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List of Abbreviations

SMC: Direct Trade organization representing South of Minas, Mogiana and Cerrado

Vrk: Values, rules and knowledge

RCM: Relationship Coffee Model

CBB: Coffee Berry Borer

LSLS: Land Sparing Land Sharing

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Abstract

Utilizing the benefits of agroecology has been proven capable of maintaining coffee yields while also preserving biodiversity. Yet, it is not commonly used by farmers, and few grasp the potential benefits of agroecological practices. In order to facilitate awareness, it is necessary to understand farmers' decision-making processes. This study seeks to understand how coffee farmers make decisions, in particular focusing on the influence of different coffee markets. This includes understanding how the values, rules and knowledge influencing decision-making are shaped by Direct Trade, trade occurring directly between producer and roaster, versus conventional markets, and linking those choices to environmental outcomes. This was examined within Brazilian coffee-producing regions by conducting interviews amongst Direct Trade and conventional farmers in addition to assessing farmers' understanding of agroecology and impact on ecosystems. Results suggest that farmers' engagement with different markets influence both pre-harvest and post-harvest methods, and usage of agroecological practices was increasing.

149 Words

1. Introduction

This thesis seeks to understand how different trading markets impact farmers' agricultural decisions, and the impact those decisions have on certain agroecological factors within coffee-producing regions of Brazil. As a highly biodiverse area, Brazil maintains a large percentage of the world's species. Agriculture, including the growth of coffee, has led to the destruction of species' habitat, and has thus decreased biodiversity. Incorporating more agroecological practices into coffee farming can increase biodiversity, in addition to increasing quality and yield of coffee. Yet, there is little understanding of how farmers make agricultural decisions, particularly with respect to how they approach ecological and biodiversity concerns. In response to on-going issues associated with the social and environmental impacts of coffee production, a business model known as Direct Trade has emerged for the purchase of high-quality and sustainable coffee. However, the impact of this model is poorly understood, especially with regards to how it impacts the environment and socioeconomic factors. Direct Trade could facilitate awareness of agroecology to farmers, and how to improve quality and yield. Therefore, this thesis aims to assess the role of Direct Trade in farmers' decision-making to evaluate the claims surrounding Direct Trade as a marketing model to predict its future development.

As problems arose within the coffee supply chain such as environmental harm and low prices paid to producers – certifications and supply chain governance emerged as a way to regulate and maintain standards. This began with Fair Trade, with the goal of de-commodifying the trade of coffee; yet has now become dominated by large coffee brands, leading to the creation of a market-capture tool through the process of 're-commoditization' (Daviron and Vagneron, 2011; Raynolds, 2008; Vicol et al., 2018). Regulation by private entities increased throughout the late 1990s, creating sustainable rules and certifications in response to the concerns of consumers and NGOs regarding the social and environmental ethics of production (Neilson, 2008; Vicol *et al.*, 2018). Direct Trade emerged as the voluntary and private regulation of trade as a form of value chain governance within the agricultural industry, where farmers communicate directly with specialty coffee roasters, and

create personal, long-term relationships (Liu et al., 2008; Vicol, 2018). Within this system, farmers know where their coffee is going, and consumers know the source of their coffee rather than via the commodity market where coffee is conglomerated and lacks traceability. Coffees with higher quality, aroma and acidity were coined as specialty coffee, and were traded directly with specialty roasters. Demand for this coffee increased as specialty coffee roasters spread throughout the 2000s (SCA, 2015). Trading directly with specialty roasters meant higher income and more personal, long-term relationships yielding more recognition. Retail sales within the US for specialty coffee grew from US$7.8 billion in 2000 to US$25.3 billion in 2014 (TransFair, 2008). Coffee is primarily produced in developing countries that comprise of roughly 80% of global coffee production, and incorporation into the Direct Trade market can offer price premiums allowing the longevity and improvement of coffee farms (Fairtrade, 2012). The Direct Trade market can also educate farmers about certain agricultural practices that may not only help the environment, but also increase the quality of the coffee. This may include reducing chemical usage, using organic material, utilizing the natural benefits of native vegetation, in addition to natural pest management and pollinators (Carvalho, 2006; Elder et al., 2014; Karp et al., 2013; Läderach et al., 2011; Méndez et al., 2009; Rappole et al., 2003).

Past studies have focused primarily the impact of certification schemes such as Fair Trade and Organic on various factors regarding coffee farmers, however, few have evaluated impacts of Direct Trade (Bacon, 2004; Elder et al., 2012). The trading concept is relatively new and there is no certification process and no third part certifier, so relies heavily on trust and personal relationships (Auld, Gulbrandsen and McDermott, 2008; McDermott, 2011).

As the leading exporter of coffee, Brazil is where innovation matters, especially with regards to agricultural practices and biodiversity. In 2017, Brazil exported US$4.6 billion worth of coffee, representing 14.1% of total coffee exports (Workman, 2018). Not only that, but Brazil is home to the most biodiverse areas in the world, housing 19% of the world's flora, and roughly 8% of the world's fauna (Giulietti et al., 2005; Galindo Leal and Câmara, 2003). Worldwide, 20-30% of the world's forested areas have been converted to agriculture, leading to species loss in areas such as the

Neotropics (Khumalo et al., 2012; Philpott et al., 2008). Coffee holds partial responsibility since modern coffee plantations consist of sun-grown, monoculture systems producing high yields of coffee regardless of quality (Philpott et al., 2008).

Coffee was traditionally grown under a diverse canopy of native vegetation in Africa (Khumalo et al., 2012). Some coffee farms are attempting to shift back to traditional rustic coffee plantations grown under or adjacent to native vegetation helping to increase agrobiodiversity and restore biodiversity of these areas. This is necessary as roughly 90% of the biodiversity resources in the Neotropics are located within human-dominated working landscapes such as coffee farms (Khumalo et al., 2012). As farmers add more native species, it increases agrobiodiversity and can potentially improve regional biodiversity in addition to bringing natural benefits to a farm (Philpott et al., 2008). Agrobiodiversity is defined as the variety of species farmers incorporate within their plots or areas of land. Potentially, increasing agrobiodiversity will provide more nutrients to the soil, more habitats for species, while also providing connectivity between fragmented forests damaged by deforestation.

Worldwide, populations are increasing, which means that the agriculture industry must maintain food security. Unfortunately, this can be detrimental to biodiversity unless more agro-ecological practices are adopted to maintain yield and preserve biodiversity. One debate that has emerged as a result of these pressures is the land sparing land sharing concept. By taking into consideration food security and biodiversity, this proposed solution incorporates wilderness into agricultural areas, and takes advantage of the natural benefits provided by ecological processes to maintain crop yields. This idea has been frequently debated and will be addressed later in the paper.

As the popularity of specialty coffee increases, and the validity of certification systems is increasingly being questioned, Direct Trade has become more prominent. Certification systems such as Fair Trade focus on environmental and socioeconomic factors, while Direct Trade focuses on long-term relationships created by specialty roasters with farmers to ensure the quality and sustainability of coffee. This includes an educational aspect, allowing farmers to learn more about how to improve

production. In addition, proponents of Direct Trade state that this relationship incentivizes farmers to adopt more agro-ecological practices such as incorporation of native trees and reduction of chemicals. Research indicates that coffee quality and sustainable agricultural practices have a positive relationship (Elder et al., 2014; Hernandez-Aguilera et al., 2018; Rappole and King, 2003). In theory, as farmers participate in Direct Trade and increase knowledge surrounding sustainable agriculture, coffee quality increases, which can lead to higher revenue and more sustainable production. This contention is what this paper seeks to understand. Participating with Direct Trade can also lend aid when farmers make agricultural decisions or attempt to understand how to increase the quality of his or her coffee. This can sometimes go hand-in-hand with increasing agrobiodiversity and adopting eco-friendlier agricultural practices that incorporate more native vegetation and taking advantage of natural benefits. If farmers maintain a coffee agroecosystem, more economic benefits may arise in addition to preserving and improving biodiversity and creating corridors within a recently intensified agricultural area (Philpott et al., 2008). Although Direct Trade seeks to improve environmental and socioeconomic standards of coffee producers and producing countries, little research has been conducted regarding the trading scheme and its impact on these factors.

This thesis aims to understand how Direct Trade, in addition to the conventional coffee market, influences farmers' agricultural decisions while also assessing environmental and coffee quality factors. In order to address this aim, this thesis presents the following research questions.

1.1 Research Questions

1. How does farmers' association with different markets (Direct Trade v. conventional) influence their agricultural decisions?
2. How do these agricultural decisions impact:
    a. Environmentally important aspects of the farm management such as native vegetation incorporation (shade tree management), chemical usage, and organic material utilization
    b. Understanding of the land sparing land sharing concept and the benefits associated
    c. Coffee quality and income

1.2 Outline of the Study

Within the following section, a literature review discusses background knowledge surrounding coffee agroecology and agrobiodiversity. Additionally, Direct Trade will be critically assessed and its presence within the coffee market will be established. Lastly, the theoretical framework is described and outlined to reveal how the study will be directed and understood to guide fieldwork and analysis.

The third section of the study describes the methods of collecting data from coffee farms, describing the location and the types of coffee farmers evaluated. Additionally, the questions used during the interview are described.

Next, the results are arranged to answer each research question and the findings are assessed within the discussion section. Specifically, the future of Direct Trade and how it will impact the environment will also be discussed. Lastly, a conclusion will be established regarding how farmers make decisions and how it is influenced by the coffee market while also focusing on farmers' impact on surrounding ecosystems.

2. Literature Review

To address the research questions, and understand the importance, this chapter begins by examining the environmental factors and challenges associated with producing coffee. This includes climate change, pests, and other coffee variables affecting the environment. This section will then transition to discussing the coffee market and how it has responded to these environmental variables concluding with the emergence of Direct Trade. Concepts within the agroecology field are discussed and a background is given regarding the Brazilian Forest Code. Lastly, the proposed theoretical framework is introduced.

2.1 Coffee Background

Coffee requires a wealth of knowledge, land and resources to produce high-quality, high-yielding coffee trees. *Coffea arabica* is the variety used for specialty coffee throughout the world. It

is an understory plant and does well under a canopy of shade rather than in the open sun, meaning that it does well if grown with or adjacent to other plant species (Perfecto and Vandermeer, 2015). Varieties of coffee range from Bourbon, Typica, and Catuai – but there are a range of others. Each variety has its own qualities, cherry shape and color, and harvesting times (Hoffmann, 2014). Overall, *Coffea arabica* is a sensitive crop, responding to the slightest change in climate, and requiring proper knowledge and experience to produce necessary yields. That being said, coffee farmers must make proper decisions to manage the coffee trees, and these decisions impact not only the coffee, but the surrounding ecosystems. In order to obtain successful levels of coffee growth, a farmer must have a set of necessary resources, knowledge and technology, especially with combatting climate change.

