-comers had less access which seemed to negatively impact their economic success. Because many Mossi late-comers did not own land, but rented it or received it as a gift, they were not granted access to the trees that grew on their field without additional payment. This eliminated important species such as *Parkia biglobosa, Adansonia digitata* and *Vitellaria paradoxa* from the foraged foods freely available to them. While Yeguere, on average, seems comparable to the other villages in most respects, the differences

in land access based on ethnicity seemed to put Mossi inhabitants in Yeguere at a disadvantage economically and nutritionally.

Statistical Analysis of Geography and Foraging

Using ANOVA, I identified between group differences in the mean foraging index and further investigated these differences using the Tukey HSD post-hoc analysis. This showed differences were present only between Medina Coura and Saki and Medina Coura and Yeguere. In both cases, Medina Coura had a lower mean foraging index indicating that its population, on average, collects the fewest number of foraged foods as compared to the two other villages. Unfortunately, it is unclear why these differences are present. While Medina Coura is geographically and demographically different from both Saki and Yeguere, nearby Seguere is nearly identical to Medina Coura (with the exception of project presence), yet no differences were found for Seguere. This indicates that project interference or another factor specific to Medina Coura could be influencing the foraging practices of its inhabitants. However, both Yeguere and Saki are project villages, and they show higher mean number of foraged foods. This indicates that something unrecorded by this study could be responsible for the difference we see here.

For the frequency of foraged food consumption, there were fewer differences based on village with the only difference being between Medina Coura and Saki where Medina Coura's mean was smaller than Saki's. This would be expected as the frequency of foraged food consumption and the number of foods foraged are highly correlated ($\rho = 0.789$, $p < 0.0001$) and a similar difference was found for the mean number of foraged foods. Thus, similar reasoning can help us to understand why we see this difference. Availability could be one difference as these two villages are in slightly different environments. However, we

would then expect to see a difference between other villages which also lie in a variety of environments. It seems that this difference is due to some unknown characteristic that could be linked to the specific customs found in each village.

There were several differences in the mean number of foraged foods sold found between villages. Most notably Saki and Siniena stood out from all other villages as having higher means number of foraged foods sold with Siniena differing the most from all other villages. This could stem from a variety of environmental and cultural factors, but most clearly appears to be a product of geography. Both Saki and Siniena are closer than any other of the villages to large cities and paved roads. They also have more access to an urban market population as Siniena is near to a provincial capital city, while Saki's main market lies on a main road between two large villages. This gives them distinct access to markets making it easier to sell their foraged goods than it would be for those living in other villages. Further, because of their proximity to urban areas there may be greater demand in these markets for foraged goods as the ability to forage in an urban landscape is significantly diminished.

The differences described above are shown using post-hoc subset analysis in the table below. Here, means for each foraging variable are placed into subsets based on which means are the most statistically different from one another. There is some overlap in groupings, for example Seguere, Siniena and Yeguere are in both group 1 & 2 for their mean number foraged foods collected. This shows that the mean values for these villages are not significantly different from any of the other villages. However, those villages that are not in the same group are significantly different from one another, in the case of mean number of foraged foods collected it is only Medina Coura and Saki that are the most different from one another. Means by village for other variables are shown in Appendix G.

	Mean #FFs Collected			Mean #FFs Consumed			Mean # FFs Sold		
	Subsets:			Subsets:			Subsets:		
Village	**1**	**2**	**Village**	**1**	**2**	**Village**	**1**	**2**	**3**
Medina Coura	4.81		**Medina Coura**	18.86		**Medina Coura**	0.86		
Seguere	5.42	5.42	**Siniena**	22.72	22.72	**Yeguere**	1.3		
Siniena	5.46	5.46	**Yeguere**	22.95	22.95	**Seguere**	1.53	1.53	
Yeguere	5.93	5.93	**Seguere**	24.76	24.76	**Saki**		2.58	
Saki		6.65	**Saki**		27.92	**Siniena**			4.71

Table 14. Shows post-hoc subset analysis based off of results from ANOVA and Tukey-HSD for the three foraging variables. Differences are shown by village. Placement in a different subset indicates statistically significant difference in means.

Sociodemographic Differences in Foraging

The only other significant relationship found for the number of foraged foods collected was by ethnicity. Those who identified as Mossi had a significantly smaller mean value for the foraging index ($\bar{x}$ = 5.08) compared to those who were not Mossi ($\bar{x}$ = 6.16). This is unsurprising as Medina Coura is a largely Mossi village and, thus, could be pulling the mean down for the whole group. However, Yeguere and Seguere both have large Mossi populations and do not have significantly smaller foraging index means. It is also possible that many Mossi participants in Yeguere did not have the same access to plants (most notably large trees) from which they could forage food due to their late-comer status in the region as many Mossi families migrated to the Southwest after severe droughts in the later 20th century.

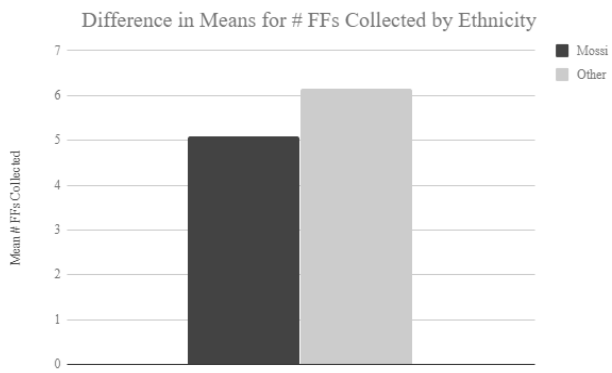

Figure 7. Represents the mean values for the number of foraged foods collected by the ethnic groups of Mossi and "other" ethnicities. These means were found to be statistically different using an independent difference of means test, showing that those who identify as Mossi have a smaller mean number of foraged foods collected.

No other significant relationships were found between the number of foraged foods collected and any other demographic variable. This includes age, marital status (married/unmarried, polygamous/monogamous and number of wives), number of children, household size, wealth, total hectares of land cultivated, religion and age (of interviewee). These results indicate foraging practices are fairly uniform over several different factors within these communities. However, the relationship found for the total hectares of land cultivated was nearly significant ($p = 0.052$) showing a possible association. This relationship should be investigated further to determine whether it is significant or a random association. To see these results in more detail, see appendix H. From these results we see that the main differences appear to be largely related to location (geography, see previous section) and land access (due to different levels of access based on ethnicity see village descriptions) indicating that the main barrier to foraging may actually be whether or not the products are available, rather than any other socioeconomic barrier.

Using a linear regression (results shown in Table 15) I found that there was also a significant positive relationship between the frequency of foraged food consumption and both the hectares of land cultivated and total household wealth. This result is rather

surprising because previous research would have us understand that foraging is most important for those who are poor and without land and must rely on foraging as their only source of food. However, this shows that greater wealth and greater land area cultivated are associated with a slightly higher frequency of consuming foraged foods meaning foraged foods may not necessarily be a coping strategy for this population, but a staple consumed regularly in most households. This also points to land access being a key component to the frequency of foraged food consumption. The two products consumed most frequently, shea butter and *soumbala* (fermented African locust beans), are products of large trees that one must own in order to have foraging rights. Without land ownership and/or wealth it is probably difficult for households to forage these products directly and consume their products frequently as they cannot access the trees. This helps to explain why we would see the relationship only for the frequency of foraged food consumption and not for the overall number of foraged foods collected, because people may still be foraging these products, just not in the same capacity that wealthier, land-owning families are able to.

