博士論文

Defining Craft Chocolate and Specialty Cacao: Standards, Trade, Equity, and Sustainable Development

(クラフトチョコレートおよびスペシャリティーカカオを定義する：標準、取引、公平性、持続可能な開発)

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Thesis Summary

論文の内容の要旨
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論文題目

Defining Craft Chocolate and Specialty Cacao: Standards, Trade, Equity, and Sustainable Development
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Craft chocolate is an artisan chocolate product, made from specialty cacao beans. This industry is made up of many small businesses, acclaimed for actively progressing farmer welfare and environmental resource conservation standards, and is well-positioned to propel the global chocolate industry to be more accountable, sustainable, transparent, and ethical. However, research that specifically investigates craft chocolate and specialty cacao is scarce and this industry faces poor coherency, definition, and standardization.

This research defines craft chocolate and specialty cacao with respect to industry standards, trade practices, equity priorities, and roles in sustainable development, through an industry assessment on specialty cacao trading and prices, providing a timely systems-level set of definitions to quantify quality parameters, and identifying primary pathways found to define characteristics for specialty cacao. In addition, craft chocolate maker priorities for quality standards, direct trade, farmer equity, and sustainable development are identified to reveal distinct sourcing methods and geographies for this industry. This research also validated low-investment opportunities to improve smallholder farmer access to specialty cacao markets through key factors that farmers can leverage to meet specialty cacao quality market standards. Lastly, this research includes a discussion on disruptions due to the COVID-19 pandemic exposing the unique vulnerabilities of craft chocolate and specialty cacao industry.

クラフトチョコレートは、スペシャリティカカオ豆を原料にして職人技術で作られたチョコレート製品である。この業界は多くの中小企業で構成されており、カカオ農家の福祉と環境資源保護の基準を高める積極的な活動でも高く評価され、世界のチョコレート産業を、持続可能で、説明責任と透明性のある、かつ倫理的なものへと前進させる存在でもある。しかしながら、クラフトチョコレートとスペシャリティカカオを具体的に調査する研究は少なく、この業界は、一貫性、定義、標準化が不十分な現実に直面している。

この研究では、スペシャリティカカオの取引方法やカカオ生産者への支払い価格など業界の評価を鑑み、クラフトチョコレートとスペシャリティカカオ業界の標準、取引慣行、公平性、持続可能な開発における役割を定義する。その結果、品質のパラメーターを定量化するためのタイムリーなシステムレベルでの定義を提供し、スペシャリティカカオの特性を明らかにする主な経路を見出した。さらに、この業界における調達方法と生産地域を明確にするために、品質基準、直接取引、農家の公平性、持続可能な開発において、クラフトチョコレートメーカーにとっての優先事項が認知されている。この研究はまた、スペシャリティカカオの市場品質基準を満たすために農家が活用できる最優先事項を認知し、小規模農家のスペシャリティカカオ市場へのアクセスを改善するための低投資の機会を有効なものとした。最後に、この研究には、クラフトチョコレートとスペシャリティカカオ産業の特有の脆弱性を明らかにする COVID-19 パンデミックによる混乱についての議論も含まれる。

Theory

Specialty cacao and craft chocolate is presented as an alternative model to traditional methods of producing and sourcing cacao or making chocolate. Through the use of direct sourcing strategies and prioritizing farmer welfare and environmental conservation, proponents of specialty cacao and craft chocolate have identified the importance of transparency, relationships between the consumers and the chocolate, and the role of every actor in the supply chain. Despite the potential for cacao as an ideal crop for sustainable agroforestry systems, the chocolate industry as a whole has been recognized for facilitating unsustainable production practices as well as ethical human welfare concerns for the millions of smallholder living under the poverty line, without access to alternative income strategies. Craft chocolate and specialty cacao have been touted as well-positioned to move the chocolate industry in the direction of more ethical sourcing strategies, improved environmental production practices, and higher quality products targeted to a growing consumer base seeking more sustainable and socially responsible products. However, this assertion of higher ethical and environmental standards has not been established through research, and such industry identifiers or environmental and social buzzwords have been easily adopted as marketing terms by groups that do not incorporate the same values into their business models. Additionally, prior research on quality analysis and postharvest production have not considered the specific analytical and logistic needs of specialty cacao. The poor consistency of quality quantifiers, standardization, and cohesion have been problematic for both advancements in farmer accessibility to specialty cacao markets and the long term resilience of small craft chocolate businesses. This research investigates the current definitions, gaps, trajectory of this industry.

Research Questions

What are the significant differentiators that distinguish the specialty cacao and craft chocolate industry?
In what ways can this industry support the sustainable development of cacao producing regions?
What is current industry trajectory and what practices are commonly being used?

Research Objectives

Identify the current definitions and gaps in knowledge for specialty cacao and craft chocolate.
Measure the parameters for sourcing and prices paid to farmers for specialty cacao.
Understand the industry-specific parameters for quality and identify gaps.
Demonstrate industry trajectory and challenges.

Research Findings

The significant differentiators for specialty cacao were identified through five primary pathways: (1) quality, (2) genetics, (3) origin, (4) certification, and (5) direct trade. In addition, landed cost price for conventionally grown cacao offered by specialty cacao buyers from 2015-2018 were, on average, 140% higher than the world market price for commodity cacao, and 205% more than the ones of fair trade cacao, not inclusive of fair trade premiums. The average farm gate price paid per kg of conventionally grown cacao by craft chocolate makers and specialty cacao buyers were, on average, 95% more than average producer price for West Africa, Brazil, and Ecuador markets between 2014 and 2019.

In stark contrast to commodity cacao acquisition strategies, 38% of craft chocolate makers find and contract individual farmers for cacao acquisition. In addition, a majority of chocolate makers (60%) believe routinely used quality assessment techniques do not meet the needs of bean to bar chocolate makers or could use improvement. Additionally, specialty cacao buyers primarily source beans from South and Central America (over 65%), in direct contrast to commodity cacao systems, which predominantly source from West Africa.

Investigating pulp quality characteristics under postharvest treatment conditions from the perspective of specialty cacao and conducting farmer interviews, measurements of disease, Brix, pH, pod weight, and seed with pulp weight in the pre-fermentation, early postharvest processing stage revealed that pod storage treatments significantly influence pulp quality. Lastly, the fragility of the craft chocolate has been recognized by industry members for years and the global crisis has further highlighted the need for investments in farmer relief, improved access to technology for business needs, and farmer empowerment for negotiations with buyers to mitigate risks.

Discussion

As global demand for chocolate continues to rise, the share of the revenue for cacao farmers continues to fall. Farmers, often living under the poverty line, also bear the risks of producing a commodity subject to extreme price volatility and seasonal fluctuation. Expansion of cacao frontiers is also destructive and contributes to the loss of biodiversity habitats. The significant differentiators that allow specialty cacao and craft chocolate to support the sustainable development of cacao producing regions include quality, genetics, origin, certification, and direct trade. Craft chocolate producers prioritize fine flavor notes, and product diversity, which can be quantified through the five pathways and promote business models that allow sourcing materials that contribute to better living conditions for farmers and addressing environmental impacts at the same time.

Specialty chocolate, also known as fine, craft, flavor, or premium chocolate, holds a small portion of the total chocolate market but is well recognized for a focus on high flavor attributes, quality, and origin specificity. The current practices for industry members include participating in direct trade acquisition strategies and offering significant price premiums. Industry members also agree on the need to establish a more inclusive quality assessment technique and prioritize farmer welfare. Unlike commodity cacao products, specialty cacao systems present substantial opportunity to refine identifiable differentiators that justify the premium pricing and educate buyers on value throughout the supply chain. Farmers can achieve significant changes in quality through easily adopted postharvest practices and improved quality assessment protocols.

The demographics of Japanese craft chocolate businesses are unique in that many small businesses make up the total market share, which is starkly different from the few industrial chocolate production companies commanding global market share since the late 1980s. Through specialized distribution channels that cater to a targeted consumer base, diverse business proprietorship, and distinct pricing strategies and quality requirements, this industry certainly employs organizational ambidexterity from an emerging market context.

Specialty cacao buyers have done well to encourage transparency and accountability systems, including publishing annual sourcing reports and which describe on-farm production practices, highlight farmer profiles, and divulge prices paid to farmers for specialty cacao. Due to the nature of direct sourcing strategies, these personal relationships have facilitated communication channels, including on health messaging to farmers and through farmer networks such as grower cooperatives and allow for more flexibility when forming buying contracts.

Craft chocolate makers impart a strong focus on craftsmanship, social responsibility, and transparency, which has highlighted the negative social and environmental impacts of chocolate production and propelled the industry to more urgently address these challenges. In an era where government support, public technical assistance, and financial resources are spread so thin, it is imperative that businesses continue to implement policies that support sustainability goals. The craft chocolate and specialty cacao industry openly claims to allocate resources that address critical issues within the industry such as deforestation, illegal and child labor, land degradation, and ethical farmer welfare, and as such, merits special support; if this nascent specialty sector can survive the pandemic, it can continue to model possibilities for ethical chocolate.

These practices propel the current trajectory of the industry as a whole, moving towards more ethical sourcing strategies and superior quality products, as long as the industry continues to prioritize sustainable development, including social and environmental welfare. Buyers often practice individual assessments, limited to farming entities they contract, and supporting inclusive conversations about quality standards with farmers could elevate producer bargaining power. Cacao farmers justifiably need access to reasonable access to independent, unbiased, and objective farmer-driven information on price transparency, market averages, and quality grading systems.