Climate Change:

As the negative impacts of climate change loom into the coffee industry, farmers need to adapt and alter their decision-making to maintain coffee yields and address environmental concerns. Coffee agroecosystems and shade-grown coffee can combat the impacts of climate change and can ensure that yield is maintained (Gordon et al., 2006; Perfecto and Vandermeer, 2015). Climate change includes changing temperatures, precipitation levels and storm occurrences. Agroecosystems are better prepared for these changes and are able to provide a resistant ecosystem. To start, coffee heavily depends on precipitation, especially in the Neotropics. Coffee requires a set wet and dry season in order for flower buds to form, and heavy wet seasons lead to rapid fruit growth. The availability of water has been known to affect photosynthetic rates, fruit set levels and size. For example, after a decrease in precipitation in a southern Mexican coffee farm, there was a decrease in production of 40-80% (Perfecto and Vandermeer, 2015).

Coffee is also sensitive to microclimates – especially for Arabica requiring a temperature between 18 and 34 degrees. The temperature increase can affect fruit quality because the development and ripening of the cherry is accelerated. Shade trees in coffee agroecosystems provide better microclimates for coffee by buffering the temperature and humidity fluctuations. Coffee

agroecology has a diminishing impact on expected consequences of changing climate by providing more agroecological resistance to extreme storms and winds, maintaining microclimatic conditions, and combatting against the changing temperature and precipitation (Perfecto and Vandermeer, 2015).

Direct Trade may be a way that farmers can learn more about climate change, and how to maintain quality and yield of coffee with the lower temperatures and rainfall. Also, trading directly with specialty roasters can help farmers learn that change will actually occur, and they can learn techniques to not only help coffee yield and quality, but also adopt eco-friendlier agricultural practices to reduce their impact on the environment. Although these goals may be achieved with other certification systems, Direct Trade attempts to be more influential by not only connecting the producer with the roaster, but also connecting the producer with the consumer.

Coffee Pests

Sustaining coffee yield and quality can be difficult with the presence of pests and understanding how to handle the plethora of pests infecting coffee trees can be an important factor when making agricultural decisions for farmers. There are numerous pests affecting coffee which can lead to decreased sales and environmental degradation. In order to manage coffee pests to ensure coffee yield, farmers relied heavily on chemicals. However, studies have indicated that using pesticides harm the product, and a decrease in chemicals must be attained (Carvalho, 2006). One technique to achieve this is by utilizing the natural predators to coffee pests within surrounding ecosystems (Perfecto and Vandermeer, 2015). Other tactics include reducing chemical usage or using chemicals only where necessary.

According to technicians associated with Cooxupé[1], below is a list of common pests found within the coffee farms of the Brazilian region examined.

1. Berry Borer Beetle – *Hypothenemus hampei*

[1] A co-operative visited during the study.

2. Coffee Leaf Miner – *Leucoptera coffeella*
3. Coffee Cicadas – *Homoptera, Cicadidae* – no specific name, different types in different regions
4. Spider Mites (Acari) – *Tetranychidae*
    a. Most common – Red Spider Mite – *Olygonychusilicis*; Leprose Spider Mite – *Brevipalpus phoenics*

The coffee berry-borer (CBB) is a small beetle burrowing into the coffee seed, destroying the seed by allowing other fungi and bacteria to enter the fruit. Techniques to combat the CBB include using pesticides which may be ineffective since the beetle burrows into the coffee fruit before infecting the seed, so chemicals rarely affect the pest. Coffee leaf rust acts as a parasite on the *Coffea*, forming pale spots on the leaves, creating spores resulting in the loss of foliage (Nutman and Roberts, 2009). Additionally, the coffee leaf-mining moth is one of the main pests to coffee in Brazil where the larvae mine the leaves leading to a reduction in photosynthesis. This leads to a reduction in coffee yield and decreases plant longevity (Fragoso et al., 2018).

This is an important agroecological aspect to understand since pests can determine whether or not a crop is successful, and management of the pest can be harmful to the plant and the environment. A harmonious balance between yield and the environment is necessary to continue meeting demands, and to maintain biodiversity. Pests can be a driver of decision-making for farmers and participating in Direct Trade may offer farmers new techniques to combat pests to maintain yield and increase quality.

Pollination

Although Arabica is a self-pollinating plant, research has indicated that with the presence of a native bee community, yield, quantity, and quality have improved. Pollination is an unknown necessity when it comes to coffee production. Fruit sets are more stabilized with greater diversity of native bees. Results from pollination tests reveal that fruit weight and shape in addition to the number of fruit produced increase with pollination by bees (Perfecto and Vandermeer, 2015). Arabica,

through research, has been proven to be an amphicarpic plant meaning that some flowers require cross pollination in order to produce a fruit, while others are able to self-pollinate. A study conducted on 24 coffee farms in Indonesia revealed that there is a positive correlation between bee species richness and Arabica coffee fruit sets (Perfecto and Vandermeer, 2015).

Coffee agroecosystems provide a better habitat for bee populations. Within the agroecosystem of coffee and shade trees, bees have more variety of trees and plants to pollinate, increasing the diversity of bees, and increasing the quality and quantity of coffee. However, this can only occur if few chemicals are used within the farm, and if more trees are incorporated.

A Costa Rican coffee study calculated the value of pollinating services provided by bees to be US$62,000 since the bees help maintain and increase yield (Perfecto and Vandermeer, 2015). Collection of data from global coffee harvests and various field studies indicate that coffee plants benefit when grown within the habitats of pollinators. This also means that farmers receive a higher revenue from the coffee due to the increase in crop yield and possibly quality (Veddeler et al., 2008). Research concludes that non-native honeybees can increase yields by over 50%, and the weight of the coffee cherries increase when the coffee flower is pollinated (Roubik, 2002). The coffee yield in Latin America increased at the same time the African honeybee was established – revealing the positive correlation between pollination and crop yield (Roubik, 2002).

With the presence of more native vegetation, and the creation of an agroecosystem within a coffee farm, the pollination by bees will increase. As this occurs, there will also be an increase in crop yield and possibly revenue. Thus, bee presence is a clear indicator of agrobiodiversity and the presence of an agroecosystem. If bee populations are maintained within a coffee farm, it could have a direct impact on yield and quality, while also maintaining ecological processes.

2.2 Direct Trade

Currently, within the specialty coffee industry and the coffee trade, Direct Trade holds prominence and must be addressed for the purpose of this study. Direct Trade is commonly referred

to as 'relationship coffee' within literature, and emerged simultaneously with the third wave of coffee[2] (Manzo, 2010). Although it is not notably mentioned within academic literature, it still maintains a presence. Reasoning behind this may be that it is an informal trade practice, where specialty coffee roasters engage with small to medium-sized coffee farms, creating a direct relationship involving personal interaction, trust, transparency of prices, a dedication to improving coffee quality, and improving the livelihoods of coffee farmers (Vicol et al., 2018). Additionally, Direct Trade relationships aim to address the sustainability of coffee and the changing climate by guiding farmers towards these goals (Weissman, 2018). This is marketed to the consumer and verified through stories, photographs of farmer interaction, and various forms of online marketing (Holland, Kjeldsen and Kendrup, 2015). Moreover, Direct Trade relies heavily on trust with the consumer. It is also necessary to understand that Direct Trade does not indicate an exclusion of trading firms and other intermediate actors, meaning that exporters and importers are sometimes included within the direct relationship (Holland, Kjeldsen and Kerndrup, 2015; Vicol et al., 2018).

This is where a debate occurs regarding Direct Trade and 'relationship coffee.' There is no way to verify the label, as there are no third-party certifiers, and it relies on trust. Additionally, the definition of Direct Trade is not well-structured, so it may be difficult for consumers to understand exactly what it means. The term is sometimes referred to as a red-herring, misleading consumers into thinking the coffee they are drinking was hand-picked by a specialty roaster, and that a relationship is maintained to ensure the quality of coffee and the improved livelihood of the farmer. The fact that this view is based on trust may also mean that it is easy for invalid information to be used and could lead to a mislabelling of coffee.

Yet, with certain certification systems, having that third-party auditing system may not be effective, as mentioned earlier, due to the 're-commoditization' of labels such as Fair Trade (Daviron and Vegneron, 2011; Raynolds, 2008; Vicol et al., 2018). Direct Trade may be a solution, but it does

[2] A movement within the coffee industry when specialty coffee roasters began to create partnerships with producers throughout the world.

involve a hefty amount of trust that could be misused (Gutierrez et al., 2014; McDermott, 2011). However, within this study, the exporting organization examined is considered to conduct valid Direct Trade practices and maintains the standards of the 'relationship coffee' model.

Trading directly also means that farmers receive a significantly higher price for their coffee compared to the conventional coffee market and Fair Trade prices. Depending on the roaster, these prices can be roughly 30% above the Fair Trade price (*Bailies Coffee Roasters*, 2018). This ensures that quality is upheld, and that farmers' livelihoods are also supported. Evidently, Direct Trade is having considerable impacts on the coffee industry but there is less clarity over how it may be impacting how farmers make agricultural decisions, particularly with respect to managing coffee and environmental decisions.

2.3 Coffee Quality

As more farmers are integrated into the specialty coffee and Direct Trade market, more farmers are attempting to improve coffee quality, which also correlates with various agricultural practices (Rappole et al., 2003). These changes can also directly impact the environment. The quality of coffee is assessed when a green buyer representing a roasting company cups each coffee and grades the coffee according to a set of certain attributes. Some of these attributes include fragrance/aroma, flavor, acidity, balance, and aftertaste (SCA, 2017). Within the specialty coffee industry, coffee must attain a score ranging from the mid-80s to the lower 90s. According to the Specialty Coffee Association, coffees scoring 90-100 are outstanding, 85-99.99 are excellent, 80-84.99 are very good, and 80 or less is below specialty quality. The importance of coffee quality first became a central aspect of the trade of specialty coffee within the past few decades during the second and third-wave of coffee and is also considered to be part of the 'quality turn' within the agriculture industry (Goodman, 2003). Through time, the quality of coffee grew into the sophisticated series of tests and cuppings mentioned earlier.

Although the process of understanding the quality of coffee is somewhat complicated, it reveals that quality is a green buyer's main priority when visiting coffee farms. In order to maintain quality,

constant work within the farm and outreach conducted to specialty roasters or various exporting companies must be attained (Holland, Kjeldsen and Kerndrup, 2015). Increasing quality can open the door to Direct Trade for farmers with higher prices and bring new opportunities to learn more about various agricultural practices.

2.4 Agrobiodiversity and Agroecology

Agriculture is considered the driving force behind biodiversity loss, and coffee is one of the drivers of this loss in the Neotropics. Yet, agroecosystems attempt to solve this issue by incorporating the production of crops with surrounding ecosystems – utilizing concepts such as land sharing and sparing (Ellis, 2013). Agriculture was intensified after World War II as populations increased, leading to monoculture, use of chemicals, and focus on yield (Thrupp, 2000; Balmford et al., 2005). This is also classified as agricultural intensification, which includes characteristics of reducing crop diversity within a farm (Perfecto and Vandermeer, 2015). This trend increased throughout the 1950s, leading to a loss in biodiversity. Specifically, the impact was made by coffee in countries such as Colombia, Brazil, and other Central American countries eliminating shade, agrobiodiversity and increasing the usage of chemicals.