Frequency of Foraged Food Consumption		
	Adj. R Squared	**Significance**
Total	0.056	0.036
Variable	**Coefficient**	**Significance**
Age	-0.006	0.936
HH Total	-0.097	0.334
# of Children	0.132	0.759
HH Wealth	1.453*	0.033
Ha. Land Cultivated	1.477*	0.013

Table 15. Shows multilinear regression results assessing the impact of socioeconomic variables on the frequency of foraged food consumption. The adjusted R^2 value representing the entire model is given, as well as the significance of the entire model. While the R^2 value is relatively small, the model is shown to be significant based on a p-value<0.05.

	Frequency of FF Consumption	
	Mossi	**Other**
Mean	20.63	25.33
Significance		0.003

Table 16. Represents the mean difference test showing a statistically significant difference in mean frequency of foraged food consumption based on ethnicity.

	Frequency of FF Consumption	
	Two Wives	**Three Wives**
Mean	25.633	19.397
Significance		0.020

Table 17. Gives the means for frequency of foraged food consumption by number of wives in the household. These means were found to be statistically significantly different.

There was also a statistically significant difference in mean frequency of foraged food consumption found between households with two wives and households with a difference of 6.2 with two wife households having greater frequency of consumption. This could be related to greater competition within the household. Assuming two and three wife households have similar access to foraging areas, three wife households would have to split the food with a greater number of people limiting their consumption. Finally, there was a difference in means found by ethnicity once again. As mentioned before frequency of foraged food consumption and number of foraged foods collected are highly correlated, thus this difference could be expected given the finding for the number of foraged foods collected and is likely due to the same causes discussed above. No other relationships were found to be significant.

Ordinal regression results showed a significant positive relationship between the number of foraged foods sold and household wealth. The number of foraged foods sold was the dependent variable in this regression model, a significant positive relationship was also found when using wealth as the dependent variable indicating the relationship could be

caused by either variable. In other words, household wealth could be greater as a result of selling more foraged foods, and/or, wealthier households may have a greater ability to collect and sell foraged foods. A significant negative relationship was found between the number of foraged foods sold and the number of children in the household. This could be due to greater need for consuming foraged foods within families with more children, thus fewer foods are sold. Additionally, having more children in the family could put greater constraints on time limiting how frequently the mothers can go to the market to sell foraged foods.

Number of Foraged Foods Sold		
Variable	**Coefficient**	**Significance**
Age	0.02	0.169
HH Total	-0.02	0.279
# of Children	-0.179	0.027
HH Wealth	0.351	0.01
Ha. Land Cultivated	0.118	0.275

Table 18. Shows ordinal regression results assessing the impact of multiple socioeconomic variables on the number of foraged foods sold.

	Number of Foraged Foods Sold	
	Mossi	**Other**
Mean	1.07	2.92
Significance		<0.001

Table 19. Gives the mean values of the number of foraged foods sold separated by ethnicity. The difference in these means was shown to be significant.

		Mean # FFs Sold	
	Population	**Subset 1**	**Subset 2**
Muslim	125	1.72	
Christian	12		3.33
Animist	8		4.63

Table 20. Represents the homogeneous subsets of the mean number of foraged foods sold by religion based on Tukey's HSD post-hoc analysis. This shows that the mean for the Muslim population is significantly different from those of the Christian and Animist populations. Population sizes are also given for each religion as the differences between the populations limit the statistical power of this test.

Once again, a significant difference in mean number of foraged foods sold was found between ethnicities where Mossi ethnicity had a significantly smaller mean than other ethnicities. This follows the other foraging indices, but also aligns with the finding that Siniena and Saki both have higher mean number of foraged foods sold as they both have very small Mossi populations. Thus, this difference may be, in truth, more related to geography than ethnicity. This is also likely to be true for the difference found by religion where Muslim households were found to have a lower mean number of foraged foods sold than Christian or animist households. Siniena contained the majority of non-Muslim households and thus this difference likely is more related to the village in which non-Muslim participants reside, than an effect of the religion itself. Additionally, the non-Muslim population is quite small thereby reducing the statistical power of these results. All other variables (age, marital status, etc.) were found to have no significant relationship with the number of foraged foods sold.

Discussion

In order to address vulnerability within this population, as outlined by Watts and Bohle as an integral piece of political ecology, I analyzed intra-community differences in foraging to identify groups that may have more difficulty accessing foraged foods (Watts & Bohle, 1993). In terms of foraging, most of the farmers in our study seem to be benefitting from the nutritional bounty at their disposal. The greatest influence in this respect is geography and land access, so those who happen to live in areas devoid of important edible species, such as the Northern villages are at risk of poorer nutritional outcomes. Further, those who do not have sufficient access to land containing productive trees face the same risk. This is particularly concerning because those with limited access to agricultural land are

also more likely to be producing smaller crop outputs meaning their income is probably much smaller and incapable of making up for the foraged foods they are unable to access. Furthermore, it seems that this difference falls on ethnic boundaries. This is, in part, due to geography because the Northern villages that have more limited access overall are also majority Mossi. But in the case of Yeguere where overall access seems good, Mossi late-comers seem to have little access to trees from which they can forage free of charge.

In Yeguere, where there are a large number of late-comers, land access can be stretched too thin leaving some without adequate access to foraging species. While most do have some access to land that is rented from original inhabitants of the villages, they do not have the right to harvest any products from trees that exist on this land which are often a large source of foraged foods. This means they must either purchase these products in the market or pay to access the tree's products which ultimately takes away from the benefit of foraging. On the other hand, some households have the rights to access these trees, but not the labor-power necessary to gather them. This is particularly true of families with very young children or children who have moved away and the adults are incapable of scaling large trees to collect fruits and leaves. While age had no significant relationship to foraging practices, some older individuals mentioned having difficulty foraging because they were no longer in good enough health. This is particularly true for products that must be collected from large trees or for which women must walk a long distance to find. On the other hand, older women in these communities have a vast amount of social capital and could probably ask others to help with the foraging if needed. Understanding these inequalities is important moving forward as those who do not have access are often already poor and may be nutrient deficient.

Other results concerning the number of wives in a household showed that intra-household competition may reduce the frequency of foraged food consumption. I believe this could be related to similar results found for the amount of land cultivated because land holdings and the foraged trees that grow on them must be divided up based on family size. In terms of how this factors into addressing access to foraged foods, it shows that plans should not focus solely on households as homogeneous units, but look at household composition before allocating resources.

These results can help to inform future projects about ways to improve access to foraged foods and who to target in this process. Most notably, the Mossi late-comer population seems to be the most easily identifiable population that has limited access. Projects should focus on ensuring that their land access is improved which could potentially be done by providing an area of fallow fields that all members of the community have equal access to. Ideally, women who already have access to large tree species on their land would not rely on this area as heavily as those who do not. Additionally, seedlings could be distributed to those who need them, though most trees take a long time before they start producing their edible products.