This emerging industry has the potential to support the future of the chocolate industry as well as the sustainable development for cacao-producing regions through environmental, social, economic, and sensory excellence.

Defining Craft Chocolate and Specialty Cacao: Standards, Trade, Equity, and Sustainable Development

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Cadby J and Araki T. Breaking the Mold: Craft chocolate makers prioritize quality, ethical and direct sourcing, and environmental welfare. Journal of Agriculture and Food Research. (Under Review)

Cadby J and Araki T. The Japanese Craft Chocolate Industry. Geo Journal. (Under Review)

Cadby J and Araki T. Postharvest Pod Storage and Maturity Effects on Specialty Cacao Pulp Quality. Journal of the Science of Food and Agriculture. (Under Review)

Cadby J. 2020. Vulnerabilities of the Craft Chocolate Industry Amidst the COVID-19 Pandemic. Journal of Agriculture, Food Systems, and Community Development. (Published)

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Presentations

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Can Chocolate Be the Key to Sustainable Agricultural Development? International Conference on Sustainability, Energy, & the Environment [Conference presentation]. Hawaii Convention Center, Hawaii, USA. 2020, January 10-12.

Pod Storage and Maturity Effects on Specialty Cacao Pulp Quality. International Joint Conference on JSAM, SASJ and 13th CIGR VI Technical Symposium [Conference presentation]. Hokkaido University, Sapporo, Japan. 2019, September 3-6.

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Abbreviations and Definitions

定義

CAOBISCO	Association of the Chocolate, Biscuit and Confectionery Industries of the EU
CCMA	Craft Chocolate Makers of America
FAO	Food and Agriculture Organization of the United Nations
FCCI	Fine Cacao and Chocolate Institute
FCIA	Fine Chocolate Industry Association
HCP	Heirloom Cacao Preservation
HPLC	High Performance Liquid Chromatography
ICCO	International Cocoa Organization
INIAP	Instituto Nacional de Investigaciones Agropecuarias (National Agricultural Research Institute)
Bean to Bar	Finished chocolate produced starting with cacao beans
Cacao	Also called ‘cocoa’, the fermented and dried seeds of the *Theobroma cacao* L. tree
Chocolate Makers	A person or company that makes chocolate from fermented and dried cacao beans
Cacao Processers	Farmers, cooperatives, and other aggregators processing fresh cacao into fermented, dried cacao for consumption
Craft Chocolate	Also described as fine, specialty, or premium chocolate
Cut Test	Cacao quality assessment test to grade and tally quality using beans cut at a vertical cross section
Dry Nibs	Cacao nibs fermented and dried at origin to 7-9% moisture content, intended for use in chocolate production
Fermentation Index	Observable degree of fermentation based on color and other physical features
Finished Chocolate	The solid bar (tablet) form of chocolate made with sugar and no less than 70% fermented, dried, and roasted cacao beans
Ground Nibs	Dry nibs reduced in size but remaining in solid form (300-1200 μ)
Liquor	Also called cocoa liquor, a mass or paste of cacao processed into a semi-solid state
Raw Nibs	Unroasted cacao nibs, what would be found at origin after fermenting and drying
Roasted Nibs	Dry cacao nibs that have been roasted

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Chapter 1. Introduction

Cacao (*Theobroma cacao*) is a major agricultural crop, produced by millions of smallholder farmers around the globe, and is used as a primary ingredient in the production of chocolate. This research aims to define craft chocolate and specialty cacao, investigating standards, trade, equity, and sustainable development throughout the industry.

Specialty Cacao

As global demand for chocolate continues to rise, the share of the revenue for cacao farmers continues to fall. Cacao farmers, many living under the poverty line, also bear the risks of producing a commodity subject to extreme price volatility and seasonal fluctuation (Fountain and Huetz-Adams 2018; Tothmihaly and Ingram 2018). Expansion for cacao frontiers is also known to be destructive and can contribute to the loss of biodiversity habitats (Clough et al. 2009).

Specialty cacao is considered a premium cacao product, identified by high flavor attributes, aesthetic and physical qualities, genetics, or origin specificity (Giller 2017; Díaz-Montenegro et al. 2018). The international development community has recognized specialty cacao production as an opportunity for integral development strategy, to enable smallholder farmers to participate in the modern globalized food system (Murray-Prior 2020) and re-territorializing chocolate to attach specific geographies and conditions of production to the finished products (McCabe, 2015). Many specialty cacao buyers choose to source cacao products directly from the farm or origin, benefitting from product consistency and quality control, by directly working with the farmers and processors. This direct sourcing strategy is presented as an alternative to the commodity cacao and fair trade markets, both of which present imperfect supply chains.

Specialty cacao can be grown in sustainable agroforestry systems that support biodiversity and diversify farmer income sources, often considered to be a viable and higher paying alternative to global commodity cacao, potentially contributing to improved farmer welfare. The production of specialty cacao demonstrates the potential to address ongoing industry concerns within sustainability science, including deforestation, supporting farmers to meet economic goals, and advocacy for biodiversity habitats, through the increased popularity of premium pricing and direct trade, to encourage sustainable production practices. However, the perceived superior consumer and producer benefits of direct trade supply chain transparency and sourcing as well as the validation of claims for premium pricing strategies still begs further investigation.

Craft Chocolate

Craft chocolate and bean to bar chocolate describes a finished chocolate product manufactured with artisanship and fine flavor in mind. Through recognizing the origin of the materials used in a production process, craft chocolate results in a product that is typically multi-national, collaborative, and unique.

Advocates in the bean to bar movement acknowledge the long production and value chain involved for processing specialty cacao into finished chocolate. Craft chocolate producers also claim to prioritize fine flavor notes, product diversity, and utilizing business models that allow sourcing materials that contribute to better living conditions for farmers or addressing environmental impacts. Craft chocolate and specialty cacao distributors may directly address challenges of social responsibility such as the lower share of revenue earned by farmers of the total marketed product, including estimates as low as three and five percent (Fairtrade Foundation 2016).

Craft chocolate fills a premium quality niche that also addresses issues surrounding sustainability and social responsibility challenges recognized in industrial chocolate. Consumers of craft chocolate may be considering ethical concerns and moral satisfaction when making purchasing decisions for chocolate rather than simply sensory enjoyment (McCabe 2015). However, craft chocolate has an unusual barrier to entry, including a lack of clear definitions and an abundance of floating signifiers in the industry. Additionally, this industry faces poor consistency of quality quantifiers, standardization, and cohesion. As the craft chocolate industry develops, understanding the current state and needs of craft chocolate makers can aid in building a better foundation for future research goals and support systems.

Craft Chocolate and Cacao in Japan

The Japanese chocolate industry in conjunction with other global markets have been steadily growing over the last few years, most recently to include specialty markets such as craft chocolate and premium bean to bar chocolate production (Squicciarini and Swinnen, 2016; Donovan, 2006; Daniels, et al. 2012). Japan is the largest consumer market for chocolate confectionery in Asia, which includes the growing craft chocolate industry. Despite being a major consumer of chocolate products with significant import volumes for cacao beans, (Japan Chocolate and Cocoa Association 2020) there is limited literature on chocolate in Japan and the craft chocolate industry as a whole. The sudden popularity of craft chocolate in Japan beginning in 2014 implores an updated investigation of the Japanese craft chocolate industry.

Specialty Cacao Quality

Cacao processing at origin includes the cultivation, harvesting, fermenting, and drying of cacao seeds (Wood and Lass 2001). Specialty cacao products demand higher quality standards throughout all stages of production (Hart 2019), and postharvest production plays a significant role in the final quality of specialty cacao. Additionally, the significant role that farmers play in the production of chocolate has been poorly detailed throughout the industry. The specialty cacao industry has recognized the need for the development of quality assessment protocols and guidelines for specialty cacao, using tools accessible to farmers, that yield repeatable results, and support a mutual understanding of quantifiable standards to support their livelihoods.

Research Summary

This research makes three contributions:

First, this research is the first to identify the pathways to define specialty cacao through quantifiable review of specialty cacao pricing, industry characterizations, and the multidimensional impacts to support future sustainable development for cacao-producing regions. Research on the commodity cacao industry extensively explores the issues of farmer welfare, labor ethics, and environmental impacts. However, research that specifically investigates specialty cacao is scarce, especially considering the potential for sustainable development that has been touted throughout the industry. The long supply chain for cacao is complicated, with every stage of production involving numerous stakeholders. The poor consistency of quality quantifiers, standardization, and cohesion have been problematic for both advancements in farmer accessibility to specialty cacao markets and the long term resilience of small craft chocolate businesses.

Through a novel investigation of both the scientific literature and industry reports, this research takes a comprehensive look at specialty cacao, reporting for the first time a systems-level overview of the definitions and gaps, to clarify the defining pathways that are representative of the system, and discuss the quality determinations that would facilitate specialty cacao industry accessibility to the producers. This research investigates the current definitions, gaps, trajectory of this industry through a literature review, followed by a comparison of specialty cacao prices and origins. The result is a timely systems-level set of definitions to quantify quality parameters and validate higher prices offered by specialty cacao buyers, to assess increased incentives for economic opportunities, support for environmental conservation within specialty cacao markets, and inform development programs and sustainability efforts in the global agricultural market.