Farmers began to transition back to traditional agricultural systems, incorporating native vegetation into their systems, and taking advantage of the benefits from surrounding ecosystems (Rappole et al., 2003; Gordon et al., 2006; Perfecto and Vandermeer, 2015). Coffee agroecosystems emerged, creating a technique for farmers to utilize the natural benefits of wilderness areas to maintain crop yields. This ensures that food security is maintained, while also preserving biodiversity. Biodiversity is a necessary component of food production but it is also valuable to environmental conservation.

Agrobiodiversity is an element of agroecosystems, and encompasses many types of biological resources associated with agriculture (Thrupp, 2000). Agrobiodiversity, or agricultural diversity, includes a variety of plant species within a given crop area, but also includes the way farmers are able to exploit biodiversity to produce and manage crops, land, water, insects, and biota (Thrupp, 2000).

This does not only include the farming system, but also the habitats and species outside of the farming system that provide natural benefits to maintain ecosystem functions.

Farmers have the ability to increase the agrobiodiversity of their farm by incorporating more native vegetation which can then have a plethora of impacts on the surrounding ecosystems. Planned biodiversity is when the diversity of organisms within a farm are purposefully altered by the farmer introducing native species (Perfecto and Vandermeer, 2015). The associated biodiversity, or the overall biodiversity of the area is then able to increase and remain stable. Incorporating agroecology into farmers' decision-making process may allow farmers to preserve biodiversity, while also ensuring yield is maintained.

2.5 Land Sparing Land Sharing

As mentioned earlier, a debate surrounding food security and preserving biodiversity emerged which can be applied to the coffee industry in areas such as Brazil. Land sparing occurs within an agricultural system where one area is designated for intensive food production with surrounding areas of protected wilderness – bringing high agricultural yields. On the other hand, land sharing is generally less intensive, lower-yielding, but incorporates wildlife into agriculture on a larger area of land (Kremen, 2015). Both enhance and promote biodiversity of the area, and act as a solution to habitat loss through agricultural intensification. These agricultural systems facilitate the need to feed the growing population, while also maintaining the world's biodiversity, decreasing the trade-off between biodiversity conservation and food production.

The urgency to conserve the world's biodiversity and meeting the demands for land to produce food, fuel, and other resources for society has led to the need to adapt and alter the world's farming practices. Land sparing first emerged during the Green Revolution in the 1960s as Norman Borlang facilitated the growth of hybrids and chemically-altered plant species, leading to the conservation of several hundred million hectares of land (Rudel et al., 2009; Perfecto and Vandermeer, 2015). Although the impact of the Green Revolution is inconclusive, the land sparing-sharing framework has been recently developed in order to begin work towards species conservation to understand its

effect (Balmford et al., 2005; Green et al., 2005). In order to successfully achieve land sparing, it requires sustainable intensification of agriculture (Phalan, 2011). It has come into question which strategy would harm biodiversity less, and the answer requires an understanding of species' population densities compared with a level of crop yield. Studies have indicated that most species' populations would remain at stable or at high levels under the land sparing system compared to the land sharing system (Phalan, 2011). This is true for widespread species, among various taxa from different regions, and species with small global ranges. Further spatial and temporal research must be conducted in order to understand the true impact each system has on biodiversity and food production. However, past studies have not looked into the long term persistence of species' populations, and it is concluded that a newer adaptive framework must be created to address social and environmental issues, including both aspects of land sharing and land sparing (Rudel et al., 2009).

Within some areas, it is difficult to execute the concept of land sharing in replacement of traditional agricultural methods due to the decrease in crop yield. Farmers may have been growing a single crop for generations and it may be difficult to adopt either of land sharing or land sparing. Yet, transitioning these monoculture farms into land sparing systems may be easier than incorporating more vegetation and wilderness into the croplands. This system could be integrated within a farmers' agricultural decision-making process to improve sustainability within the farm while also facilitating corridors to maintain biodiversity.

Critics of the LSLS framework indicate that there are some limitations and assumptions associated with the model. Currently, with a constantly growing population, the need to grow food is high – yet this may not be the case in the future. In addition, even if one area of land is used for agriculture, and the other used for wildlife conservation; the negative impacts of agriculture such as chemical usage might possibly seep into protected areas. Not only that, but there are secondary negative consequences of agriculture such as the Dead Zones within the ocean due to high Phosphorus levels from agricultural runoff (Balmford et al., 2005; Green et al., 2005; Kremen, 2015; Rudel et al., 2009; Thrupp, 2000). Lastly, overproduction has been an issue in some areas, and this could continue to be

a problem if too much food is grown within an area and is too much to feed a population (Perfecto and Vandermeer, 2015). Coffee and Direct Trade could be a solution to this issue and understanding the decision-making process of farmers may indicate how land sparing and land sharing could be used within the coffee industry.

Brazilian Forest Code

Through legislation, the Brazilian government has attempted to incorporate agroecological principles by requiring farmers to protect areas of land within their plots. The Brazilian Forest Code was enacted by the Vargus administration in 1934 to improve and regulate forest management within the agricultural sector of Brazil. The New Forest Code was released in 1965 to improve the infrastructure and goals of the Code to make it easier for farmers and landowners to make the transition to creating protected areas within his or her land. Over time, various revisions and amendments have been made and the enforcement has increased within the last few decades. In 2012, the Brazilian government released an updated version which states that it is necessary to protect native vegetation within an agricultural area (FC, 2012). This is achieved through two land protection methods: Legal Reserves and Areas of Permanent Protection. Legal Reserves were defined as an area existing in a rural property with the goal of creating sustainable use of resources and restoring ecological processes and biodiversity. On the other hand, Areas of Permanent Protection are areas protected in order to preserve water resources, geological functions and to protect soil to ensure the well-being of human populations. With regards to coffee farms, the farms are required to have an area set aside as a Legal Reserve so Areas of Permanent Protection will not be addressed within this study (FC, 2012).

Article III Section III describes a Legal Reserve as an area within a rural property that is protected in order to ensure sustainable use of the resources provided by nature (FC art. 3, 2012). The Code also states that the Legal Reserve should promote the conservation of biodiversity and protect native wildlife and flora. By law, farmers must have at least 20% of agricultural land set aside as a Legal Reserve. The Forest Code outlines techniques for landowners to delimitate the land for Legal

Reserves, and a management plan must be submitted to state-level authorities to be approved (FC, 2012). This law helps farmers learn about the importance of protecting native flora and fauna and can attempt to facilitate awareness of agroecology.

2.5 Developing the Theoretical Framework

In order to understand how farmers make decisions and how these decisions impact the environment and biodiversity, the Relationship Coffee Model is assessed (Hernandez-Aguilera et al., 2018), and combined with the value-rules-knowledge (vrk) framework created by Gorddard *et al.* (2016). The Relationship Coffee Model is a conceptual framework that was established to understand the specialty coffee business, the long-term relationships created with producers to ensure quality, while also examining certain inputs leading to a number of long-term outcomes. The focused inputs are agricultural practices and knowledge such as incorporation of more native plant species, chemical usage, pruning, and presence of pollinators and pest predators.

Additionally, to understand why the farmers make certain decisions regarding their farming practices to adapt to the changing climate and market, the study will also be framed around the value-rules-knowledge (vrk) theoretical framework developed by Gorddard et al. (2016). The vrk theoretical framework resembles the values, rules and knowledge used by a subject(s) as variables in the decision-making process with regards to adaptation to the changing climate but can be employed in a number of other contexts. Below, each factor of the vrk framework is laid out with the importance each factor has regarding coffee farmer decision-making.

Values

Values heavily influence decision-making primarily because it represents a cultural and emotional aspect of someone. Kerkhoff (2017) mentions that values encompass not only cultural, but also personal and ethical aspects that influence the preferences people have when questioned about specific knowledge and rules. A study within Peruvian Quechua communities farming potatoes and maize concluded that values originate from the goals a farmer might have, which could be

influenced by quality (taste), monetary gain, and heritage (Zimmer, 1991). Values are not rules, and do not hold a farmer back from making decisions. They provide personal guidance with an ethical standard relating back to culture and heritage.

With regards to Brazilian coffee farmers, values comprise a large portion of a farmers' decision-making. This is primarily due to the fact that Brazilian coffee farming is family-based, and farmers tend to follow in his or her family's footsteps. It is difficult to break these farmers from tradition, and they are proud of the coffee farms their ancestors created which is revealed later in the study. That being said, decisions will normally be made keeping in mind the past and how the older generations maintained the coffee farm.

Rules

Compared with values, rules differ slightly in this conceptualization in that they are generally created by governing agencies and must be followed such as laws or policies geared towards farmers. Gorddard et al. (2016) notes that rules can be formal or informal, and can range from a collection of practices, habits, regulations, legislations, and treaties; but can also be constraints such as a lack of water or a possible threat from climate change (Soler and Cleveland, 1993; Turner, 2016). Rules are conceptualized as influencing objects that in turn create implementation, yet the lack of resources can also influence a farmer's decision-making process more than a piece of legislation (Agrawal, 2017; Colloff et al., 2017; Gorddard et al., 2016). A lack of resources or restriction within nature can act as a rule and guide decision-making.

When considering Brazilian coffee farmers, people who own land in Brazil are faced with numerous legislations due to the government's goal to protect and preserve biodiversity. An example is the Brazilian Forest Code, described earlier, stating that farmers must have an area set aside as a protected Legal Reserve. The government may also impose regulations regarding chemical usage and bans on various chemicals.

Additionally, farmers may be faced with struggles such as climate change that could influence decision-making. This could include the reduction in precipitation, more sunlight, and increased temperatures. Here, farmers may need to make different decisions in order to ensure a profitable crop yield.

Knowledge

Farmers have ranging forms of knowledge that guide how and when to make agricultural decisions. Knowledge may refer to various forms of judgements or beliefs regarding the socio-ecological system and how it functions, in addition to an awareness of future changes and impacts of certain decisions (Kerkhoff, 2017). A study found that indigenous farmers in Chiapas have a collection of 'traditional ecological knowledge,' in addition to an understanding of modern technology to make decisions within their farms (Bellon and Taylor, 1993). Knowledge can range from local to global, and from specific forms of knowledge to a knowledge generated from experience. Regardless, the knowledge farmers generate over time help influence their decision-making, and these decisions continue to build on each farmers' knowledge base.