Projects can also focus on improving access for entire populations, particularly for villages with limited access to forested areas. Reforestation could be used to bring some products closer to the homes of farmers, though this may conflict with agricultural land. Additionally, in areas where certain species are lacking, such as in the Northern villages where the edible caterpillar, *Cirina butyrospermi*, did not live, research and projects could be undertaken to better understand why this is and how to repopulate the area. Finally, while agroforestry already appears to be commonly practiced here (Gausset et al, 2005; Lamien et

al, 1996), providing tools and best practice methods to those who wish to participate could make it easier and more successful.

Future research should focus on the differences in access to foraged foods as a way to predict dietary diversity. The associations and differences in foraging practices discussed above can be a useful guide for who may be at risk for malnutrition, but more importantly they provide a starting place for researchers to investigate more of the nuances within these relationships. They could also be useful in designing future studies in other regions that have similar characteristics. More specific to this region, it is important that research focus on how land access, ethnicity and late-comer status interact with foraging. Such research could prove useful in finding solutions for late-comer families who are at a disadvantage when it comes to foraging and avoiding malnutrition

Chapter 6: Strengths and Limitations

This is one of the first studies to examine these issues in the West African context and provides much needed quantitative and qualitative data on the interactions of imposed commercialization projects on existing food systems and nutrition with particular attention paid to foraging. Additionally, the study analyses a heterogeneous sample representing over five ethnicities, three religions, five villages and a variety of wealth categories. This allows the results to be fairly generalizable to the greater rural population of Southwestern Burkina Faso. Lastly, I played a large role in collecting the data analyzed in this study giving me particular insight into nuances in responses and access to the qualitative data which provides greater context to the quantitative data. Simple observation such as body language, tone and demeanor significantly aided my understanding of these data and allow me to better understand the context about which I am writing. Most importantly, connecting with the communities in person gave me a great appreciation and care for the people with whom we worked adding to my motivation to produce a quality and representative analysis of their situation with the hope that it will encourage steps to be taken in order to improve their situation.

Though this study offers important insight into the nutrition-foraging-commercialization relationship, several limitations alter both the internal and external validity of its results. I will begin by discussing internal validity related to issues in the collection and interpretation of data. Firstly, samples were chosen through communication with local leaders and may not reflect true population diversity depending on the perspective leaders were hoping (intentionally or unintentionally) to give us into their community. The role of the leaders we worked with also varied in each village, thus the potential biases in sample populations may differ by village.

The variables collected may also have issues with bias and validity. For example, the main variables used in the study were proxies for the larger concepts of nutrition, foraging and project involvement that cannot be captured with a single all-encompassing measure. While nutrition indicators were taken using standardized surveys that have shown to be effective at measuring adequate nutrition in this country (Savy, 2005), foraging and project involvement variables were created for the purpose of this study. For example, the foraging index was not created using a pre-collected list of foraged foods. Instead, participants in group and individual interviews were asked to list commonly foraged foods. While certain products were known at the outset of the study, others were reported during the interviewing process and could not be factored into the foraging index. Additionally, some products were unavailable in certain areas, such as caterpillars which were commonly eaten in Southern villages (Saki, Yeguere, Siniena), but were absent in Northern villages (Medina Coura, Seguere) meaning they couldn't be involved in cross-village examinations. Lastly, recall bias may have impacted participant's responses as all questions were asking about previous events or behaviors.

The validity of the information on foraged foods also has some minor issues. Firstly, I was not able to see many of the plant species because they were too far away from the interview sites and women were too busy to spend the time taking me there. This made identification of species difficult and I relied solely on matching the common names, rather than matching by physical features. Because of this constraint I was unable to find the scientific name and, therefore, the nutritional properties of certain plant products. Finally, the data collected on the nutrients in the wild foods was collected from a variety of sources spanning across West Africa, most of which came from Nigeria. Because of this different

calibrations in lab equipment or geographical differences in the composition of plant and animal species could mean that the values represented in tables 17 and 18 are not accurate for the plants that women access in Burkina Faso.

Additionally, all interviews were done through translation by a research assistant. We worked with five different assistants over the course of the two years. They were primarily female (in Medina Coura, Seguere, Saki and Siniena), though, two were male (Yeguere). Gender differences and social hierarchies may have impacted answers based on different assistants. Mistranslations or miscommunications could also have biased results, particularly for the more complex questions involved in the food security survey and when asking about the necessity of foraged foods as different understandings or translations of 'need' could seriously impact responses. We were there for a very limited amount of time (one month in 2016, two months in 2017) which impacted our ability to bond with communities and understand their culture and situation outside of structured interviews. None of the researchers had spent a significant period of time in this area previous to the study, though the principal investigator (Professor Bill Moseley) had worked in neighboring Mali for several years in the past. This lack of cultural knowledge could have impacted both the data I collected as well as the ways in which I am interpreting it.

Lastly, the comparisons done in this study are between different villages with different levels of project integration rather than between one village over different periods of time. This means that differences in nutrition and foraging could be due to geographical differences rather than project involvement. While I attempted to account for this by discussing the geographical differences in each village, it still most certainly plays a role, particularly with foraging. A temporal analysis would have allowed me to assess whether the

introduction of a project altered foraging and nutrition practices. Of course other variables could still interfere in this case, but vastly different geographies would be less at fault in this case.

The external validity of the study is also somewhat limited. The study was conducted only within a finite rural area of Southwestern Burkina Faso that is culturally, ecologically and economically different from other areas of the country. Thus, the findings may be limited only to this region, though they may hold some value in other areas depending on their similarity. It may also not be applicable to urban areas where agriculture and foraging are less commonly practiced but are still present. Further, the study only interviewed female farmers because they are the household experts on food preparation and foraging, however men are also implicated in these projects. The ways in which the project may impact male livelihoods is unclear given this research. Lastly, the crop under consideration in this study is rice which requires intensive cultivation and has both subsistence and commercial value. When understanding the implications of commercialization for other crops, particularly those that only hold commercial value, this study may not be relevant, most notably cotton.

Conclusion

This study adds to the previous literature on foraging in Southwestern Burkina Faso in several distinct ways. Findings on the importance of foraging within the community were strong and generally agree with the existing literature that foraged foods play a significant role in the diets of rural farmers. In contrast to other studies, however, I posit that foraging is not only a famine coping method, but a valid method of food access that works in conjunction with agricultural production to build a diverse diet. Results also showed that better nutritional outcomes for both food insecurity and dietary diversity are associated with increased foraging suggesting that the practice does improve household nutrition.

My findings also add to the very limited amount of literature concerned with the interaction between agricultural commercialization and foraging as they impact nutrition. In this case, the rice commercialization project had no significant relationship with foraging practices or household dietary diversity. There was a significant negative relationship between food insecurity and project involvement suggesting that increased involvement in intensified agricultural practices can help increase household food supply. This impact on nutrition was expected because in theory the project would allow women to produce and/or sell greater quantities of rice increasing their grain stores, though not necessarily adding additional food groups to the diet. It was unexpected that the project had no impact on foraging practices, but in light of the extremely limited success of project influence in some of our villages this is not entirely surprising. Further research should be done to investigate whether this is true for other, more successful agricultural intensification projects.