Second, this research shows for the first time the distinctive characteristics of the craft chocolate industry that show prioritization of ethical chocolate to promote farmer welfare and environmental conservation as well as identifying the sourcing methods and geographies that make this industry unique from their commodity cacao counterparts. Industry members have maintained that they operate as a distinct entity within the chocolate world, with a targeted consumer base that demands a product that meets their unique values for high quality food experiences and supporting sustainable development, and this research investigates this.

Lastly, this research highlights craft chocolate and specialty cacao, a relatively unstudied industry, as a pioneering agricultural production system largely driven by consumer preferences for high quality food experiences and sustainable, ethical food sourcing. This emerging industry has the potential to support the future of the chocolate industry as well as the sustainable development for cacao-producing regions through environmental, social, economic, and sensory excellence as long as the industry continues to prioritize sustainable development, including investments in social and environmental welfare, and particularly in regard to demanding gender, racial, and social equality across the board.

This research defines craft chocolate and specialty cacao from the perspective of standards, trade, equity, and sustainable development.

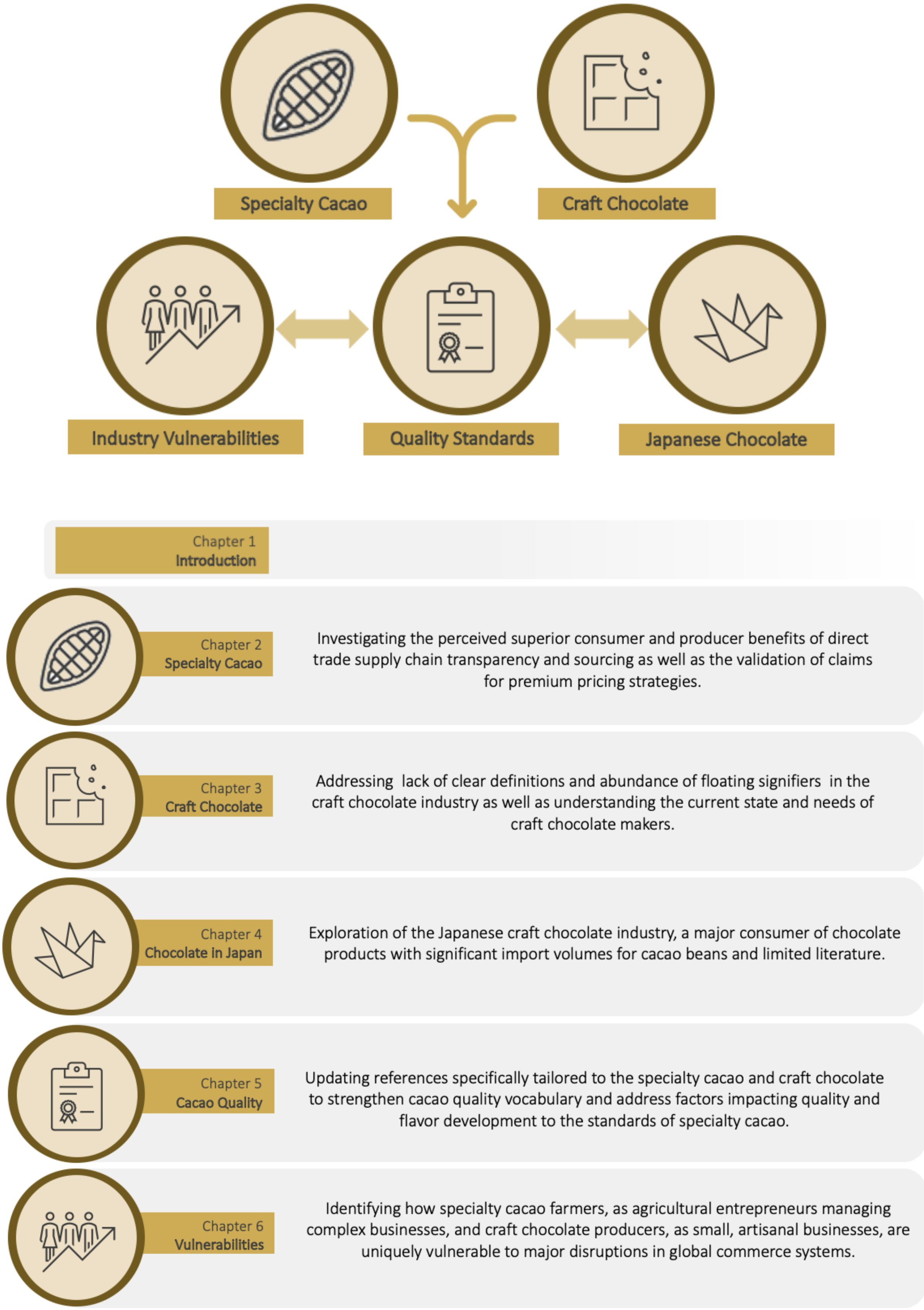

Figure 1. Chapter relationships.

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Chapter 2. Specialty Cacao Characteristics

Towards Ethical Chocolate: multicriterial identifiers, pricing structures, and the role of the specialty cacao industry in sustainable development

Published in the SN Business & Economics.

2.1 Abstract

The specialty cacao industry is unique in that it is thought to offer higher price premiums and claims to provide cacao farmers with considerably more sustainable resources than traditional cacao systems, prioritizing farmer welfare and environmental resource conservation. However, with poor coherency of industry definition, quality quantifiers, and standardization, specialty cacao buyers can set prices and quality requirements without clear definitions that are easily externalized. Poorly defined standards put farmers at a disadvantage, allowing buyers to wield more bargaining power over producers, often assessing beans with independent or internal quality requirements. This research identified current industry definitions, and prices paid to farmers were collected and compared to world market prices, fair trade prices, and commodity producer prices. Five primary pathways were found to define characteristics for specialty cacao: (1) quality, (2) genetics, (3) origin, 4) certification, and (5) direct trade. This research shows for the first time, variability in farm gate prices for specialty cacao, as well as an average price 95.13% higher than commodity cacao, demonstrating the critical role that specialty cacao can play in developing a more sustainable chocolate industry. Ultimately, cacao farmers are agricultural entrepreneurs managing complex businesses that require reasonable access to independent, unbiased, and objective farmer-driven information on price transparency, market averages, and quality grading systems. This research reveals the need for systems-level definitions to quantify quality parameters to help farmers gain access to higher prices offered by buyers and provide incentives for economic opportunities and support for environmental conservation within specialty cacao markets.

Keywords: Sustainable Business and Economics; specialty cacao; *Theobroma cacao*; direct trade; farmer welfare

2.2 Introduction

Cacao trees (*Theobroma cacao*, L.) produce fruits containing seeds used in chocolate production. Processed cacao seeds destined for use in chocolate products predominantly originate in equatorial regions but are consumed worldwide. Specialty cacao, sometimes also called fine, craft, flavor, artisan, or premium cacao, represents 5% or less of market sales (FCIA 2019; Daniels et al. 2012). Specialty cacao may provide a model for a more ethical and sustainable chocolate supply chain and production system, as it can be produced in sustainable agroforestry systems that support biodiversity and diversify farmer income sources and is thought to be a sustainable and higher paying alternative to global commodity cacao, potentially contributing to improved farmer welfare. Craft chocolate and specialty cacao have been touted within the industry as well-positioned to move the chocolate industry in the direction of more ethical sourcing strategies, improved environmental production practices, and higher quality products targeted to a growing consumer base seeking more sustainable and socially responsible products. Beans traded as specialty cacao are typically recognized by high flavor attributes, aesthetic and physical qualities, genetics, and origin specificity (Giller 2017; Díaz-Montenegro et al. 2018), although there is no clear consensus on the defining factors. The market price is highly variable and is usually determined by the origin, product quality, certification status, personal relationships, and demand, often traded directly, commanding a higher price compared to commodity cacao (Daniels et al. 2012; ICCO 2019a).

Global Cacao Production

Cacao processing at origin includes the cultivation, harvesting, fermenting, and drying of cacao seeds (Wood and Lass 2001). Fermented and dried cacao seeds, hereby referred to as “beans”, make up the majority of traded processed cacao used for making finished chocolate. Commodity cacao, also referred to as bulk or industrial cacao, makes up most of the global cacao produced today, estimated at around 93-95% of global production, mainly out of West Africa, (ICCO 2019a; ICCO 2019b). The majority of this cacao is produced from small and family-run farms, on average, two to four hectares in size (WCF 2014). Larger scale plantations for cacao production are also contemporary, such as in Brazil and Malaysia (Leiter and Harding 2004). Production methods used for commodity cacao rose in popularity in the 1800s and have since allowed for larger manufacturing companies to specify protocols that favored high production and more uniform beans, standardized for their markets (Giller 2017; Roos 2018). Similar to industrial chocolate processing, a small number of commodity cacao buyers hold significant authority in major cacao producing regions, with few trading houses dominating total sales in West Africa, for example (George 2012). The limited diversity of players, combined with wealthier market chain participants more easily gaining access to high-quality information, culminates in farmers having less bargaining power, with benefits from efficiency gains getting passed on to consumers rather than to farmers (Jano and Mainville 2007).