Brazilian coffee farmers, for example, range from university-educated, to hobby-farmers. Many farmers attended a university to gain an education in agronomy, while others took on coffee farming as an attempt to make a profit. Some coffee farms have existed for over 100 years, and the knowledge within those farms was generated over time within the family. Yet, some farmers earned a degree to understand agronomy better in order to increase quality, yield, and the health of the farm and environment. As discovered when visiting coffee farms in Brazil, the cooperatives also provide lecture series that attempt to educate farmers about certain agroecological principles. Agronomists regularly visit coffee farms in order to educate and ensure the health of the farm is maintained, as well.

Regardless of the form or level of knowledge, each farmer carries a wealth of knowledge that he or she uses to guide the decision-making process.

Relationship Coffee Model/vrk Framework

The vrk framework will be incorporated into the Relationship Coffee Model to create a new framework to understand how coffee farmers make decisions with the presence of Direct Trade or the conventional coffee market, and the impact on agroecology and the environment. Below (Figure 2.1) is the proposed framework to describe the relationship between how farmers make decisions, the influence of the coffee market and how the decisions impact the environment. The values, rules and knowledge that influence each farmer's decision-making also coincide with production factors such as maintaining yield and increasing quality. Additionally, other production factors including size of the farm and capital also drive farmers' decisions. The vrk and production factor considerations then contribute to the actual decisions made by a farmer regarding technology, agricultural practices etc. The decisions made here are impacted by the trading arrangements each coffee farmer is associated with. This includes Direct Trade, and the conventional coffee market. Essentially, what each farmer does within his or her farm must comply with each coffee market.

Lastly, the previous steps all contribute to environmental and social outcomes. This includes the impact on biodiversity in addition to a farmer's livelihood. Moreover, these environmental outcomes can also influence a farmer's decision-making process, and the conceptualization is visualized in a linear fashion for the analysis, but in reality, it is more interconnected and dynamic. A farmers' decisions may directly benefit the environment, and this may influence how a farmer decides to grow his or her coffee in the future. Also, rules and regulations may demand that coffee farmers reach certain environmental outcomes, and this will also relay back to the initial decision-making phase.

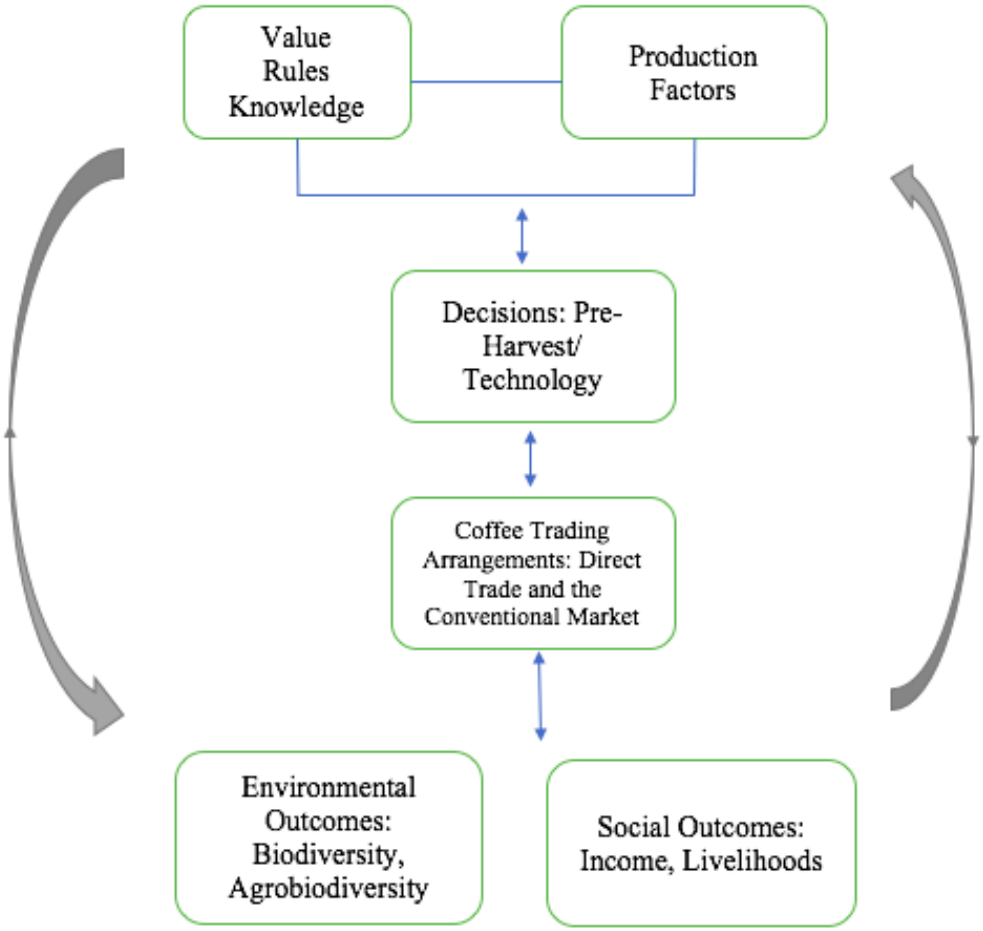

Figure 2.1: Incorporating the Value, Rules, Knowledge framework as a driver of why farmers make a change with regards to certain production factors such as the use of certain technology and harvesting techniques, leads to a new form of decisions made by the involved farmers. The flow simplifies the interactions between the decision-making process, and the impacts decisions have on the environment and social factors. Additionally, the type of coffee market (i.e. Direct Trade and conventional) have a place within the decision-making process. In the long run, this can lead to environmental changes and outcomes such as an increase in agrobiodiversity, also linked with overall biodiversity.

3. Methodology

This section lays out the methods for collecting data and analysing the results. In order to conduct the research, a mixed-methods approached was used and is described in the following sections. Limitations were also considered, and mitigations are addressed and explained. Overall, eighteen farms were visited in the Minas Gerais and São Paulo region of Brazil, ten of which were associated with SMC and Direct Trade, and eight of which were commodity-level farmers associated with Cooxupé.

3.1 Location

The coffee farms visited were all located within the Minas Gerais and São Paulo states within Brazil. Specifically, the farms were situated in South of Minas, and Mogiana as indicated in the map below, all farms ranged with size and location (Figure 3.1). Minas Gerais and Mogiana are two of the top coffee-producing regions in Brazil, and provided an excellent case study area for understanding how farmers make decisions (*Brazilian Coffee Regions – Casa Brasil Coffees*, 2015). Each farm displayed a dominant farmer that made most or all of the decisions within the farm. The farms were purposively selected based on involvement with certain coffee markets (conventional and Direct Trade) which helped understand the impact the market type had on coffee farmers and their decision-making. Farms were spread out within the regions, although some were located in the same areas as indicated in Figure 3.2.

Figure 3.1: Map of States visited in Brazil. Minas Gerais (South of Minas) and Mogiana were the locations of the farms visited.

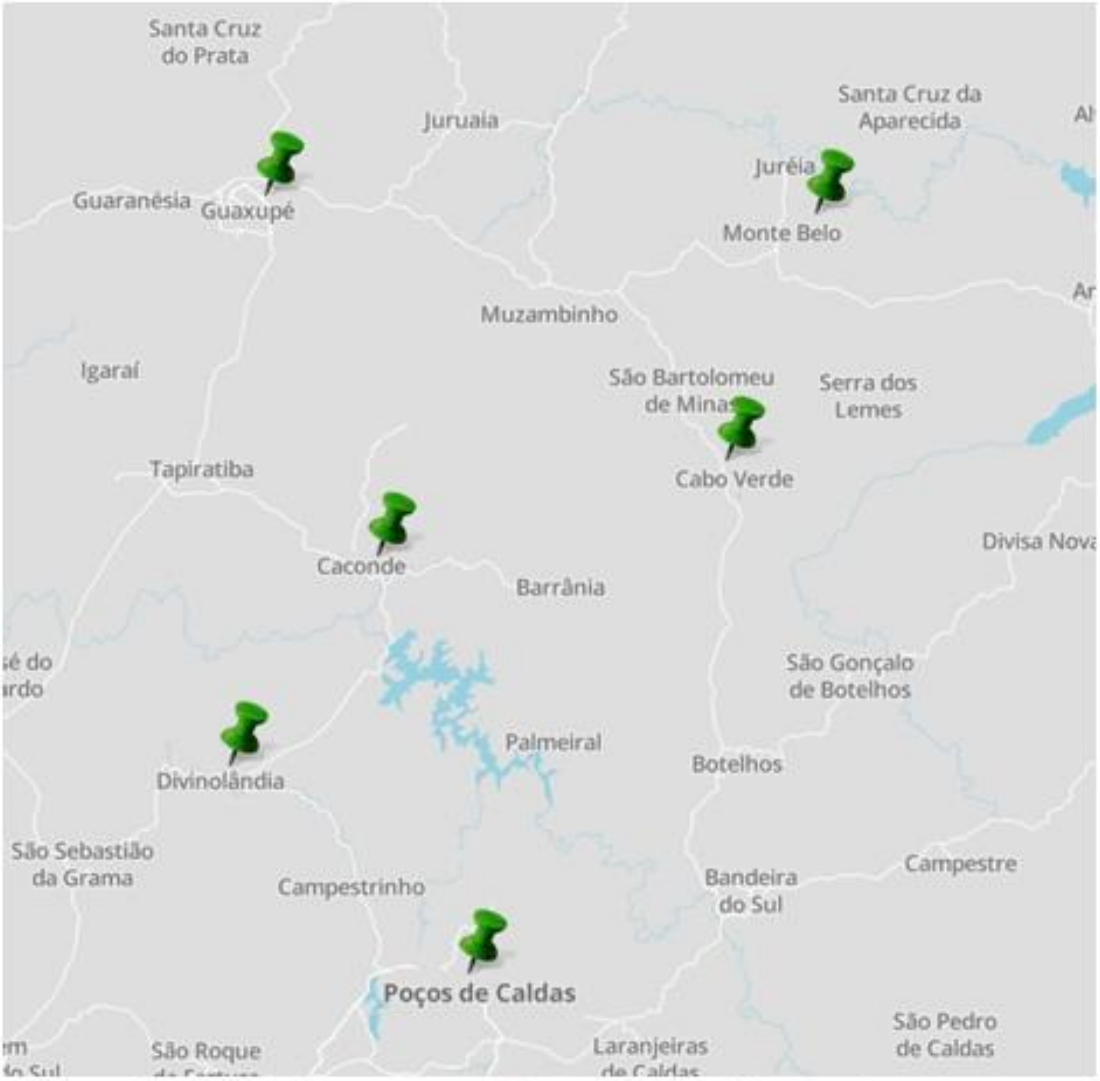

Figure 3.2: Pinpoints show approximate locations of studied farms; each point represents a region where a number of farms were visited.

3.1.1 SMC and Cooxupé

In order to understand the relationship between quality and agricultural decisions, farms were visited in southern Minas Gerais associated with SMC and Cooxupé. By assessing a selection of farms associated with Direct Trade, and farms not associated with Direct Trade, this relationship could be revealed.