The results also showed that foraging was impacted most by geography and land access. Due to cultural and environmental differences, I hypothesize that geography limits the extent that farmers can participate in foraging. Geography has one of the greatest effects

on the sale of foraged foods because market access is imperative for this to happen at a large scale. Proxies for land access such as the amount of land cultivated, ethnicity and wealth were associated with increased foraging which I hypothesize means that decreased access to land may limit the extent to which farmers are able to forage because many important trees for foraging grow on agricultural fields. This is especially important in villages that contain a mix of late-comer and original inhabitants because land tenure is particularly unequal here causing late-comers to be unable to access important foraged products. Because the products listed by survey participants contain such a wide array of macro and micronutrients access to these wild foods is important for maintaining a healthy diet.

Based on these results I suggest that BRICOP and other commercialization projects take care to consider the importance of foraging in their future plans. Additionally, based on individual testimonials I believe that BRICOP has a responsibility to work with farmers to improve their system to better address farmers needs and, more specifically, return to the villages to redo the land improvement procedure to prevent flooding. The government and other organizations should also make protecting foraging practices a priority when designing projects and policy to combat malnutrition. This research also adds to the existing literature supporting the importance of foraging as a food source to rural diets (Lykke, 2002; Shiundu & Oniongo, 2007). However, it shows that in this case, commercial agriculture does not interfere with foraging practices which is likely due to both the resiliency of foraging and the lack of project success. Further, involvement in BRICOP's project was shown to be associated with marginally improved food security suggesting the project may be helping farmers gain better access to food during the hungry season.

Lastly, I suggest that a future project be created based on a pre-existing model used in

Togo where women are able to sell their foraged food products at a higher price in order to improve their incomes. While this could result in environmental degradation, gendered labor imbalances or men using their status to gain access to women's new privileges, I believe if the project is designed by and for community members these can be avoided. Additionally, building off of previous case studies and learning from their mistakes could help us to bypass these complications. Regardless of what the future holds, foraged foods represent a culturally and nutritionally important part of the food system in Burkina Faso and their many uses should not go undervalued.

References

Achinewhu, S. C., Ogbonna, C. C., & Hart, A. D. (1995). Chemical composition of indigenous wild herbs, spices, fruits, nuts and leafy vegetables used as food. *Plant Foods for Human Nutrition*, *48*(4), 341–348. https://doi.org/10.1007/BF01088493

Anderman, T. L., Remans, R., Wood, S. A., DeRosa, K., & DeFries, R. S. (2014). Synergies and tradeoffs between cash crop production and food security: a case study in rural Ghana. *Food Security*, *6*(4), 541–554.

Anvo, Morgane Paul M, Toguyéni, Aboubacar, Otchoumou, Athanase K, Zoungrana-Kaboré, Chantal Yvette, & Kouamelan, Essetchi Paul. (n.d.). Nutritional qualities of edible caterpillars Cirina butyrospermi in southwestern of Burkina Faso - ProQuest. Retrieved March 14, 2018, from https://search.proquest.com/openview/075dc55f4f1febc7134a48e8075723dd/1?pq-origsite=gscholar&cbl=2031961

Arimond, M., Hawkes, C., Ruel, M. T., Sifri, Z., Berti, P. R., Leroy, J. L., … Frongillo, E. A. (2011). Agricultural interventions and nutrition: lessons from the past and new evidence. *Eds B.Thompson and L.Amoroso*, 41–75.

Arsenault, Joanne E, Nikiema, Laetita, Allemand, Paulina, Ayassou, Kossiwavi A, Lanou, Hermann, Moursi, Mourad, … Mrtin-Prevel, Yves. (2014). Seasonal differences in food and nutrient intakes among young children and their mothers in rural Burkina Faso. *Journal of Nutritional Science*, *3*(55). https://doi.org/10.1017

Ashraf, N. (2009). Spousal Control and Intra-Household Decision Making: An Experimental Study in the Philippines on JSTOR. *The American Economic Review*, *99*(4), 1245–1277.

Avallone, S., Brault, S., Mouquet, C., & Treche, S. (2007). Home-processing of the dishes constituting the main sources of micronutrients in the diet of preschool children in rural Burkina Faso. *International Journal of Food Sciences and Nutrition*, *58*(2), 108–115. https://doi.org/10.1080/09637480601143320

Ayanwale, A., Oyedele, D., Adebooye, O., & Adeyemo, V. (2011). *A socio-economic analysis of the marketing chain for under-utilised indigenous vegetables in Southwestern Nigeria*.

Banjo, AD, Lawal, OA, & Songonuga, EA. (2006). The nutritional value of fourteen species of edible insects in southwestern Nigeria. *African Journal of Biotechnology*, *5*(3), 298–301. https://doi.org/10.5897/AJB05.250

BARANY, M., HAMMETT, A. L., STADLER, K. M., & KENGNI, E. (2004). Non-Timber Forest Products in the Food Security and Nutrition of Smallholders Afflicted by Hiv/Aids in Sub-Saharan Africa. *Forests, Trees and Livelihoods*, *14*(1), 3–18. https://doi.org/10.1080/14728028.2004.9752475

Bedigian, D. (2004). Slimy Leaves and Oily Seeds: Distribution and Use of Wild Relatives of Sesame in Africa. *Economic Botany*, *58*(sp1), S3–S33. https://doi.org/10.1663/0013-0001(2004)58[S3:SLAOSD]2.0.CO;2

Berti, P. R., Krasevec, J., & FitzGerald, S. (2004). A review of the effectiveness of agriculture interventions in improving nutrition outcomes. *Public Health Nutrition*, *7*(5), 599–609.

Beyala, B. (2014). *Burkina Faso: Filière riz - Le projet « BRICOP » pour accroître les rendements*. Retrieved from http://fr.allafrica.com/stories/201404291189.html

Bharucha, Z., & Pretty, J. (2010). The roles and values of wild foods in agricultural systems. *Philosophical Transactions of the Royal Society of London.Series B, Biological Sciences*, *365*(1554), 2913–2926. https://doi.org/10.1098/rstb.2010.0123 [doi]

Boamponsem, Georgina A, Johnson, Frank S, Mahunu, Gustav K, & Awiniboya, Stephen F. (2013). Determination of biochemical composition of Saba senegalensis (Saba fruit). *Asian Journal of Plant Science and Research*, *3*(1), 31–36.

Braun, J. V. (1988). Effects of technological change in agriculture on food consumption and nutrition: rice in a West African setting. *World Development*, *16*(9), 1083–1098.

Braun, J. V. (1995). Agricultural commercialization: impacts on income and nutrition and implications for policy. *Food Policy*, *20*(3), 187–202.