Around the world, smallholder cacao farming systems are dominant, with many farmers living below the poverty line (Fountain and Huetz-Adams 2018; Tothmihaly and Ingram 2018). Furthermore, the share of the revenue for commodity cacao farmers has fallen from sixteen percent of the marketed product in 1980 to six to seven percent in 2013 (George 2016b), although other estimates describe shares as low as three and five percent (Fairtrade Foundation 2016). Certification schemes and marketing such as fair trade, single-origin, or other labels may or may not necessarily designate products as a specialty but can offer a price premium for farmers. Cacao produced for specialty markets can also demand higher price premiums when compared to commodity cacao, possibly contributing to the long-term improvement of farmer livelihoods, offering an opportunity to participate in cacao production that meets current economic, social, and environmental needs.

Similar to the development of specialty coffee supply chains, specialty cacao markets emphasize fine flavor, higher quality ingredients, and a specialized consumer base. For example, direct trade markets can simplify the supply chain and thrive through long-term relationships and improved stakeholder communication (figure 1). Additionally, the craft chocolate market is made up of many small businesses, in stark contrast to the industrial chocolate oligopoly, but operates within a similar buyer power dynamic due to the low ratio of buyer-to-producers.

Specialty cacao buyers are known to be willing to pay higher prices for specialty cacao, often negotiating private contracts with individualized parameters for production processes or quality outcomes. However, with a lack of universally accepted criteria, individual users often assess fine and specialty cacao beans based on independent or internal quality requirements. Sustainable growth for the specialty cacao market will require established standards for quality, reputation, and competitiveness (Jano and Mainville 2007).

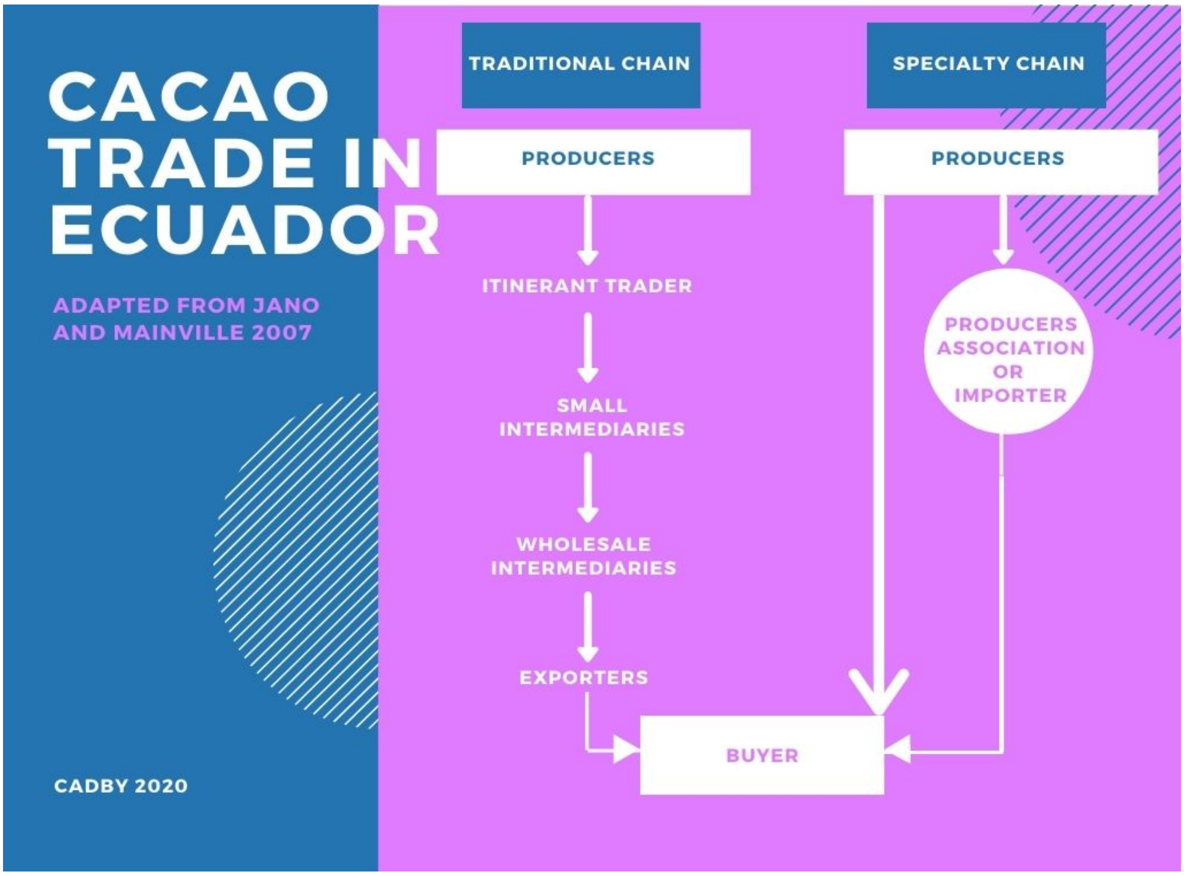

Figure 1. Cacao trade chains in Ecuador. Adapted from Jano and Mainville 2007.

Potential for Sustainable Change

Farmers have experienced increasingly disadvantageous economic conditions in recent years, including a volatile production and supply chain and few options for alternative sources of income in tandem with unsustainable agricultural practices. Continuous development of cacao frontiers, such as converting shaded agroforests to more intensively managed plantations, is often practiced by farmers to increase short-term economic returns. The expansion of cacao production into forested areas, including protected forestlands, brought about by boom and bust cycles, has resulted in increased forest fragmentation and decreased forest area, as well as widespread encroachment into biodiversity hotspots (Clough et al. 2009).

High yielding varieties, which are less susceptible to sun damage, are often produced in monoculture systems with densely planted parcels, using higher levels of inputs such as fertilizers, insecticides, and herbicides (Blare and Useche, 2013), and yield considerably more per hectare under optimized conditions when compared to traditional agroforestry systems (table 1), although low resource farmers using fewer inputs may experience a smaller yield gap (Middendorp et al. 2018).

Table 1. Average global cacao yield in 2016. (1) Amores et al. 2011; (2) ICCO (2017) 2018; (3) Kozicka et al. 2018; (4) Sánchez-Mora et al. 2015; (*) Major producer (over 200k MT/year).

Country	**Yield** (kg·ha^{-1})	**ICCO Majority Production**
Ivory Coast*	516.40[3]	Commodity Cacao[2]
Ghana*	509.99[3]	Commodity Cacao[2]
Indonesia*	386.05[3]	Commodity Cacao[2]
Cameroon*	402.72[3]	Commodity Cacao[2]
Nigeria*	282.21[3]	Commodity Cacao[2]
Brazil	296.98[3]	Commodity Cacao[2]
Ecuador	390.86[3]	Fine Cacao[2]
Peru	859.38[3]	Fine Cacao[2]
Dominical Republic	469.79[3]	Fine Cacao[2]
Colombia	338.65[3]	Fine Cacao[2]

Sustainability in the cacao industry has long been an issue at the forefront of social, environmental, and economic considerations, including deforestation due to the production of cacao, which has proliferated with rising global demand for chocolate, decreased production of aging trees, lack of good agricultural practices, and shrinking suitable land area attributable to climate change (Kroeger et al. 2017).

Diverse agroforestry systems present a more sustainable form of cacao production, as these systems do not negatively impact overall species richness and can produce a cash crop while maintaining soil quality and mature forest systems, while also buffering farmers against unpredictable market fluctuations (Schroth et al. 2016). When compared to intensive monoculture systems, shaded agroforests can support high levels of biodiversity, store above-ground biomass, and better support landscape carbon stocks (Middendorp et al. 2018). Stakeholders with distinct sustainability interests have long recognized the potential of cacao grown in diverse agroforestry systems for meeting current social and environmental priorities. Fine flavor cacao production and the specialty cacao industry may offer an opportunity to address those needs, by placing additional value on economic incentives and farmer empowerment.

The production of specialty cacao is ideal for diverse agroforestry systems. Fine flavor cacao varieties, susceptible to damage from wind, full sun, and monoculture conditions, perform well in diverse, shaded, agroforestry conditions with well-selected companion crops. Additionally, specialty cacao beans are generally destined for use in craft chocolate production, where many specialty cacao buyers seek to prioritize farmer welfare and environmental resource conservation. Farmer willingness to grow fine flavor cacao, due to environmental and other non-market benefits, as well as for potential price premiums or economic incentives of agroforestry systems, has been demonstrated in multiple surveys, including Bentley et al (2004), Jano and Mainville (2007), and Blare and Useche (2013), examining Ecuadoran farmers transitioning between the production of shaded agroforest fine (specialty) cacao and full-sun, high yielding cacao systems.

Theoretical Background

Research on the commodity cacao industry extensively explores the issues of farmer welfare, labor ethics, and environmental impacts. However, research that specifically investigates specialty cacao is scarce, especially considering the potential for sustainable development that has been touted throughout the industry. A quantifiable review of specialty cacao pricing, industry characterizations, and the multidimensional impacts to support future sustainable development for cacao-producing regions is currently lacking. The long supply chain for cacao is complicated, with every stage of production involving numerous stakeholders. The poor consistency of quality quantifiers, standardization, and cohesion have been problematic for both advancements in farmer accessibility to specialty cacao markets and the long term resilience of small craft chocolate businesses.