SMC is a specialty coffee cooperative located in Minas Gerais consisting of a collection of twenty farms working towards improving the quality of coffee in order to sell to specialty roasters. It is managed and run by the larger cooperative Cooxupé and seeks to improve coffee quality and connect high quality coffee with specialty roasters around the world to earn farmers a higher price and create transparent relationships. The company first started twenty years ago as Alfenas Café and became SMC nine years ago after it was bought up by Cooxupé. Each farmer produces his or her

own lots that are directly traded to roasters and are not conglomerated with lots from other farms. This allows the coffee to be traceable and recognizable.

Cooxupé, on the other hand, is the largest cooperative in the world, consisting of roughly 40,000 farmers, 90% being smallholders. Cooxupé focuses on yield, and conglomerates coffees from farms based on certain types and classification. Within each Cooxupé farm, the 4C and C.A.F.E. Practices certifications were achieved, both of which are described in later sections. Cooxupé also employs agronomists that regularly visit farms, provide advice for farmers, in addition to aid with regards to agricultural technologies, chemicals, and other necessary tools. Warehouses function throughout Minas Gerais as hubs for farmers to visit if they require agricultural advice or certain tools. The Cooxupé agronomists also visit SMC farms (less frequently) to ensure the health of the soil and coffee trees are maintained though the conduction of annual tests.

3.1.2 Certifications

Each farm varied with regards to which certifications were held and maintained. As mentioned earlier, all Cooxupé farms were required to maintain Starbucks' C.A.F.E. (Coffee and Farmer Equity) Standards and the 4C Certification. Other farms had certifications including Utz, Rainforest Alliance and Fair Trade. The 4C Association was created to begin making sustainability goals within coffee farms, working to improve the economic, social and environmental conditions of coffee production (4C Association, 2010). C.A.F.E. Standards ensure similar goals with regards to coffee farming and sustainability (C.A.F.E. Practices, 2017). Utz and Rainforest Alliance are similar, aiming to create sustainable growth of goods and equal trade of goods worldwide specifically aiming at certain environmental standards (Utz and Rainforest Alliance, 2017).

Four of the SMC farmers were also associated with Aprod, an external organization made up of 57 smallholder coffee farmers that sell coffee directly to SMC or with Fair Trade. SMC interacts with individual farmers that work with Aprod. Aprod also works with Bourbon, another Direct Trade organization in Brazil. The presence of a certification system has a possible impact on the decision-making process occurring within a farm.

3.2 Interviews

Semi-structured interviews were the principle means of data collection and were conducted to allow farmers to not only answer the questions but add supplemental information if necessary. General questions were gathered, and each interview allowed for the farmer to answer each question to his or her own extent. Farmers were free to answer as long as they felt, yet the interviews maintained a structure that sought certain answers from each farm.

To prepare for the interviews, two question lists were generated – one set of questions for SMC farmers and another list for Cooxupé farmers. The set of questions for each farmer set (Appendix 1) were used on ten SMC farmers and eight Cooxupé farmers each lasting from 15 – 60 minutes. Farmers interviewed were randomly selected based on who was available to answer questions and willing to participate.

Interviews were translated and transcribed. In order to code the interviews, common themes and answers were grouped together to understand the similarities and differences between the farmers (Miles and Huberman, 1994).

General limitations of the interviews may be regarding bias towards what respondents wanted researcher to hear and record, which could be difficult to make proper and true conclusions. Before each interview, respondents were assured that his or her answers would be used for research purposes and that they would have access to the research after completion.

The semi-structured interview style worked more efficiently because it allowed farmers to add additional information not asked within the questions. This is recommended to be used when situations only allow for the researcher to speak with a respondent one time, which was the case for this study (Bernard, 1995).

3.2.1. Interview Questions

A general list of questions were generated in order to frame the interview with each farmer. Question sets with SMC farmers had the same basic structure but varied slightly to the Cooxupé

question sets in order to match the context. With SMC farmers, general background information was acquired with regards to the farm size, history, production, and percentage of Direct Trade coffee sold. Duration of time trading directly and perception of Direct Trade was also acquired to understand how each farmer viewed Direct Trade. Next, SMC's impact was assessed, and it was questioned if SMC and quality of the coffee have an impact on agricultural practices.

The next set of questions related to specific agricultural practices and certain agroecology indicators. This included the amount of chemicals used, incorporation of native vegetation such as shade trees, wind breakers, and any other vegetation planted with coffee. Additionally, the Legal Reserve was questioned – the size and history, in addition to if the farmer noticed any natural benefits from the protected area. This includes benefits from pest predators such as birds, the presence of bees, and impact of wind breakers. Farmers were able to add any additional information necessary.

Farmers were then asked to describe how they make agricultural decisions. Additionally, farmers discussed the future of the coffee farm, and the lingering impact of climate change.

The Cooxupé interviews were structed similarly, but rather than asking about Direct Trade and SMC; farmers were asked about Cooxupé and other certifications' input on how the farmers made agricultural decisions. The same questions were asked about various agricultural practices, the Legal Reserve, and the agroecology indicators. The interviews concluded by asking about the future of the farm, and the impact of climate change.

3.2.2. Other Interviews and Data Collection

Aside from interviewing coffee farmers and recording the answers to the interviews, there were other forms of data collection. This included interviews and discussions with SMC officials, Cooxupé agronomists and representatives, and a specialty coffee green buyer. Additionally, the visits to each farm overall were a form of data, as the environment and organization of the farm, and the overall tour of each farm culminated into final understandings of each farm and of each group of farmers.

3.3. General Limitations

Time was limited during the collection of data from the interviews conducted with coffee farmers. Only eighteen farmers were interviewed over the study duration of two weeks. This was also due in part to the distance of the coffee farms – each being roughly an hour or two away from the other. A longer period of time, and more extensive visits of the farms would have been more beneficial to understand the impact of SMC and Cooxupé. However, the results gained from the eighteen farms were sufficient to understand the decision-making process, impact of market involvement, and how decisions affected the environment.

Additionally, on-the-ground data collection including soil sampling, leaf tests, and other ecological samplings were not conducted. This type of data would have provided more evidence to support what farmers stated about the farms, soil, and coffee.

Although this was a small-scale qualitative study with few data from a small number of farms, it could contribute to a larger study to develop more concise conclusions about coffee farmers and decision-making.

4. Results

Below, the results are organized based on the findings generated from each research question. To start, a collection of statistical information is displayed in tables, followed by the vrk factors influencing each farmer. The following section addresses how each farmer makes decisions with regards to the vrk framework, assessing how values, rules, and knowledge influence farmers' decision-making. The next section then reviews how agricultural decisions impact various environmental aspects of the farm, in addition to how the decisions impact coffee quality and income. Next, the land sparing land sharing concept is evaluated based on the information collected from each farm. The last section gives a general overview of the results discovered from the interviews. Within each section, the vrk framework is used to understand how each farmer makes decisions, and how the decisions impact various factors within the farm.

Table 4.1a: Summary of background of SMC farms visited. Means were calculated, but statistical differences not tested due to the sample size.

	Farm Duration (years)	Farm Size (ha)	Production (Direct Trade %) (Bags/year)	Involvement with Direct Trade (years)	Size of Legal Reserve (%)
1	75	180	6,500 (N/A)	5	30
2	76	150	N/A (25%)	10	36
3	75	80	5,000 (50%)	7	28
4	10	100	3,000 (70%)	6	20
5	75	230	8,000 – 12,000 (40%)	16	20
6	100	25	1,000 (30%)	4	20
7	20	6.5	300 (50%)	13	20
8	17	7.5	250 (100%)	13	20
9	20	7	130 (50%)	13	20
10	100	200	10,000 (50-60%)	20	25
Mean	57	99	3,798 (94%)	11	24

Table 4.1b: Summary of background of Cooxupé farms visited. Means were calculated, but statistical differences were not tested due to the sample size.

	Farm Duration (years)	Farm Size (ha)	Production (Bags/year)	Involvement with Cooxupé (years)	Size of Legal Reserve (%)
1	34	100	3,000	32	20
2	40	8	250	25	20
3	40	250	8,000	35	20
4	58	285	4,000	59	20
5	20	20	500 – 700	20	0
6	18	8	100 – 200	18	16
7	70	100	2,000	70	20
8	50	35	700	20	20
Mean	41	101	2,356	35	17

Table 4.2: Regarding the vrk framework, these are the main values, rules and knowledge that influence farmers' decision-making.

Values	Rules	Knowledge
Sustainability Yield Harvesting – Technology Post-Harvest (Natural, Honey, etc.) Quality	Brazilian Forest Code Limited Water Coffee Quality Scores	Agronomy Pest Control

4.1. Research Question One – Analyzing Different Marketing Channels' Influence

After visiting and interviewing ten SMC farms, a common theme was discovered amongst the farms and how each farmer made agricultural decisions. SMC had little impact on the decisions the farmers made pre-harvest including chemical usage, Legal Reserves, pruning, shade tree management, and incorporation of native vegetation. As a result, the claims made regarding Direct Trade and sustainability are only partially true, and farmers involved within Direct Trade have more knowledge and execute independent-decision-making to enforce various agricultural methods. SMC's primary role was to create relationships with the farmers and specialty roasters throughout the world, which was visible throughout each Direct Trade farm. The most impact SMC had on farmers pre-harvest was due to the Cooxupé agronomist that visited the farm to conduct soil and leaf tests, which only occurred annually. A majority of the farmers were already agronomists and had been studying agronomy for decades so the necessary knowledge was already present without aid from an outside agronomist (Appendix 2). In fact, one of the SMC farms acted as a model farm for other farmers to consult with agricultural questions.

However, SMC is able to connect farmers with specialty green buyers, the people associated with specialty roasters who go out and taste coffee from farms and decide which coffee to purchase. SMC helps facilitate this process, thus allowing farmers to learn about the quality of his or her coffee and perhaps how to improve it. When asked how each farmer viewed Direct Trade, the answers ran parallel with each other and all farms found the trading process to be beneficial. Common answers included references to creating long term relationships, transparency, better prices, and improving the quality of the coffee and the environment. Farmers are able to meet who buys the coffee, and how it will be brewed, roasted and served. This also allows for farmers to ask questions regarding quality, and ways to improve it. This can include changing techniques with post-harvest processes.

As mentioned by one farmer, "*agricultural decisions are made looking for ways to increase quality, productivity and coffee production*" and that "*quality is a driver of changing agricultural*

practices." Quality has an impact on the agricultural decisions made by the farmers, but the SMC farmers are independent and are able to make decisions based on their own knowledge and judgement.

On the other hand, different results were discovered with Cooxupé farmers. The farmers not trading directly with specialty roasters were more closely associated with the cooperative and relied on advice and aid from Cooxupé. Agronomists regularly visited these farms, compared to the annual visit to SMC farms. With a stronger dependence on the cooperative, quality was not necessarily a driving factor for agricultural decisions. Decisions were made primarily for the health of the farm, and to ensure yield.