Broegaard, R. B., Rasmussen, L. V., Dawson, N., Mertz, O., Vongvisouk, T., & Grogan, K. (2017). *Wild food collection and nutrition under commercial agriculture expansion in agriculture-forest landscapes* (Vol. 84). https://doi.org/10.1016/j.forpol.2016.12.012

Brunken, U, Schmidt, M, Dressler, S, Janssen, T, Thiombiano, A, & Zizka, G. (2008). West African Plants - A Photo Guide - Home. Retrieved March 15, 2018, from http://www.westafricanplants.senckenberg.de/root/index.php

Carney, J. A. (1988). Struggles over crop rights and labour within contract farming households in a Gambian irrigated rice project. *The Journal of Peasant Studies*, *15*(3), 334–349. https://doi.org/10.1080/03066158808438366
CDC. (2015, March 31). Micronutrient Facts. Retrieved February 12, 2018, from http://www.cdc.gov/immpact/micronutrients/index.html
Chen, T. (2017). *Impact of the shea nut industry on women's empowerment in Burkina Faso: a multi-dimensional study focusing on the Central, Central-West and Hauts-Bassins regions*. Rome: Food and Agriculture Organization of the United Nations.
Christian, Paul, & Dillon, Brian. (2016). Long term consequences of consumption seasonality. African Development Bank Group.
Clapp, J. (2006). WTO agriculture negotiations: implications for the Global South. *Third World Quarterly*, *27*(4), 563–577.
Coates, J., Swindale, A., & Bilinsky, P. (2007, August). Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. USAID. Retrieved from http://www.fao.org/fileadmin/user_upload/eufao-fsi4dm/doc-training/hfias.pdf
Collier, Paul. (2008, December). The Politics of Hunger: how illusion and greed fan the food crisis. The Council on Foreign Relations.
Cooper, M. W., & West, C. T. (2017). Unraveling the Sikasso Paradox: Agricultural Change and Malnutrition in Sikasso, Mali. *Ecology of Food and Nutrition*, *56*(2), 101–123. https://doi.org/10.1080/03670244.2016.1263947
Council, N. R. (2006). *Lost Crops of Africa: Volume II: Vegetables* (Vol. 2). National Academies Press.
Delgado, C. (1999). Sources of growth in smallholder agriculture in sub-Saharan Africa: The role of vertical integration of smallholders with processors and marketers of high value-added items. *Agrekon*, *38*, 165–189.
DeWalt, K. M. (1993). Nutrition and the commercialization of agriculture: ten years later. *Social Science & Medicine*, *36*(11), 1407–1416.
Diamond, Jared. (1987, May). The Worst Mistake in the History of the Human Race. *Discover*, 64–66.
Dickson, Rita A, Annan, Kofi, Fleischer, Theophilus C, Amponsah, Isaac K, Nsiah, Kwabena, & Oteng, JA. (2012). Phytochemical Investigations and Nutritive Potential of Eight Selected Plants from Ghana. *Journal of Pharmacy and Nutrition Sciences*, *2*, 172–177.
Digital, A. (2015). *A Rice-Powered Green Revolution in Burkina Faso* (Vol. 2017).
Dury, S., & Bocoum, I. (20129-10). The Sikasso (Mali) "paradox": Why isn't "producing more" a sufficient means for feeding the children of farmers' families? *Cahiers Agricultures*, (5), 324–336. https://doi.org/10.1684/agr.2012.0584
FAO. (2010). *Nutrition country profiles: Burkina Faso* (Vol. 2017).
FAO Cereal Supply and Demand Brief | World Food Situation | Food and Agriculture Organization of the United Nations. (n.d.). Retrieved February 20, 2018, from http://www.fao.org/worldfoodsituation/csdb/en/
FAOSTAT. (n.d.). Retrieved December 11, 2017, from http://www.fao.org/faostat/en/#data/FBS/visualize
Foran, T., Butler, J. R. A., Williams, L. J., Wanjura, W. J., Hall, A., Carter, L., & Carberry, P. S. (2014). *Taking Complexity in Food Systems Seriously: An Interdisciplinary Analysis* (Vol. 61). https://doi.org/10.1016/j.worlddev.2014.03.023
Gausset, Q., Yago-Ouattara, E. L., & Belem, B. (2005). Gender and trees in Péni, South-Western Burkina Faso. Women's needs, strategies and challenges. *Geografisk Tidsskrift-Danish Journal of Geography*, *105*(1), 67–76. https://doi.org/10.1080/00167223.2005.10649527
Gengenbach, H., Schurman, R. A., Bassett, T. J., Munro, W. A., & Moseley, W. G. (2017). Limits of the New Green Revolution for Africa: Reconceptualising gendered agricultural value chains. The Geographical Journal. https://doi.org/10.1111/geoj.12233
Glew, > Robert S., & Vanderjagt, D. (2006). Coping strategies and nutritional health in rural Niger: recommendations for consumption of wild plant foods in the Sahel. *International Journal of Food Sciences and Nutrition*, *57*(5–6), 314–324.
Glew, R. H., Vanderjagt, D. J., Lockett, C., Grivetti, L. E., Smith, G. C., Pastuszyn, A., & Millson, M. (1997). Amino Acid, Fatty Acid, and Mineral Composition of 24 Indigenous Plants of Burkina Faso. *Journal of Food Composition and Analysis*, *10*(3), 205–217. https://doi.org/10.1006/jfca.1997.0539
Green, R. E., Cornell, S. J., Scharlemann, J. P. W., & Balmford, A. (2005). Farming and the Fate of Wild Nature. *Science*, *307*(5709), 550–555. https://doi.org/10.1126/science.1106049

Grivetti, L. (2004). Ethical and Ethnical Requirements in the Production of Food L. E. GRIVETTI. *Journal of Food Science*, *69*, CRH20–CRH28. https://doi.org/10.1111/j.1365-2621.2004.tb17845.x
Grivetti, L. E., & Ogle, B. M. (2000). Value of traditional foods in meeting macro-and micronutrient needs: the wild plant connection. *Nutrition Research Reviews*, *13*(1), 31–46.
Harris, F. M., & Mohammed, S. (2003). Relying on nature: wild foods in northern Nigeria. *AMBIO: A Journal of the Human Environment*, *32*(1), 24–29.
Herforth, A. (2010). Promotion of traditional African vegetables in Kenya and Tanzania: a case study of an intervention representing emerging imperatives in global nutrition.
History. (n.d.). Retrieved March 19, 2018, from https://alaffia.com/history/
Honfo, F., H.N., A., Linnemann, A., Mohamed, S., & A J S Van Boekel, M. (2014). *Nutritional Composition of Shea Products and Chemical Properties of Shea Butter: A Review* (Vol. 54). https://doi.org/10.1080/10408398.2011.604142
Hovorka, A. J. (2006). The No. 1 Ladies' Poultry Farm: A feminist political ecology of urban agriculture in Botswana. *Gender, Place & Culture*, *13*(3), 207–225. https://doi.org/10.1080/09663690600700956
Hyacinthe, T., Charles, P., Adama, K., Diarra, C.-S., Dicko, M. H., Svejgaard, J. J., & Diawara, B. (2015). Variability of vitamins B1, B2 and minerals content in baobab (Adansonia digitata) leaves in East and West Africa. *Food Science & Nutrition*, *3*(1), 17–24. https://doi.org/10.1002/fsn3.184
Investigation-on-the-Medicinal-and-Nutritional-Potentials-of-Some-Vegetables-Consumed-In-Ekiti-State-Nigeria.pdf. (n.d.). Retrieved from http://www.eajournals.org/wp-content/uploads/Investigation-on-the-Medicinal-and-Nutritional-Potentials-of-Some-Vegetables-Consumed-In-Ekiti-State-Nigeria.pdf
Johns, T., Powell, B., Maundu, P., & Eyzaguirre, P. B. (2013). Agricultural biodiversity as a link between traditional food systems and contemporary development, social integrity and ecological health: Traditional food systems, agricultural biodiversity and sustainable development. *Journal of the Science of Food and Agriculture*, *93*(14), 3433–3442. https://doi.org/10.1002/jsfa.6351
Kennedy, G., Ballard, T., & Dop, M. (2011). Guidelines for measuring household and individual dietary diversity. Food and Agriculture Organization. Retrieved from http://www.fao.org/fileadmin/user_upload/wa_workshop/docs/FAO-guidelines-dietary-diversity2011.pdf
Kristensen, M., & Balslev, H. (2003). Perceptions, use and availability of woody plants among the Gourounsi in Burkina Faso. *Biodiversity & Conservation*, *12*(8), 1715–1739. https://doi.org/10.1023/A:1023614816878
Kubmarawa, D., Magomya, AM, Yebpella, GG, & Adedayo, SA. (2011). Nutrient content and amino acid composition of the leaves of Cassia tora and Celtis integrifolia. *International Research Journal of Biochemistry and Bioinformatics*, *1*(9), 222–225.
Ladeji, O., & Okoye, Z. S. C. (1993). Chemical analysis of the fruit ofVitex doniana (verbanaceae). *Journal of the Science of Food and Agriculture*, *63*(4), 483–484. https://doi.org/10.1002/jsfa.2740630416
Lamien, N., Traore-Gue, J., & Lingani-Coulibaly, P. (2009). Importance of local fruits consumption in diet balance in Burkina Faso, West Africa. Retrieved from https://idl-bnc-idrc.dspacedirect.org/handle/10625/41647
Lamien, Niéyidouba, Sidibe, Amadou, & Bayala, Jules. (1996). Use and commercialization of non-timber forest products in western Burkina Faso. *Domestication and Commercialization of Non-Timber Forest Products in Agroforestry Systems, Non-Wood Forest Products*, *9*, 51–64.
Lamien-Meda, A., Lamien, C. E., Compaoré, M. M. Y., Meda, R. N. T., Kiendrebeogo, M., Zeba, B., … Nacoulma, O. G. (2008). Polyphenol Content and Antioxidant Activity of Fourteen Wild Edible Fruits from Burkina Faso. *Molecules*, *13*(3), 581–594. https://doi.org/10.3390/molecules13030581
Leakey, R. R. (1999). Potential for novel food products from agroforestry trees: a review. *Food Chemistry*, *66*(1), 1–14.
Lenhardt, Amanda, Glennie, Jonathan, Intscher, Nicholas, Ali, Ahmed, & Morin, Gabriel. (2014). A greener Burkina: sustainable farming techniques, land reclamation and improved livelihoods. *Development Progress*. Retrieved from https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9153.pdf
Lockett, C., Christopher C. Calvert, Louis E. Grivetti. (2000). Energy and micronutrient composition of dietary and medicinal wild plants consumed during drought. Study of rural Fulani, Northeastern Nigeria. *International Journal of Food Sciences and Nutrition*, *51*(3), 195–208.
Longhurst, R. (1988). Cash crops, household food security and nutrition. *IDS Bulletin*, *19*(2), 28–36.