Commodity cacao production often prioritizes consistency rather than fine flavor notes (ISO 2017), a style that is in contrast to the specialty chocolate industry, which strives for a unique product experience (Leissle 2013; Roos 2018; FCIA 2019). This intrinsic diversity has made the standardization of specialty cacao quality a more complicated, but much needed process, and setting established definitions for quality has been universally identified as one of the most important responsibilities for industry development (Bioversity International 2019a). Inconsistent definitions of specialty cacao currently used within the industry (Williams and Eber 2019), may contribute to instability within the craft chocolate and specialty cacao world and additional hurdles towards the upward mobility and sustainable development of cacao producing regions.

Poorly defined standards allow buyers to wield more bargaining power over producers, often assessing beans based on independent or internal quality requirements (Jano and Mainville 2007). Farmers, buyers, and consumers are impacted by the poor communication of standards to identify the sustainability factors and consequent quality quantifiers that build informed negotiations. As the specialty cacao industry grows and becomes more international, developing a consensus on quality standards and definitions has become much more necessary for future sustainable development.

Previous scientific research has investigated specific genetic and organoleptic differentiators to identify varieties and origins of fine flavor cacao. Additionally, cacao industry reports have discussed internal quality requirements from the perspective of the buyer. Through a novel investigation of both the scientific literature and industry reports, this research takes a comprehensive look at specialty cacao, reporting for the first time a systems level overview of the definitions and gaps, to clarify the defining pathways that are representative of the system, and discuss the quality determinations that would facilitate specialty cacao industry accessibility to the producers.

This research investigates the current definitions, gaps, trajectory of this industry through a literature review, followed by a comparison of specialty cacao prices and origins. The result is a timely systems-level set of definitions to quantify quality parameters and validate higher prices offered by specialty cacao buyers, to assess increased incentives for economic opportunities, support for environmental conservation within specialty cacao markets, and inform development programs and sustainability efforts in the global agricultural market.

The objectives of the presented paper include:

To identify, validate, and quantify the premium pricing described by specialty cacao buyers.

To identify the primary industry pathways as found in the literature.

To reveal emerging topics and gaps that give direction for further research.

These objectives will be achieved through an analysis of transparency, sourcing, and annual reports from specialty cacao buyers; and an analysis of existing literature on the topic of specialty cacao and craft chocolate to understand pricing strategies, primary origins, and definitions for quality.

2.3 Materials and Methods

Two datasets were identified for this paper; the first was a comprehensive pricing analysis based on publicly available transparency reports, and the second was a literature review of relevant craft chocolate and specialty cacao publications. Methodology for data collection is outlined below.

Specialty Cacao Pricing

Prices paid per kg of specialty cacao were collected from craft chocolate makers' and specialty cacao distributors' annual reports, sourcing and transparency reports, to identify Farm Gate (FG) or Producer Price, Landed Cost (LC), and Free on Board (FOB) pricing. Reports that included prices paid to producers per kg of cacao were used to gather data on regional prices, certification status, and other characteristics that were relevant to the pricing strategies for specialty cacao buyers. These data were selected by cross-listing self-described craft chocolate makers and specialty cacao distributors within the industry databases Bar & Cocoa, bean.bar, Ecole Chocolat and the Fine Cacao and Chocolate Institute (FCCI), (Bar & Cocoa 2019; bean.bar 2019; Ecole Chocolat 2019; FCCI 2019).

The average world market price (WMP) is recorded by the International Cocoa Organisation (ICCO) and this data was sourced from their records. WMP does not reflect the actual price paid to the farmer but is often used as an industry benchmark. Prices for West African cacao are described per season, which begins in October. Fair trade prices were collected from announcements made by fair trade organizations, which indicate FOB prices. Fair trade premiums, paid by organizations to further support farming organizations, were not considered in this study. Global commodity price was determined by averaging the farm gate prices for commodity cacao in the Ivory Coast and Ghana (hereby described as 'West African' cacao with the understanding that not all West African countries are represented), Brazil, and Ecuador, found in industry publications.

This study included 63 industry reports that were found to be suitable for quantifying the specialty cacao prices, culminating in 280 data points between 2014-2019. Few craft chocolate and specialty cacao industry reports were published prior to 2014, thus setting the parameters for data collection. Pricing data was extracted from individual reports, only recording data provided, (no extrapolation of expected prices). Not all reports included sourcing quantity and not all reports reported farm gate price. Average direct trade prices offered by specialty cacao buyers were calculated by averaging individual farm gate, LC, and FOB price in USD paid per kilo of specialty cacao and comparing each average to world trade commodity cacao farm gate prices and fair trade farm gate prices for the 2014-2019 period average.

$$\left(\frac{specialty\ cacao\ FG\ price - \ commodity\ cacao\ FG\ price}{commodity\ cacao\ FG\ price}\right)$$

Specialty Cacao Pathways and Definitions

A literature review was used to identify synthesize relevant definitions and pathways for specialty cacao using four databases: Web of Science, Scopus, Science Direct, and Agricola. A Scopus search using the terms ("fine cacao" OR "specialty cacao" OR "craft chocolate" OR "fine cacao" OR "fine cocoa" OR "flav* cacao" OR "flav* cocoa" OR "specialty cocoa" OR "fine chocolate" OR "bean to bar") in the Title Abstract, and Keywords search fields yielded 112 document results between 2012- 2021. A Web of Science search using the same terms in the Topic Search field yielded 98 results between 1997- 2021. A Science Direct search using the terms ("fine cacao" OR "specialty cacao" OR "craft chocolate" OR "fine cacao" OR "fine chocolate" OR "bean to bar" OR "flavor cacao") in the Terms search yielded 131 results between 1997- 2021, and the terms ("fine cocoa" OR "specialty cocoa" OR "craft chocolate" OR "fine cocoa" OR "fine chocolate" OR "bean to bar" OR "flavor cocoa") yielded 229 results between 1997- 2021. Agricola search included only two results, published in 1986 and 1991. In addition, a review of the literature and preliminary analysis of secondary data selected by searching Google and the Google Scholar database was performed in September 2019 to complement references cited in the primary literature and unpublished studies (table 4).

Article abstracts and text were investigated for definitions of specialty cacao and craft chocolate. For inclusion into this review, only studies that met the following criteria were selected:

(1) cacao/cocoa industry official publication or academic thesis, report, or scientific publication;

(2) examines specialty cacao as a distinct product from commodity cacao; and

(3) written in English or Spanish.

Following these criteria, 100 articles published between 1997 and 2021 were investigated.

2.4 Results

Specialty Cacao Pricing

Landed cost for conventionally grown cacao offered by specialty cacao buyers from 2015-2018 were, on average, 140% higher than the world market price for commodity cacao (figure 2), and 205% more than the ones of fair trade cacao, not inclusive of fair trade premiums. The average FG price paid per kg of conventionally grown cacao by craft chocolate makers and specialty cacao buyers were, on average, 95% more than the average producer price for West Africa, Brazil, and Ecuador markets between 2014 and 2019 (figure 3).