Due to this relationship, Cooxupé farmers made decisions with much support from the cooperative. The farmers follow a set of rules and maintain the standards held by Cooxupé or by various certification schemes.

Overall, SMC's role primarily focuses on quality and trade, rather than influencing agricultural decisions. However, in order to participate within the Direct Trade market and maintain high quality, SMC farmers must make decisions geared towards improving quality. On the other hand, Cooxupé farmers are directed and regulated by the cooperative, and each farm depends on the agronomists that visit on a regular basis.

Values

Brazilian farmers take pride in the history and yield of their coffee farms. When asked about the duration of the farm, and the time producing coffee, farmers took time to explain the heritage and story of the farm. This indicated that the practices adopted by older family members were still maintained and used. Harvesting practices remained the same, and the values held by the farmers were clear when they relayed the history of their farms. The associated values that influenced decision-making on all farms is displayed in Table 4.2.

In some cases, farmers cared about the environment, and felt that not only must yield be maintained, but also sustainability. This was more common amongst SMC farmers, and there were more developed sustainable practices within these farms such as capturing methane from pig farms to generate power for the farm and using leftover coffee cherries as a natural and organic fertilizer for the coffee. Chemicals were more regulated within the SMC farms, and sustainability was a common theme amongst the farmers participating in Direct Trade.

On the contrary, although the Cooxupé farmers had sustainable practices, maintaining yield was a higher priority, in addition to new technology for harvesting. That being said, the conventional farmers did attempt to conserve water and adopt sustainable practices to improve the environment within the farms. Yet, these practices were more developed and prominent within the Direct Trade farms.

Values heavily influenced how each farmer made decisions, and these values ranged from continuing farming legacies, improving the environment and sustainability, maintaining yield, adopting new harvesting technology, and new post-harvest tactics (natural, honey process, etc.) (Table 4.2).

Rules

As noted before, each farmer must comply with the Brazilian Forest Code, meaning that each farm must have at least 20% of the land cover as a Legal Reserve. This meant that farmers must maintain an area of natural wilderness and can sometimes guide decision-making. Additionally, farmers noted that the usage of certain chemicals was against the law, and this was also an important factor within the decision-making process. One SMC farmer noted that "*there is a strict and demanding legislation in Brazil about the usage of chemicals*" and that the usage is decreasing due to legislation and application techniques.

Aside from the set laws and regulations from the Brazilian government, farmers were also guided by the limitations within each of their farms (Table 4.2). This included limited water usage,

harvesting methods, and utilization of certain agricultural methods. Due to low water levels, farmers used certain post-harvesting methods that required the usage of less water. This is known as natural processing[3]. Farmers ensured that Legal Reserves were placed in areas that preserved springs so that water could be conserved.

Harvesting was primarily conducted by machines on most farms, some had a mix of machine and hand-picking, and few had no machines at all. Due to the usage of machinery, this forced farmers to only plant coffee in consecutive rows to make it easier for the machines to harvest.

When comparing SMC and Cooxupé farms with regards to the rules used within decision-making, it was evident that SMC farmers had similar rules to Cooxupé farmers but followed the rules in a different fashion. For example, when looking at Table 4a and Table 4b, it is noticeable that the farmers associated with SMC were more likely to have a Legal Reserve, and more likely to have a larger Legal Reserve. These farmers were also more likely to discuss the wilderness within their farms and discuss the maintenance and importance of this area.

Additionally, the SMC farmers had stricter rules regarding chemical usage. Although chemical usage on every farm visited was decreasing from year-to-year, SMC farmers were more interested in reducing chemical usage, and maintained goals of using no chemicals in the future. More tests were conducted and organized on the SMC farms regarding chemical usage, and one farm took pride in their report on the various chemical data within the farm, with notes of each coffee variety, pest, and time of year to apply chemicals (Appendix 2). This was not present within the Cooxupé farms, but attempts were made to regulate chemicals.

Due to these listed rules and limitations, farmers made certain decisions to comply with certain laws and restrictions within the farm.

Knowledge

[3] Process where coffee cherry is dried in the sun to remove the cherry from the seed.

Farmers' understanding of agriculture, the environment, and coffee overall was a prominent decision-making factor within the farms visited. The knowledge factors that influenced decision-making are listed in Table 4.2. The SMC farmers were more likely to hold university degrees in agronomy, and had more knowledge of certain agricultural concepts, sustainability, and equilibriums within nature and farms. The knowledge within the Cooxupé farms was a combination of a farmer's experience and the education provided by agronomists who regularly visited the farm.

Overall, these forms of knowledge were what primarily guided certain agricultural decisions with regards to what chemicals to use, how and when to use them and where. Additionally, decisions on how to combat pests and improve yield primarily came from knowledge surrounding agronomy.

It then came into question if participating within Direct Trade required farmers to hold more agronomic knowledge, or if Direct Trade allowed farmers to gain this knowledge. Perhaps involvement with Direct Trade gave farmers more opportunities to take the time to ensure quality was maintained on the farm, in addition to sustainability. Yet, a small portion of Cooxupé farmers had a wealth of knowledge surrounding technology, harvesting methods, and some agronomic knowledge – but execution differed within the farm. Perhaps involvement with Direct Trade revealed how to increase sustainability within a coffee farm.

In summary, farmers involved with the conventional coffee market made decisions with the guidance of Cooxupé, whereas Direct Trade farmers relied less on SMC to make decisions. Direct Trade has more of an influence on post-harvesting methods (i.e. processing) but has limited impact on pre-harvesting decisions which are driven by the pre-existing values, rules and knowledge held by the farmers, as one SMC farmer noted "*SMC's impact occurs after the plant is picked, during post-harvest*" and helps connect farmers to clients around the world. Compared to a Cooxupé farmer who noted that the cooperative "*helped with agricultural decisions by offering courses and lectures in addition to offering new products such as better chemicals*" revealing the strong presence Cooxupé has within its farms.

4.2. Research Question Two – Assessing the Impact of Farmers' Decisions

Environmental Factors

This section examines farmers' key decisions that have an impact on the environment which range from chemical usage, native vegetation, pruning, and shade tree management. The decisions made regarding these factors have a direct impact on the environment and can determine the sustainability of a farm (Table 4.1a/b).

To start, chemical usage decreased over time on every farm, both conventional and Direct Trade. Yet, within the Direct Trade farms, chemical usage was drastically lower, and more natural forms of pest control were used. One SMC farmer noted that "*chemical usage on the farm has been reducing over the years*" and that the coffee is constantly watched to find the disease and control it. Other SMC farmers noted that "*the microenvironment and organic matter help the coffee*" and that coffee does not need chemicals. Additionally, the Direct Trade farmers were more likely to take advantage of the resources available and took time to record when each tree was infected with various pests to know when and where to apply the pesticide if necessary (Appendix 2). Chemicals were more regulated, and a goal of using zero chemicals was more likely within the Direct Trade farms.

Next, native vegetation was examined and questioned which included the use of wind breakers, shade grown coffee, and other native vegetation planted within the coffee trees. The Direct Trade farmers all took advantage of planting banana trees or other native trees as wind breakers (Appendix 2). Reasoning behind the usage of wind breakers included mainly protecting the coffee from wind and disease; but some farmers mentioned maintaining the microclimate and providing nutrients to the soil, in addition to preserving natural springs within the farm. With regards to shade, a large portion of the Direct Trade farmers mentioned that they have some or have attempted shade-grown coffee in the past, but it led to low coffee yields, and made harvesting difficult. The same answer was given when other native vegetation was inquired about. Some farmers had grasses and beans planted with the coffee to maintain Nitrogen levels within the soil. Yet, a majority of the

farmers maintained rows of only coffee to simplify harvesting since most harvested coffee cherries with a large machine that fit between the rows of coffee.

The conventional farms, on the other hand, differed slightly. Once again, wind breakers were used on every farm to protect the coffee from disease and wind. No shade was attempted on any of these farms, due to the same issues associated with the Direct Trade farms. And most farmers had only coffee planted on their farms, the few that had native vegetation within the coffee mentioned it was used for water preservation and maintaining soil nutrients.

The usage of pruning was also assessed, as pruning is key to maintaining not only the health of the coffee tree, but also the surrounding ecosystems. On both Direct Trade and conventional farms, pruning was carried out regularly, and the resulting clippings were left underneath the coffee trees to maintain soil nutrients and moisture levels. Additionally, a small portion of farmers used the pulp from the processing of coffee as a natural fertilizer. This occurred within the Direct Trade farms, in addition to one Direct Trade farm that used fertilizer from the on-site pig farm mentioned earlier.

Overall, Direct Trade and conventional coffee farmers both seemed to have an awareness for the environment and maintaining sustainability. However, Direct Trade farmers' techniques were more developed and more geared towards sustainability, with more organization, planning, and execution, these farmers maintained more environmentally-friendly practices, and understood the impact certain decisions had on the environment.

Land Sparing Land Sharing Concept

The specific concepts were not mentioned throughout the farms visited in Brazil, but there was a common theme that emerged regarding the coffee farmers' perception of the Legal Reserve within the farms. Direct Trade farms were more likely to have a Legal Reserve, and more likely to have more than the 20% legal requirement (Table 4a/b).

With a focus on the Direct Trade farms, one farmer noted that the Legal Reserve "*provides a natural balance*" with the coffee and nature in order to "*help prevent disease with the coffee*." The concept of balance and an equilibrium within the coffee farm was mentioned throughout the Direct Trade farms. This group of farmers found natural benefits from the Legal Reserves including pest management, disease protection, water conservation, maintaining microclimates, and improving soil quality. The presence of bees was also noted, and many mentioned that the Legal Reserve allows for the presence of more pollinators. One farm was even the center of a study regarding bird and bee populations within the farm. Another farm had a goal of keeping bees within their farm to not only produce coffee blossom honey, but to also increase the quality of the coffee.

Within the conventional coffee farms, a different view towards the Legal Reserves was discovered. When asked about the benefits of the Legal Reserve, conventional farmers were more likely to mention water conservation. Although this was also a benefit within the Direct Trade farmers, it was not the only source of benefits. Some of the conventional farmers also mentioned that the Legal Reserves actually harmed the coffee farm because the native vegetation provided habitats for coffee pests. Some farmers also noted that the Legal Reserves did not help with pest management, and that in order to maintain the presence of pests, chemicals were necessary. Perhaps this differing view is due to a gap in knowledge of natural areas and natural benefits. Although these farmers maintained a Legal Reserve, they did not notice many natural benefits coming from the Reserve.

Overall, the SMC farmers were more likely to notice benefits from nature, or in other words, from executing the land sparing concept within the farm by having a protected Legal Reserve and an area for coffee production. This was not coherent within the conventional coffee farms, however, who did not see the same benefits from the Legal Reserves.

Quality Factors

Regarding coffee quality and income, each farmer was assessed based on the influence each of these factors had on his or her decision-making. Overall, each farmer cared about making a profit

and maintaining coffee yield (Table 4.2). However, coffee quality was not necessarily a prime influence on how farmers made agricultural decisions.