Lourme-Ruiz, A., Dury, S., & Martin-Prével, Y. (2016). Consomme-t-on ce que l'on sème ? Relations entre diversité de la production, revenu agricole et diversité alimentaire au Burkina Faso. *Cahiers Agricultures*, *25*(6), 65001. https://doi.org/10.1051/cagri/2016038

Lykke, A. M., Mertz, O. L. E., & Ganaba, S. (2002). Food consumption in rural Burkina Faso. *Ecology of Food and Nutrition*, *41*(2), 119–153.

Made At The Source. (n.d.). Retrieved March 19, 2018, from https://madecasse.com/made-at-the-source/

Mangos, raw Nutrition Facts & Calories. (n.d.). Retrieved March 5, 2018, from http://nutritiondata.self.com/facts/fruits-and-fruit-juices/1952/2

Maseko, H., Shackleton, C. M., Nagoli, J., & Pullanikkatil, D. (2017). Children and Wild Foods in the Context of Deforestation in Rural Malawi. *Human Ecology*, *45*(6), 795–807. https://doi.org/10.1007/s10745-017-9956-8

Mehra, R., & Rojas, M. H. (2008). Women, food security and agriculture in a global marketplace. *International Center for Research on Women (ICRW)*.

Mertz, O., Lykke, A., & Reenberg, A. (2001). Importance and seasonality of vegetable consumption and marketing in Burkina Faso. *Economic Botany*, *55*(2), 276–289.

Moseley, W. (2017). The New Green Revolution for Africa: A Political Ecology Critique. *Brown Journal of World Affairs*, *23*(2). Retrieved from file:///Users/juliadmorgan/Downloads/Moseley-New%20Green%20Revolution%20for%20Africa%20Critique%20-%20Published%20version_stamped.pdf

Moseley, W. G., Carney, J., & Becker, L. (2010). Neoliberal policy, rural livelihoods, and urban food security in West Africa: A comparative study of The Gambia, Côte d'Ivoire, and Mali. *Proceedings of the National Academy of Sciences*, *107*(13), 5774–5779. https://doi.org/10.1073/pnas.0905717107

Neumann, K., Breunig, P., & Kahlheber, S. (2006). Early food production in the Sahel of Burkina Faso.

Nicolas Cyrille Ayessou. (n.d.). Nutritional Contribution of Some Senegalese Forest Fruits Running across Soudano-Sahelian Zone.

Njuki, J., Kaaria, S., Chamunorwa, A., & Chiuri, W. (2011). Linking smallholder farmers to markets, gender and intra-household dynamics: Does the choice of commodity matter? *The European Journal of Development Research*, *23*(3), 426–443.

Nordeide, M. B., Hatløy, A., Følling, M., Lied, E., & Oshaug, A. (1996). Nutrient composition and nutritional importance of green leaves and wild food resources in an agricultural district, Koutiala, in southern Mali. *International Journal of Food Sciences and Nutrition*, *47*(6), 455–468.

Padoch, C., & Sunderland, T. (2013). Managing landscapes for greater food security and improved livelihoods. *Unasylva*, *64*, 12.

Pimentel, D., & Edwards, C. A. (1982). Pesticides and Ecosystems. *BioScience*, *32*(7), 595–600. https://doi.org/10.2307/1308603

Pimentel, D., McNair, M., Buck, L., Pimentel, M., & Kamil, J. (1997). The value of forests to world food security. *Human Ecology*, *25*(1), 91–120.

Poole, N., Audia, C., Kaboret, B., & Kent, R. (2016). Tree products, food security and livelihoods: a household study of Burkina Faso. *Environmental Conservation*, *43*(04), 359–367. https://doi.org/10.1017/S0376892916000175

Pouliot, M., & Treue, T. (2013). Rural people's reliance on forests and the non-forest environment in West Africa: evidence from Ghana and Burkina Faso. *World Development*, *43*, 180–193.

powbab. (n.d.). powbab® | Natural Superfood Products Powered by Baobab. Retrieved March 19, 2018, from https://www.powbab.com/

Press, A. (2014). *Burkina Faso : BRICOP, un nouveau projet de commercialisation du riz*. Retrieved from http://www.27avril.com/blog/affaires/agriculture/burkina-faso-bricop-nouveau-projet-commercialisation-du-riz

Pulp, kernel and butter nutrients. (n.d.).

Quisumbing, A. R., Brown, L. R., Feldstein, H. S., Haddad, L., & Peña, C. (1995). Women: The key to food security. *Food Policy Statement*, *21*.