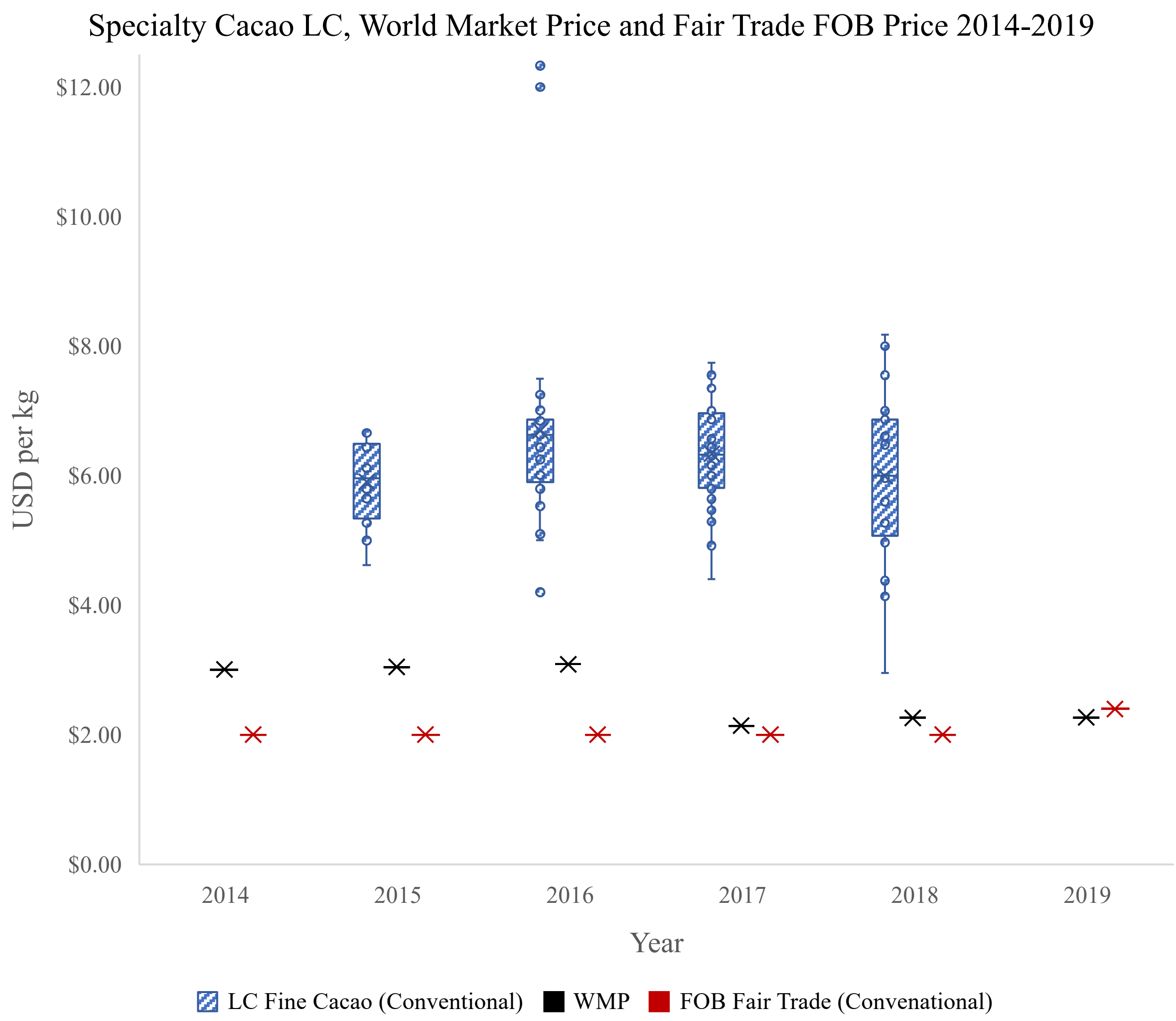

Figure 2. Average Price Paid per kg Cacao. Average landed cost (LC) price paid per kg cacao by craft chocolate makers and specialty cacao buyers for conventional fine cacao between 2015 and 2018, and fair trade market Free on Board (FOB), and commodity world market price (WMP) for commodity cacao between 2014 and 2019. Note: LC, FT, and WMP are not directly comparable, as each market operates uniquely. This data is non-inclusive of fair trade premiums.

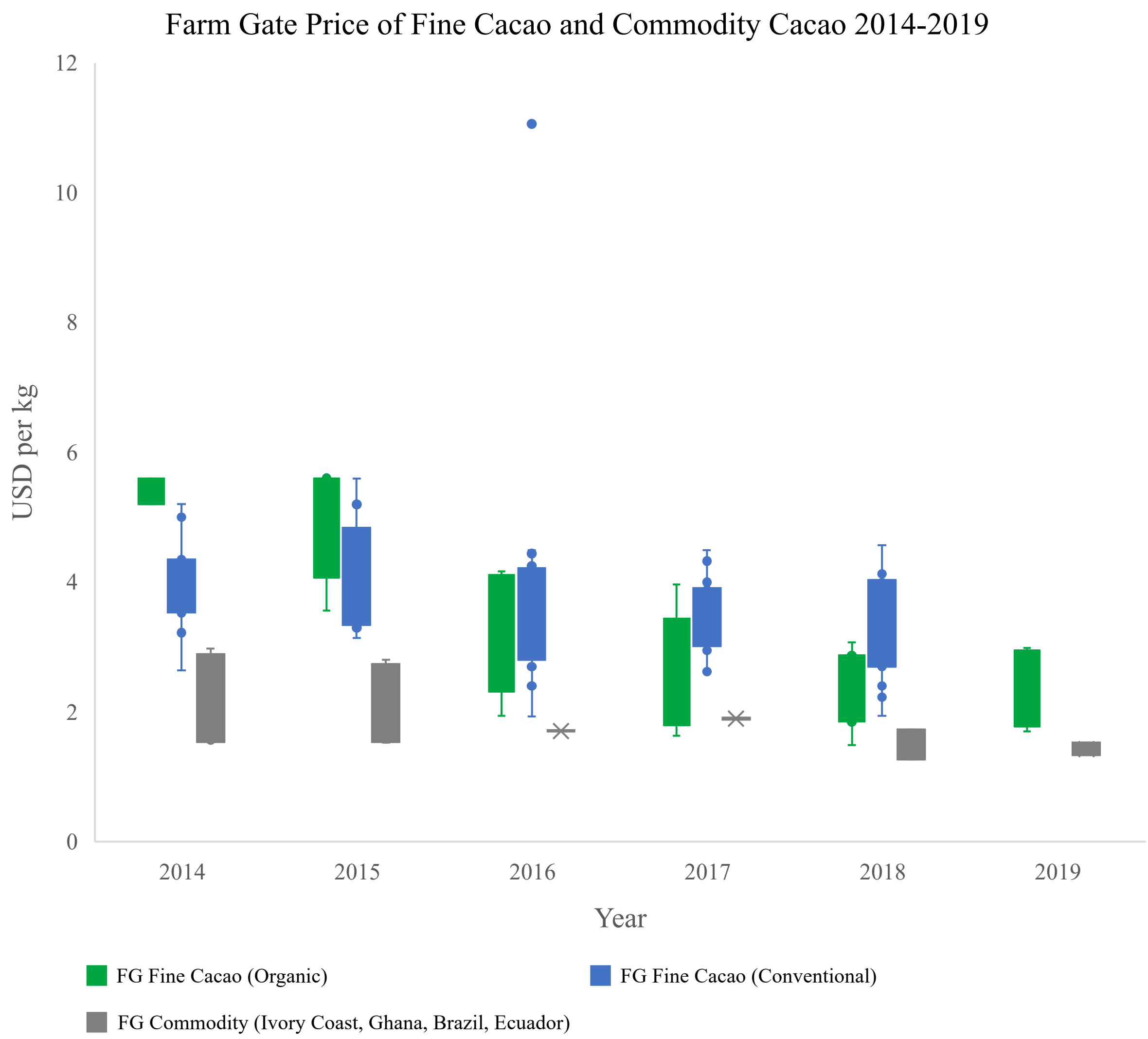

Figure 3. Average Price Paid per kg Cacao. Average farm gate (FG) price paid per kg cacao by craft chocolate makers and specialty cacao buyers for conventional and organic fine cacao, and average producer price for the Ivory Coast, Ghana, Brazil, and Ecuador markets between 2014 and 2019.

This research revealed that global specialty cacao prices were consistently higher than global commodity cacao farm gate prices. These results reflect inconsistent prices offered for specialty cacao from year to year, for both conventional and organic products. It should be noted that LC, WMP, and FT are not directly comparable, as each market operates uniquely, and this data does not reflect the cost of production, certification, and transport, which will vary by country, and is non-inclusive of fair trade premiums (table 2).

Table 2. Landed Cost, Farm Gate Price, Free on Board, and World Market Price for direct trade, fair trade, and commodity traded cacao as of 2019, based on self-reported transparency reports, public announcements, and market reports (USD). (LC) Landed Cost; (FG) Farm Gate; (FMP) Fairtrade Minimum Price; (FOB) Free on Board; (WMP) World Market Price. (a) Certified USDA Organic; (b) Intermediary; (*) not inclusive of fairtrade premium; (**) estimated by Bymolt, et al. 2018; (***) estimated by Peprah 2019; (***) announced by COCOBOD 2019.

Company	Year	USD/kg (highest)	Location (highest)	USD/kg (lowest)	Location (lowest)
Askinosie Chocolate	2016	$11.60 (FG)	Madagascar	$3.40 (FG)	Tanzania
Askinosie Chocolate	2017	$4.49 (FG)	Ecuador	$3.00 (FG)	Tanzania
Askinosie Chocolate	2018	$4.29 (FG)	Ecuador	$3.00 (FG)	Tanzania
Dandelion Chocolate	2015	$6.67[a] (FOB)	Ecuador	$4.62[a] (FOB)	Dominican Republic
Dandelion Chocolate	2016	$7.50 (FOB)	Ecuador	$5.10[a] (FOB)	Dominican Republic
Dandelion Chocolate	2017	$7.74 (FOB)	Ecuador	$4.40[a] (FOB)	Dominican Republic
Dandelion Chocolate	2018	$8.18 (FOB)	Ecuador	$5.60[a] (FOB)	Belize
Marou Chocolate	2017	$4.09 (FG)	Vietnam	$3.81 (FG)	Vietnam
Marou Chocolate	2018	$4.19 (FG)	Vietnam	$3.83 (FG)	Vietnam
Raaka	2018	$6.40[a] (FOB) $2.90 (FG)	Dominican Republic	$5.00 (FOB) $1.61 (FG)	Tanzania
Taza Chocolate	2016	$5.60[a] (FOB) $4.17 (FG)	Belize	$3.82[a] (FOB) $1.94 (FG)	Haiti
Taza Chocolate	2017	$3.45[a] (FOB)	Haiti	$2.87[a] (FOB)	Ecuador
Taza Chocolate	2018	$3.45[a] (FOB)	Haiti	$2.80[a] (FOB)	Ghana
Uncommon Cacao[b]	2015	$5.60 (FOB) $4.04 (FG)	Belize	$5.60 (FOB) $3.30 (FG)	Guatemala
Uncommon Cacao[b]	2016	$6.87[a] (LC) $4.44 (FG)	Belize	$4.31[a] (LC) $1.93 (FG)	Haiti
Uncommon Cacao[b]	2017	$7.56 (LC) $3.91 (FG)	Colombia	$4.50[a] (LC) $1.96 (FG)	Dominican Republic
Uncommon Cacao[b]	2018	$6.55 (LC) $2.70 (FG)	Colombia	$3.63[a] (LC) $1.49 (FG)	Ghana
Fair Trade USA[b]	2011-19	FMP $2.30[a] (FOB)	Worldwide*	FMP $2.00 (FOB)	Worldwide*
Fair Trade USA[b]	2019/20	FMP $3.00[a] (FOB)	Worldwide*	FMP $2.40 (FOB)	Worldwide*
Fairtrade International[b]	2012-19	FMP $2.30[a] (FOB)	Worldwide*	FMP $2.00 (FOB)	Worldwide*
Fairtrade International[b]	2019/20	FMP $3.00[a] (FOB)	Worldwide*	FMP $2.40 (FOB)	Worldwide*
Commodity Market	2016	$3.09 (WMP)	Worldwide (May)	$2.28 (WMP)	Worldwide (Dec.)
Commodity Market	2017	$2.19 (WMP)	Worldwide (Jan.)	$1.91 (WMP)	Worldwide (Dec.)
Commodity Market	2018	$1.95 (WMP)	Worldwide (Jan.)	$2.65 (WMP)	Worldwide (May)
West African Market	2015	$1.73**(FG)	Ghana	$1.66** (FG)	Ivory Coast
West African Market	2017	$1.63***(FG)	Ghana	$1.48*** (FG)	Ivory Coast
West African Market	2018	$1.53****(FG)	Ghana	$1.24**** (FG)	Ivory Coast