In order to trade directly with specialty roasters, it was necessary for SMC farmers to have a certain level of coffee quality. As mentioned earlier, one farmer noted that "*quality is a driver to change agricultural practices*" and that quality pays off when farmers are connected to specialty roasters through Direct Trade, and this farmer speaks for many other of the Direct Trade farmers who feel similarly about coffee quality. This same farmer also noted that agricultural decisions are made with increasing quality and productivity in mind.

Coffee quality was not as prominent within the conventional farms compared to the Direct Trade farmers. The conventional coffee farmers were more focused on maintaining the health of the farm, soil, and coffee trees to maintain yield.

With regards to income, it was not mentioned as a driver of how farmers made decisions, but it was an underlaying factor that was necessary to maintain in order to continue producing coffee. The Direct Trade farmers were more likely to mention an increase in prices due to higher quality of coffee and the direct relationship with specialty roasters. Most farmers mentioned that Direct Trade allowed them to participate within a market with better prices and opportunities.

4.3. Overall Results

After visiting the eighteen coffee farms; with groups participating with Direct Trade, and groups simply trading at the commodity level, in addition to interviews with both SMC and Cooxupé representatives, and a specialty coffee green buyer, a general pattern emerged. Farmers associated with SMC were more independent than the farmers associated with Cooxupé, yet both were required to maintain soil tests to ensure the health and sustainability of the coffee farm. SMC farmers were independent in the sense that they were able to make decisions based on their own knowledge, with less guidance from outside organizations. Farms associated with SMC were more likely to have a larger Legal Reserve and were more likely to understand how to take advantage of the natural benefits

from the reserves. Reliance on chemicals was lower within the SMC farms, yet both set of farmers were attempting to decrease chemical usage. All but one conventional farm had a Legal Reserve, and shade was only mentioned with SMC farmers. However, shade is not a viable technique with Brazilian coffee farmers because it leads to lower yields and a more difficult harvesting process.

5. Discussion

This section reflects on how the vrk/Relationship Coffee Model applies to Direct Trade and conventional coffee farmers in Brazil. Additionally, the impact of the decisions is assessed and a reflection on the farmers' knowledge of agroecology and how it affects biodiversity and surrounding ecosystems.

5.1. Farmer Decision-Making Impact

Through agricultural expansion and intensification, coffee has been denoted as one of the drivers of deforestation and biodiversity loss in the Neotropics. The trade of coffee may have an impact on restoring this biodiversity by using various agroecological techniques (native vegetation incorporation, organic material, reduced chemical usage, etc.) and utilizing agroecology. This can be achieved by grasping the decision-making process occurring within coffee farms. Direct Trade is a new trading method creating personal relationships between farmers and specialty roasters that seeks to incorporate sustainability into coffee production. Through this relationship, farmers may learn more and make decisions differently.

After visiting eighteen coffee farms in the Minas Gerais region of Brazil, ten of which traded directly with specialty coffee roasters, and eight of which sold directly into the conventional coffee market – a common theme was discovered regarding the decision-making processes occurring on the farms, and the view of agrobiodiversity and agroecology. The Direct Trade farms, or the farms associated with SMC, were more independent when it came to decision-making. Quality was a stronger influencing factor within the decision-making framework, yet more knowledge regarding agriculture was displayed within these farms, so external support or guidance was not necessary. On the other hand, the conventional farms, or the farms associated with Cooxupé, relied more on the

knowledge base within the cooperative, required numerous agronomist visits, and decisions were made with more support from Cooxupé. Quality within these farms was an important factor, but not as valuable compared to the SMC farms.

5.2.Value as a Decision-Making Driver

The Brazilian coffee farmers each held a set of values that guided decision-making. Family values and how each farmer's family grew coffee in the past guided farmers on various agricultural decisions.

Not only that, but what a farmer valued such as sustainability, quality or yield was a main driver of decision-making. Quality was a stronger driver within the SMC farms compared to the Cooxupé farms, primarily because SMC farmers were required to maintain a certain level of specialty quality. Not only that, but SMC farmers showed more desire to create a sustainable farm, with more advanced techniques and technologies utilizing natural benefits versus the farmers associated with Cooxupé. Yet, sustainable practices were still used within the conventional farms.

Overall, the values each farm had were reflected in the decisions made within each farm. These values differed from farm-to-farm, especially between the two groups of farmers.

5.3. Rules as a Decision-Making Driver

Farmers were required to follow a collection of Brazilian laws within their coffee farms. For example, as mentioned before, the Brazilian Forest Code required the presence of the Legal Reserve, and other laws required the restriction of various chemicals. This pushed farmers to make decisions following a set of laws, thus nearly every farmer maintained a Legal Reserve within their farms and were gradually reducing chemical usage.

Rules were followed nearly uniformly amongst each farm, yet the SMC farmers were able to execute the requirements of the laws in a more organized fashion. For example, the SMC farmers had an organized farm-layout with the Legal Reserve adjacent to the coffee, in addition to wind breakers carefully surrounding the coffee (Appendix 2). Some even maintained maps of the farm

revealing the protected areas in addition to corridors for species (Appendix 2). Furthermore, SMC farmers had more organized plans with records of each plant, chemical used, and pest occurrence to indicate when and where to use chemicals and how to reduce usage (Appendix 2). Although the SMC farms were more developed with regards to techniques, both farms indicated that the Brazilian laws were strong decision-making drivers within the farm.

5.4. Knowledge as a Decision-Making Driver

The knowledge held by each farmer was a primary decision-making driver. Additionally, the knowledge given to farmers through the visiting agronomists from Cooxupé also provided knowledge guiding farmers to make certain agricultural decisions. This included altering chemical usage, planting certain vegetation, usage of wind-breakers, shade tree management, and pest control.

Moreover, a majority of the SMC farmers and a small portion of the Cooxupé farmers held a wealth of knowledge surrounding agronomy. University degrees in agronomy were acquired within some of the SMC farms, and a few farmers participated as educators for other farmers to increase agricultural knowledge elsewhere. The knowledge and experience held within each farm was a prominent driver of decision-making. Even if farmers did not have a wealth of agricultural knowledge, they relied on the education from Cooxupé to provide lectures and agronomist visits to aid with decision-making.

5.5. Relationship Coffee Impact

The results pose the question regarding whether coffee farmers who trade directly are more able to acquire high levels of knowledge and independence, or if the knowledge and independence is maintained by a farmer gives them the opportunity to trade directly.

Amongst the farms assessed during the study, it appeared that with more knowledge, independence, technique, and more developed methods – resulted in higher quality of coffee and the opportunity to participate in Direct Trade relationships.

With that in mind, the price paid for coffee was also a defining influence on the decisions made within the coffee farm. Both groups of farmers emphasized the need to maintain yield, yet the Direct Trade farmers discussed the importance of maintaining quality to participate in the Direct Trade market to receive higher prices. Although both farms cared about yield and income, the Direct Trade farmers were more focused on maintaining quality to ensure specialty standards to trade directly and receive higher prices.

With regards to agrobiodiversity and agroecology, it was discovered that farmers took advantage of using the government-mandated Legal Reserves in various ways. Farmers within the Direct Trade group were more likely to understand the benefits of the Legal Reserve with regards to pest management, pollination, and maintaining microclimates in addition to the contribution of soil nutrients. Yet, the conventional coffee farmers discussed the benefits from the Legal Reserves more from a water conservation standpoint and felt that the protected area did not provide other benefits to the coffee trees.

The benefits from the land sparing land sharing concept were mentioned, revealing a rough understanding of maintaining yields while also ensuring that biodiversity is preserved. This occurred more frequently in the SMC farms, indicating that this group of farmers had a better understanding of agronomy and ecology.

5.6. Limitations of the Framework

Although the developed conceptual framework took into account the values, rules and knowledge that influenced farmers' decision-making, and how the coffee market impacted those decisions, there were some shortfalls the framework did not address. Farmers could have been influenced by socioeconomic restrictions, or other external influencing factors. It was difficult to capture every aspect that influenced decision-making, and the factors assessed may not be the only influencing elements contributing to a farmer decision-making process.

6. Conclusion

Biodiversity is vital for the health of ecosystems and ecological processes and cannot be regained once lost. Preserving biodiversity is widely acknowledged and must be implemented within the agricultural sector. As the population continues to increase, the agricultural industry must maintain its yield to sustain food security. Agroecology is a viable option for creating an equilibrium between the demand for food security and biodiversity conservation. Understanding the decision-making process of a farmer may lend aid to legislators or trading industries to identify ways to increase farmers' awareness regarding the improvement of agricultural practices to incorporate biodiversity into agriculture. Additionally, the market-type each farmer participates with can also have a direct relation to a farmer's decision-making process. Using the vrk in addition to the Relationship Coffee Model reveals what impacts a farmer's decisions, simultaneously revealing the impact the decisions have on the environment.

After conducting this research, and understanding the implications of Direct Trade, it became clear that farmers who care about improving coffee quality and trade directly with specialty roasters tend to utilize surrounding ecosystems and have a stronger understanding of agrobiodiversity and agroecology. Yet, the evidence surrounding this finding is limited, and it is not definitive if Direct Trade is the actual cause or reason for this.

Overall, farms are gradually becoming more sustainable, using less chemicals and attempting to understand how to take advantage of natural benefits. However, it appears that the more farmers try to improve the quality of their coffee and participate in the specialty/Direct Trade coffee market, the more likely the farmers are to understand agroecology, and make more attempts to preserve biodiversity. Nevertheless, it was prevalent that organizations such as Cooxupé and SMC are attempting to educate and advance coffee farms towards sustainability. Within the Direct Trade sector, SMC worked to bring coffee farmers into contact with specialty roasters to trade. These farmers, through independent education and goals, had different values, rules and knowledge compared to the conventional Cooxupé farmers. Reasoning for this is unclear but could be due to farmers striving to increase coffee quality in order to participate in the Direct Trade market to receive

higher prices. Moreover, farmers also had a more developed awareness of agroecological concepts such as land sparing and land sharing within the SMC farms.

These conclusions are valuable to consider within the coffee industry in addition to the agricultural industry as a whole. Future research should be conducted in other regions to understand if the same decision-making occurs in other areas where coffee is grown. It may differ in African countries and Central American countries, which is why more research is necessary to understand how coffee production and trading impacts ecosystems in other places. Additionally, more time and more farms would have allowed for a more confident conclusion to be made regarding the coffee farmers in Brazil. More surveys could potentially be conducted to test hypotheses quantitatively, and an increased number of farms could be visited to gain a more specific and conclusive answer.