Rémy, D. A., Hervé, B. B., & Sylvain, O. N. (2017). Study of Some Biological Parameters of Cirina butyrospermi Vuillet (Lepidoptera, Attacidae), an Edible Insect and Shea Caterpillar (Butyrospermum paradoxum Gaertn. F.) in a Context of Climate Change in Burkina Faso. *Advances in Entomology*, *06*(01), 1. https://doi.org/10.4236/ae.2018.61001

ResearchGate Link. (n.d.). Retrieved from https://www.researchgate.net/publication/258826779_Nutritional_Composition_of_Shea_Products_and_Chemical_Properties_of_Shea_Butter_A_Review
Robbins, P. (2011). *Political Ecology: A Critical Introduction*. John Wiley & Sons.
Rocheleau, D. E., Thomas-Slayter, B. P., & Wangari, E. (1996). *Feminist political ecology: global issues and local experiences*. London; New York: Routledge. Retrieved from http://www.123library.org/book_details/?id=96543
Rumpold, B. A., & Schlüter, O. K. (2013). Nutritional composition and safety aspects of edible insects. *Molecular Nutrition & Food Research*, *57*(5), 802–823. https://doi.org/10.1002/mnfr.201200735
Sahn, D. E. (1990). The impact of export crop production on nutritional status in Cote d'Ivoire. *World Development*, *18*(12), 1635–1653.
Savy, M., Martin-Prével, Y., Sawadogo, P., Kameli, Y., & Delpeuch, F. (2005). Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *European Journal of Clinical Nutrition*, *59*(5), 703–716.
Several wild foods that we also found are extremely important in the diet in rural areas and provide important nutrients. (n.d.).
Shiundu, K. M., & Oniang'o, R. K. (2007). Marketing African leafy vegetables: Challenges and opportunities in the Kenyan context. *African Journal of Food, Agriculture, Nutrition and Development*, *7*(4), 1–17.
Smith, G. C., Clegg, M. S., Keen, C. L., & Grivetti, L. E. (1996). Mineral values of selected plant foods common to southern Burkina Faso and to Niamey, Niger, West Africa. *International Journal of Food Sciences and Nutrition*, *47*(1), 41–53. https://doi.org/10.3109/09637489609028560
Smith, I. F., Eyzaguirre, P., & International, B. (2005). African leafy vegetables: their role in the world health organization's global fruit and vegetables initiative. *Developing Afrcan Leafy Vegetables for Improved Nutrition*.
sorrel leaves good for nutrition, generally sauces contain important micronutrients while starchy bases contain bulk of . (n.d.).
Sow, A., Sidibé, I., Bengaly, Z., Bouyer, J., Bauer, B., & Van den Bossche, P. (2010). Fifty years of research and fight against tsetse flies and animal trypanosomosis in Burkina Faso. An overview. *Bulletin of Animal Health and Production in Africa*, *58*(2). https://doi.org/10.4314/bahpa.v58i2.62044
Spring, A. (2000). *Women farmers and commercial ventures: Increasing food security in developing countries*. Lynne Rienner Publishers.
Sunday, Arowosegbe, Sunday Dele, Oyeyemi, & Olayemi, Alo. (2015). Investigation on the medicinal and nutritional potentials of some vegetables consumed in Ekiti State, Nigeria. *International Research Journal of Natural Sciences*, *3*(1), 16–30.
The Geographical Journal - Wiley Online Library. (n.d.). Retrieved March 27, 2018, from https://onlinelibrary.wiley.com/journal/14754959
Tieguhong, J. C., Ndoye, O., Grouwels, S., Mala, W. A., & Betti, J. L. (2012). Rural enterprise development for poverty alleviation based on non-wood forest products in Central Africa. *International Forestry Review*, *14*(3), 363–379.
Titus Friday, Emmanuel, James, O., Olupinyo, Olusegun, & Gabriel, Adah. (2011). Investigations on the nutritional and medicinal potentials of Ceiba pentandra leaf: A common vegetable in Nigeria. *International Journal of Plant Physiology and Biochemistry*, *3*(6), 95–101.
Trade and sustainable forest management. (n.d.). Retrieved March 26, 2018, from http://www.fao.org/docrep/008/y5918e/y5918e11.htm
Traoré, S. (2016). *Le système de riziculture intensive, ou SRI, à Bama au Burkina Faso*. Retrieved from http://www.rfi.fr/emission/20161127-burkina-faso-bama-riziculture-intensive-riz
Tucker, B., Tsimitamby, M., Humber, F., Benbow, S., & Iida, T. (2010). Foraging for development: a comparison of food insecurity, production, and risk among farmers, forest foragers, and marine foragers in southwestern Madagascar. *Human Organization*, *69*(4), 375–386.
UNICEF. (n.d.). *Burkina Faso: Health and Nutrition* (Vol. 2017).
UNICEF Burkina Faso - Health and Nutrition - Issue overview. (n.d.). Retrieved March 19, 2018, from https://www.unicef.org/bfa/english/health_nutrition.html
Valorisation des produits forestiers entrant dans l'alimentation des populations. (2004). UNESCO. Retrieved from http://www.unesco.org/mab/doc/mys/2004/taita/Rapportfinal1.doc
Vinceti, B., Ickowitz, A., Powell, B., Kehlenbeck, K., Termote, C., Cogill, B., & Hunter, D. (2013). The contributions of forest foods to sustainable diets. *Unasylva*, *64*, 11.

von Braun, Joachim, & Meinzen-Dick, Ruth. (2009, April 13). “Land Grabbing” by Foreign Investors in Developing Countries: Risks and Opportunities. International Food Policy Research Institute.
Watts, M., & Bohle, H. (1993). The space of vulnerability: the causal nature of hunger and famine. Progress in Human Geography, 17(1), 43–67.
Weisdorf, J. L. (2005). From Foraging To Farming: Explaining The Neolithic Revolution. *Journal of Economic Surveys*, *19*(4), 561–586. https://doi.org/10.1111/j.0950-0804.2005.00259.x
What are Mangos Good For? (n.d.). Retrieved March 5, 2018, from https://foodfacts.mercola.com/mango.html
Wiggins, S., & Keats, S. (2013). Smallholder agriculture’s contribution to better nutrition. *ODI, London*.
Wild plants provide important nutrients, but have traditionally been disparaged by policy as weeds and shouldn’t be beca. (n.d.).
Zizka, A., Thiombiano, A., Dressler, S., Nacoulma, B. M., Ouédraogo, A., Ouédraogo, I., … Schmidt, M. (2015). Traditional plant use in Burkina Faso (West Africa): a national-scale analysis with focus on traditional medicine. *Journal of Ethnobiology and Ethnomedicine*, *11*(1), 9.

Appendix

A

Base Survey

Name of Surveyor :_____

Date : _____

B) General Information

B1Village test □ ou control □? If test, in the project □ or out of project □? North □ ou South □?

B2) Number : _____

B3) Name :_____

B4) Location : Village:_____ Commune: _____

B5) Name of head of household : _____

B6) Age:_____ Marital status_____ Polygamous ? _____ If yes, how many ? (her + cowives) _____ If polygamous, which number of wife is she ? :_____

B7) Ethnicity :_____

B8) Religion :_____

B9) Does she have children ? _____If yes, how many and their age and sexes

Her + husband + kids = _____

B10) Identify and count the other members of the household such as cowives, their children, brothers in law, parents in law etc.

Other members in the family= _____ Household total_____

C) Questions about agriculture

C1) What do you cultivate and what is the area of land that you cultivate for each crop?