Specialty Cacao Production

Despite significant global cacao production in West Africa, Indonesia, and Brazil, specialty cacao is often sourced from South and Central American countries (Bolivia, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, Mexico, Nicaragua, Peru, and Venezuela) (ICCO 2018). An analysis of published reports from craft chocolate makers and specialty cacao distributors revealed that the majority of reported specialty cacao purchases (MT) between 2014-2019 came from the Dominican Republic (54%). Less significant volumes were sourced from Belize (10%), Haiti (8%), Guatemala (8%), Ecuador (6%), and Bolivia (6%), with only 2% originating out of Ghana and no sourcing from the Ivory Coast (figure 4).

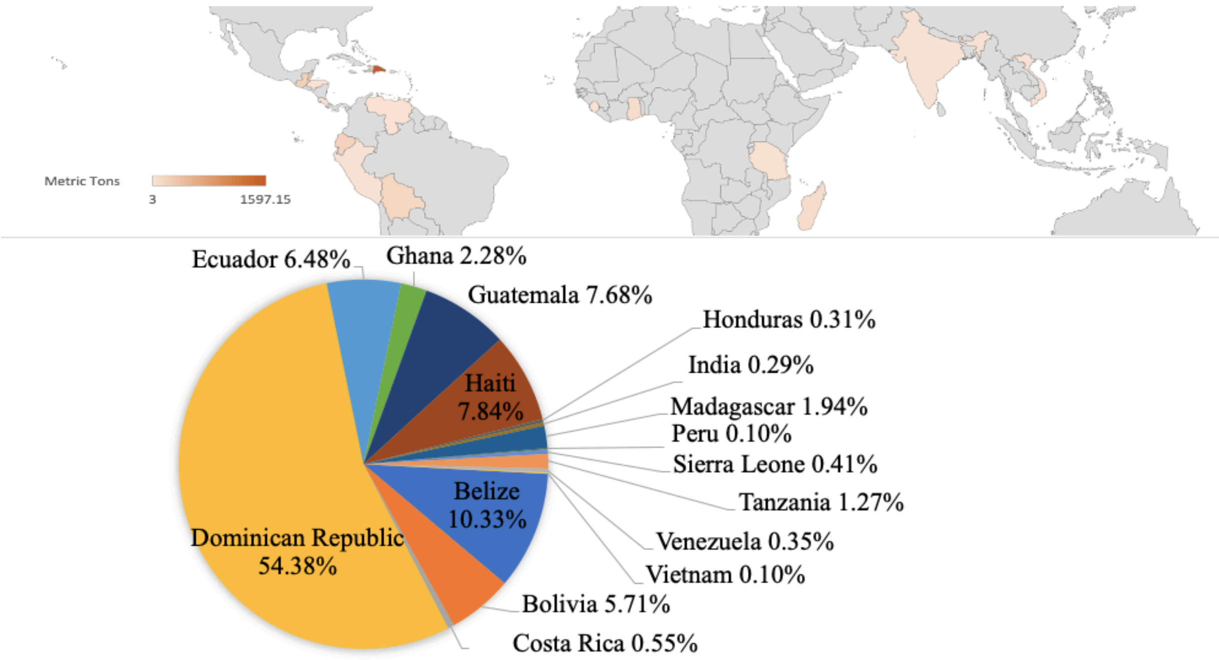

Figure 4. Reported Specialty Cacao Origins (MT) 2014-2019. Sources of fine cacao in metric tons (MT) as reported by craft chocolate makers and specialty cacao distributors, which revealed significant sourcing from South and Central America between 2014-2019.

Primary Pathways

Clear, accessible, and uniform standards for specialty cacao quality would help to level the playing field between cacao growers and buyers. Better definition and distinction of the production methods and product characteristics would increase our understanding of the mutual interactions between specialty cacao and sustainable development in cacao producing regions to aid long term sustainability, environmental, and farmer welfare goals. A review of the literature and industry working definitions have revealed the defining characteristics for specialty cacao through five primary pathways: (1) quality, (2) genetics, (3) origin, 4) certification, and (5) direct trade.

Pathway 1: quality

Quality may refer to exceptional flavor characteristics, as well as the physical appearance of cacao beans (including a lack of undesirable traits such as mold, breakage, contamination, and insect damage) (CAOBISCO/ECA/FCC 2015). Flavor and texture are often cited as a major identifier for specialty chocolate, delivering one of the most measurable distinctions between industrial chocolate and craft chocolate products (Engeseth and Ac Pangan 2018). Establishing protocols and standards for broad flavor profiling to differentiate at the point of marketing is a development of the specialty cacao industry (Sukha et al. 2009).

Quantifying fine flavor quality has been universally identified as one of the most important responsibilities for industry development (Bioversity International 2019a). Reliably measurable quantifiers for flavor quality identification also allows for accessibility to specialty cacao markets by new or lesser-represented members of the industry.

Existing quality assessment definitions and protocols are generally determined, surrounding the purpose of the initiative, and typically rely on evaluation from the buyer's perspective (Sukha 2016). Organizations such as the Fine Chocolate Industry Association (FCIA), the Fine Cacao and Chocolate Institute (FCCI), the Cocoa of Excellence (CoEx) program, and various industry members have collaboratively and individually taken steps in developing quality assessment standards. The following quality assessment protocols, identified by Sukha (2016), evaluate cacao quality according to a defined procedure, followed by "qualitative and/or quantitative assessment by a trained or experienced tasting panel":

- CoEx focuses on recognizing and promoting high-quality cacao with the International Cocoa Awards (ICA) program, which includes global representation, evaluated by panels of experts (Eskes et al. 2012). The quality assessment protocol offers terms for evaluation with matching descriptors and is a robust and repeatable sampling procedure for specialty cacao (Bioversity International 2019b).
- The Cocoa Research Centre, Sensory Training Guide (CAOBISCO/ECA/FCC 2015), also offers a broad attribute set with descriptors for flavor evaluation.
- The HCP (Heirloom Cacao Preservation) Fund is a sister organization to FCIA, which also focuses on identifying high quality, fine flavor cacao, linking flavor to genetics to preserve and propagate for current and future generations, as well as to recognize and reward responsible growers (HCP 2019a).
- Equal Exchange in collaboration with TCHO and USAID (United States Agency for International Development) has produced a quality assessment procedure accessible to both cacao buyers and producers. Protocols are based on specialty coffee evaluation methods, which accompany training and origin-based facilities with a focus on shared vocabulary (USAID-Equal Exchange-TCHO 2017).

Not mentioned by Sukha (2016) is the IICCT (International Institute of Chocolate and Cacao Tasting) certificate in cacao evaluation and flavor profiling tasting protocol, developed as a training tool for chocolate and cacao industry members (IICCT 2018), and the FCCI quality assessment (FCCI 2017).

Physical appearance is also a factor in specialty cacao identification under the umbrella of quality. Processing methods can noticeably impact the physical qualities of beans, with the particularly significant variation found in beans with differing fermentation, drying, storage, and other post-harvest processing methods (Lima et al. 2011; Kongor et al. 2016).

CoEx provides physical quality standards for submissions for the ICA program as well as a proposed harmonized international standard for specialty cacao, which is still under review as of writing (CoEx 2017; Bioversity International 2019a). Outside of specialty cacao quality assessment protocols, key information about cacao quality and overall flavor defects may be gathered from the Fermentation Index (FI) or cut test (Romero-Cortes et al. 2013; Seguine and Sukha 2015). However, physical standards for specialty cacao are not widely documented across all quality assessment protocols.