Coffee is one of the most traded commodities in the world, and in order to ensure its yield is maintained, quality increased, and biodiversity preserved – perhaps adopting agroecological practices such as increasing agrobiodiversity and utilizing the benefits from natural areas, should be enforced. This would require educating farmers about these practices, which could be achieved through Direct Trade. Yet, the new trading practice is already bringing about change within the coffee industry by improving the livelihoods of farmers, and slowly improving the environment. This research aims to reveal to coffee farmers, roasters, and traders that understanding agroecology can bring benefits to coffee and biodiversity. Future research should attempt to understand the framework at a deeper level and collect soil samples and other natural data to gain a better understanding for farmers' decision-making process, what influences those decisions, and the impact those decisions have on surrounding ecosystems and biodiversity.

The future of Direct Trade and its trajectory are unknown, yet research similar to this thesis could predict its presence on coffee farms over time. A great deal of trust is required to participate within the Direct Trade market, yet there is growing pressure to transition Direct Trade into a certification system. Direct Trade also has its limitations with regards to its impact on the environment, and prospects including increasing the quality of coffee and improving livelihoods of producers. The

model is loosely defined and has no clear goal. Each specialty roaster executes Direct Trade differently, so perhaps a common set of goals, prices, techniques and system could be developed to ensure Direct Trade achieves the same set of goals amongst each roaster. More research and more organization may be required to standardize Direct Trade. Yet, perhaps Direct Trade should remain untouched to prevent the commodification of a label that occurred with other certification systems in the past. Regardless, coffee production must maintain certain environmental goals to ensure the preservation of biodiversity.

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Appendix 1: Semi-structured Interview Questions

Questions for Direct Trade Brazilian Coffee Study

Questions may be altered or changed based on the environment the questions are being asked, or how the conversation carries out. The interviews will be semi-structured, meaning that the interview will not be structured wholly on these questions, and the person being interviewed can direct the conversation to other related topics not on the questionnaire.

The first set of questions will be directed towards SMC farmers involved in a Direct Trade relationship.

Briefly describe how you have been involved with coffee farming and SMC. Describe the history of your coffee farm. What do you understand by the term Direct Trade?

How would you define your Direct Trade relationship?
What benefits have Direct Trade brought to you?

Have your agricultural practices changed after incorporation with SMC?

Have you learned about how to improve quality of your farm?

Specific Farm Management Practices (Chemicals, Shade, Pruning)
Have you begun to move away from monoculture practices?
Have you noticed more natural predators to pests such as ant and bird species?
Have you started incorporating more native vegetation into your farm and shade? Less monoculture?
Do you use chemicals on your farm?
How often do you prune?

Changes within Farm (Natural Predators, Bees, Pest Reduction)
Have you noticed more natural predators to pests such as ant and bird species?
Are there bees on your farm? If so, what variety?

What is the role of SMC and guiding you to make farming decisions?

How do you make decisions? Does quality drive your decision-making?

How has the price changed?

How do you see the future of your coffee farming and work with SMC?

The second set of questions will be directed at farmers not associated with SMC or Direct Trade – this could include Fair Trade-certified farmers, or conventional coffee farmers associated with Cooxupé.

How long have been with Cooxupé? Describe history of coffee farming and any certification schemes.

Have your agricultural practices changed in the past ten years? (Shade Trees, Native Vegetation, Pruning, Chemicals)

What is the role of Cooxupe with making farming decisions?

How do you see the future of your coffee farming practices, and would you consider Direct Trade?

Appendix 2: Supporting Figures

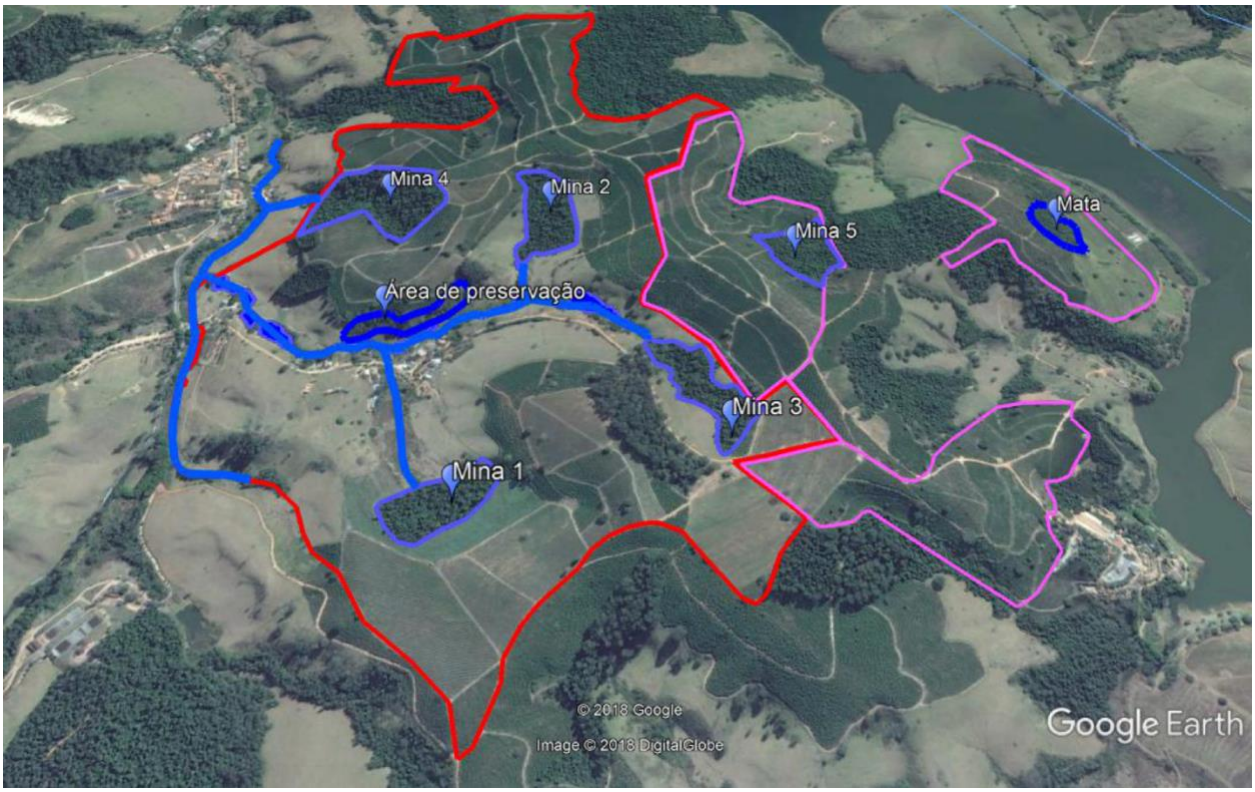

Figure 1: Example of Direct Trade farm in Minas Gerais – the Legal Reserve is also mapped out within the farm. Corridors are also present to indicate the importance of protecting species and connecting natural areas.

Figure 2a: Example of Direct Trade farmer's report on coffee farm.

Figure 2b: Maps indicating various pH and other nutrient levels throughout farm to understand where and when to apply fertilizers.

Figure 2c: Maps of farm's pH and nutrient levels continued.

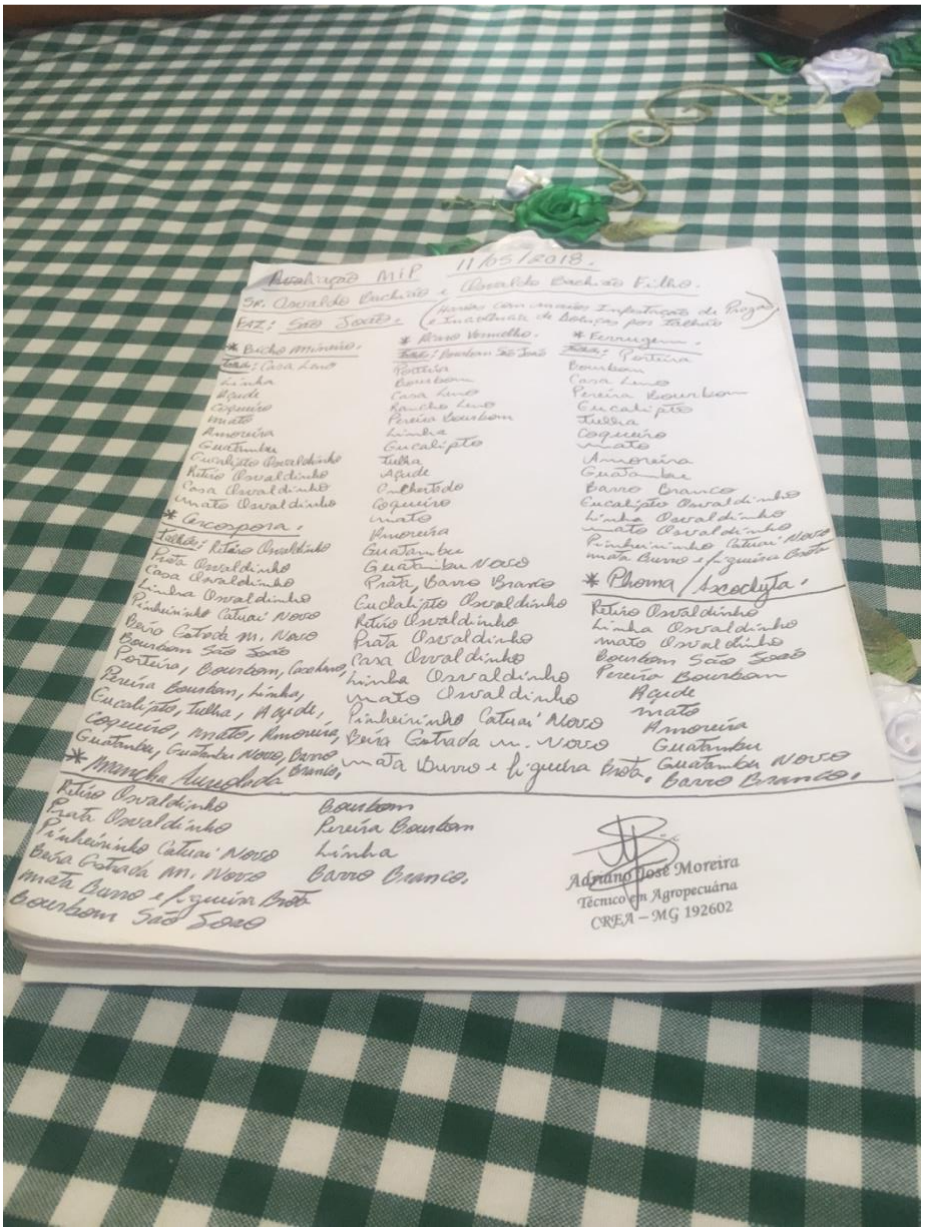

Figure 2d: Collection of data on Direct Trade farm to indicate presence of pests on which coffee tree, in which area, at what time to guide when and where to apply chemicals.

Figure 3: Example of Direct Trade farmer's agronomy degree from a Brazilian University.

Figure 4: Direct Trade farm with visible Legal reserve and organized coffee trees.

Figure 5: Another Direct Trade farm visited, with windbreaks surrounding the coffee trees and Legal Reserve adjacent to coffee trees.