Rice :_____ Peanuts :_____ Beans_____ Corn _____ Sesame _____
Sorghum_____ Millet_____ Ground peas_____ Others ?

C2) Questions about land tenure
Of these parcels do any belong to you ?
Of those that do not belong to you, who do they belong to ?
Number of hectares in fallow ?

C3) Questions on Sale of Crops
Of your crops, which are sold ?
Rice :_____ Peanuts :_____ Beans_____ Corn _____ Sesame _____
Sorghum_____ Millet_____ Ground peas_____ Others ?

D) Questions on the improved rice field

D1) Do you have land in the improved rice field?
D2) If yes for how long have you owned it ?

D3) What is the area of the land you cultivate in the improved field ?
D4) How do you prepare the field before planting ?
D5) What is the technique used to sow the seeds ?
D6) Do you use improved or traditional seeds ? What kind?
D7) Other inputs ? (fertilizer, compost, pesticide, insecticide)
D8) Who works in your improved field ?
D9) Do you pay people to work in your improved field ?

D10) Estimate your rice production for the previous year?
D11) Estimate your rice production for the 2 years preceding ?
D12) Part sold_____ Part kept_____
D13) Sold in which month?
D14) Sold in which market ?

E) Questions for the non-improved rice field (same as above)

Important goods	**Family**	**Woman**	**Important goods**	**Family**	**Woman**
People of working age			Goats		
Roof quality of house			Chicken		
Wall quality of house			Guinea fowl		
Improved toilet			Ducks		
Motor bike			Pigs		
Labor cows			Phones		
Plow			Solar panels		
Cart			Television		
Donkey			Tracotrs		
Cows			Tricycle motor bikes		
Sheep			Electricity		

F) Economic classification of the household

Other large goods ?

B

Wild Food Survey
Date: ____-____-_____ Interviewer:_____

Name: _____ Village:_____ #: _____

1. Did you eat anything in the bush yesterday? **Yes** **No**

2. What?

Products:

Baobab, nere, l'oseille, karite, zaban, mangues, termites, agouti, peche, tamarind

kirikiri, koto, pekun, finsan, pompony

boulvanka, sogoda, kapoka

Plant	Mark if collected	Is it sold?	Eaten how many times per week?

Is it necessary for you to forage in order to have enough to eat?

What do you cultivate?

Crop	Quantity Sold	Season Sold

C

	# People Producing <2 100kg Sacks of Rice		
	N	**% of Total**	**% of Village**
Medina Coura	16	38.10%	44.44%
Seguere	7	16.67%	36.84%
Saki	2	4.76%	8.33%
Siniena	1	2.38%	3.85%
Yeguere	16	38.10%	40.00%
Total	42	100.00%	28.97%

D

		Mean	Significance
Project Index	**Project**	4.94	
	non-Project	3.26	0.023
# Crops Sold	**Project**	2.01	
	non-Project	1.76	0.823
% Rice Sold	**Project**	42%	
	non-Project	30%	0.008

E

Achinewhu, Ogbonna, & Hart, 1995; Anvo, Morgane Paul M, Toguyéni, Aboubacar, Otchoumou, Athanase K, Zoungrana-Kaboré, Chantal Yvette, & Kouamelan, Essetchi Paul, n.d.; Arimond et al., 2011; Arsenault, Joanne E et al., 2014; Avallone, Brault, Mouquet, & Treche, 2007; Banjo, AD, Lawal, OA, & Songonuga, EA, 2006; BARANY, HAMMETT, STADLER, & KENGNI, 2004; Boamponsem, Georgina A, Johnson, Frank S, Mahunu, Gustav K, & Awiniboya, Stephen F, 2013; CDC, 2015; Dickson, Rita A et al., 2012; > Robert S. Glew & Vanderjagt, 2006; R. H. Glew et al., 1997; Grivetti & Ogle, 2000; Honfo, H.N., Linnemann, Mohamed, & A J S Van Boekel, 2014; Hyacinthe et al., 2015; "Investigation-on-the-Medicinal-and-Nutritional-Potentials-of-Some-Vegetables-Consumed-In-Ekiti-State-Nigeria.pdf," n.d.; "Mangos, raw Nutrition Facts & Calories," n.d.; "Pulp, kernel and butter nutrients.," n.d.; "ResearchGate Link," n.d.; "Several wild foods that we also found are extremely important in the diet in rural areas and provide important nutrients," n.d.; "Snapshot," n.d.-a; "Snapshot," n.d.-b; "sorrel leaves good for nutrition, generally sauces contain important micronutrients while starchy bases contain bulk of ," n.d.; "What are Mangos Good For?," n.d.; "Wild plants provide important nutrients, but have traditionally been disparaged by policy as weeds and shouldn't be beca," n.d.; Kubmarawa, D., Magomya, AM, Yebpella, GG, & Adedayo, SA, 2011; Ladeji & Okoye, 1993; Lamien-Meda et al., 2008; Lockett, 2000; Nicolas Cyrille Ayessou, n.d.; Nordeide, Hatløy, Følling, Lied, & Oshaug, 1996; Rémy, Hervé, & Sylvain, 2017; Rumpold & Schlüter, 2013; Sunday, Arowosegbe, Sunday Dele, Oyeyemi, & Olayemi, Alo, 2015; Titus Friday, Emmanuel, James, Olupinyo, Olusegun, & Gabriel, Adah, 2011

F

	Mean # FFs Sold by Project Status (excluding Siniena)	
	Project	**non-Project**
Mean	1.46	1.49
P-value		0.372

	Project Index Regression (excluding Siniena)		
	Coeff.	**P-value**	**R**
# FFs Sold	-0.043	0.146	0.001

G

	N	# FFs Collected	Freq. FF Consumption	# FFs Sold	HHDD	Food Insecurity
Medina Coura	36	4.81	18.861	.86	6.53	36.06
Seguere	19	5.42	24.763	1.53	5.89	63.47
Saki	26	6.65	27.923	2.58	6.96	23.15
Siniena	24	5.46	22.729	4.71	7.13	42.21
Yeguere	40	5.93	22.950	1.30	6.18	42.65
Total	145	5.63	23.028	2.01	6.52	40.17

	N	# of Children	HH Total	HH Wealth (USD)	# Crops Sold	# Ha Cultivated
Medina Coura	36	5.62	20.47	$3759.7	2.64	1.47
Seguere	19	5.89	15.47	$2722.2	2.21	1.88
Saki	26	4.68	15.35	$3830.9	1.62	2.77
Siniena	24	4.50	14.08	$3850.1	1.27	1.99
Yeguere	40	4.79	13.38	$2286.5	1.55	1.20
Total	145	5.07	15.88	$3240.9	1.87	1.77

	% Rice Sold (N)	Mean Project Index (N)
Medina Coura	51% (21)	5.09 (32)
Seguere	56% (10)	2.95 (19)
Saki	39% (19)	4.58 (24)
Siniena	12% (23)	1.25 (20)
Yeguere	34% (25)	4.23 (39)
Total	36% (98)	3.87 (134)

H

# FFs Collected		
Variable	**Coeff. Estimate**	**Significance**
Age	-0.006	0.68
HH Total	-0.007	0.712
# of Children	-0.082	0.296
HH Wealth	0.117	0.343
Ha. Land Cultivated	0.212	0.052