Development of International Standards for the Assessment of Cocoa Quality and Flavour (ISCQF 2019) offers more information on quality assessment for the cacao industry as a whole. These initiatives assist in the development of common protocols and terminology to facilitate evaluation using accessible standards. More information regarding aspects of bean quality and quality standards are summarized by CAOBISCO/ECA/FCC (2015). Quality differences using the qualifier of heritable flavor, most reportedly in Ecuadorian Nacional varieties, are further described under "Genetics." Additional factors influencing quality variation in cacao have been described by Kongor et al 2016).

Pathway 2: genetics

Genotype and genetic makeup have been identified as a major component of the final flavor and texture quality and profile of cacao (Argout et al. 2011; Boza et al. 2014). For example, the Heirloom Cacao Preservation Initiative has developed a partnership between the Fine Chocolate Industry Association and USDA/ARS, focused on the development of fine flavor cacao with a particular interest in identifying genetic relationships. HCP utilizes genetics and sensory analysis as primary tools to determine specialty cacao potential for conservation purposes (Seguine and Meinhardt 2014). This flavor diversity seeking approach to conservation is common throughout the specialty cacao community.

Indicators gathered from proper genotyping, and the identification of known fine flavor cacao varieties can be reliably used to identify flavor potential in unknown specimens before post-harvest processing has been applied (Afoakwa et al. 2008; Santander Munoz et al. 2019). Several cultivars and groups of cacao have been generally identified to have fine flavor quality potential, such as Nacional (Solorzano et al. 2012) and Criollo (Castro-Alayo et al. 2019), and have been used as a standard for identifying other groups or cultivars with fine flavor potential, through quality assessment (Hegmann et al. 2017).

Classification of fine or flavor cacao has also been achieved by examining fruit pulp containing comparable levels of various volatile aroma compounds to that of known selections (Hegmann et al. 2017). The development of components and consistency of pulp surrounding the seed is highly associated with genotype, which contributes to fruit pulp quality. Volatile and non-volatile aroma components, stored predominantly in fruit pulp, including secondary plant metabolites such as terpenes, alcohols, esters, aldehydes, or methyl ketones in addition to base “cocoa” flavor characteristics, are combined to contribute to fine flavor potential (Ali et al. 2014).

Genotype may also impact different metabolic pathways for particular molecules to function, to influence flavor for varieties with fine aroma components (Kadow et al. 2013). Studies investigating the relationship between anthocyanin and chlorophyll (Anita-Sari et al. 2016a), anthocyanin pigmentation (Motamayor et al. 2013), theobromine to caffeine ratio (Aprotosoaie et al. 2015), and other components (Smulders et al. 2008) suggest using molecular screening techniques to identify indicators for fine flavor potential. However, identification of molecular markers alone does not guarantee fine flavor quality, as environment and processing method, in addition to crop season and fruit maturity, greatly influence flavor, with variations in molecular composition and intensity (Amores et al. 2007).

Modern cacao production often utilizes clonally propagated materials, though propagation by seed is also widespread (Trognitz et al. 2011). Cross-pollination is prevalent, especially among cultivated trees, although bi-directional pollen flow between wild and cultivated populations can also occur, with instances of self-pollination occurring at a meaningful rate for both wild populations and cultivated trees, situationally (Chumacero de Schawe et al. 2013). The female parent has been identified to principally influence fine flavor, in addition to yield, bean size, and pod characteristics, in conjunction with small and inconsistent effects found in astringency due to male parent genotype donation (Sukha et al. 2017). Further relationships between pollen donor and flavor attributes have been investigated, without substantial results (Sukha 2008; Engeseth and Ac Pangan 2018), although the influence of pollen donor on specialty cacao quality is most reported in bean color (cotyledon) expression (Ratule 2001).

Phenotypic identifiers, including bean color (or lack thereof), are widely associated with fine flavor potential (Anita-Sari et al. 2016b). White bean color, frequently associated with fine flavor, is often used in breeding programs (Devy et al. 2018a), even though bean color reportedly displays poor potential for use as a discriminating parameter between fine and bulk cacao (Amores et al. 2007). Bean color has been utilized as a tool to confirm genetic crosses in breeding programs (Fritz et al. 1995), although criollo type characteristics are commonly selected for (Maharaj et al. 2011). White beans are likely a result of a lack of anthocyanins, or a gene encoding an enzyme in the anthocyanin biosynthetic pathway (Elwers et al. 2009; Fritz et al. 1995). This trait can be recessive (Anita-Sari et al. 2018) and may require sustained homozygosity or near homozygosity for both the female parent and pollen donor for expression to occur (Arevalo-Gardini et al. 2019).

Breeding programs to combat devastating disease susceptibility in genetically diverse origins have played a role in industry resilience, as well as in developing new varieties of fine flavor cacao, such as in the case of the CATIE (Centro Agronómico Tropical de Investigación y Enseñanza) breeding program (Phillips-Mora 2012; Hegmann et al., 2017; Osorio-Guarín et al. 2017) and the Trinidad Selected Hybrids (TSH) program. Cacao breeding efforts have been further reviewed by Wickramasuriya and Dunwell (2018).

The simplified distinctions of Criollo, Trinitario, and Forastero are somewhat justified in terms of genetic similarities and clusters; however, these classifications are not all-encompassing (Motamayor et al. 2008). While there are certainly exceptions, simplified identifiers are often used to suggest “fine” flavor to contain a genetic background of ‘Trinitario’ or ‘Criollo’ heritage (Amores et al. 2007; Maharaj et al. 2011). Such “fine flavor varieties” are reported to be less preferred by the industrial chocolate industry, as they characteristically display lower yield, higher disease susceptibility, and poor consistency of flavor profiles (Rusconi and Conti 2010). “Bulk” flavor varieties from hearty, disease-resistant, ‘Forastero’ heritage, are suggested to have inferior flavor and aromatic qualities when compared to fine flavor varieties

(CAOBISCO/ECA/FCC 2015). For these reasons, ICCO defines specialty cacao by using a combination of genetic background and origin in relation to the majority category of cacao exported by country (figure 5), via the 2010 International Cocoa Agreement, (discussed in more detail under "Origin").

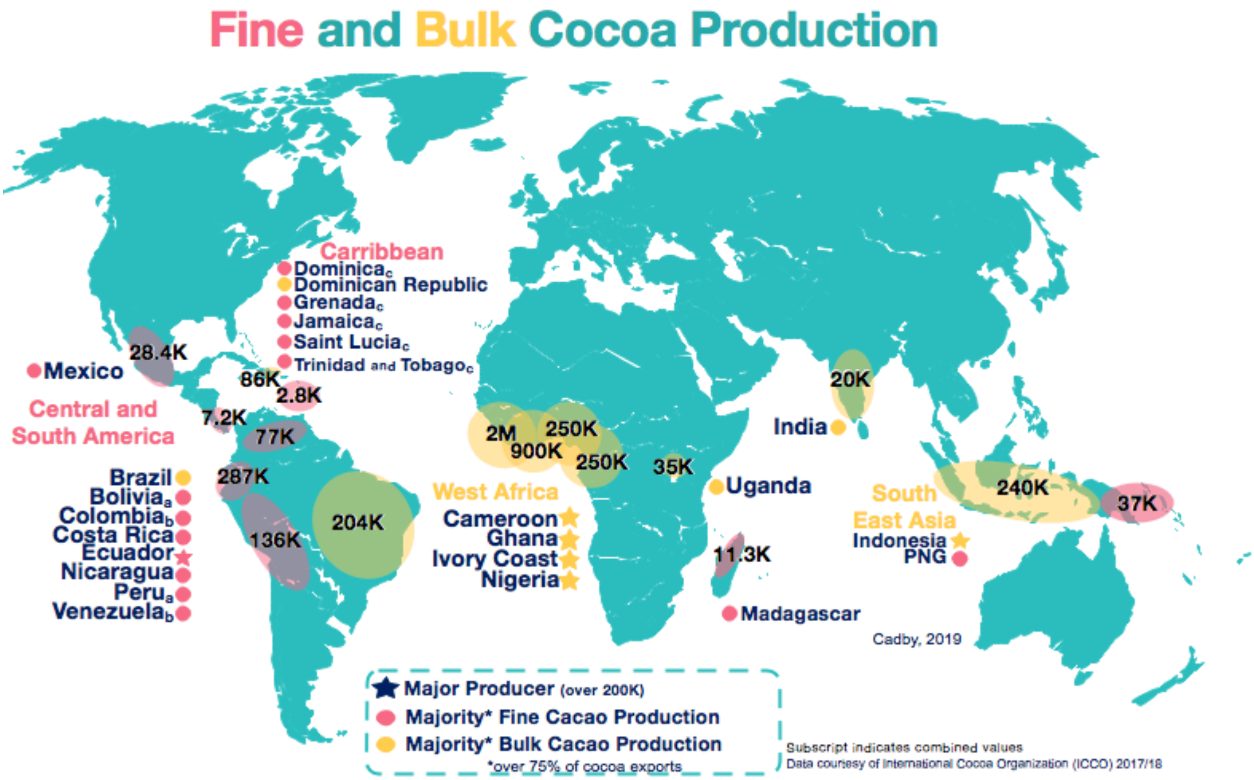

Figure 5. Fine and Bulk Cacao Production by Origin. Annual production in metric tons (MT) of major specialty/fine cacao (pink) and major bulk cacao (yellow) producing countries, according to 2017/2018 ICCO data (ICCO 2018).

The terms Criollo and Forastero, when used in Central and South America, may be used to distinguish traditional cultivars from introduced foreign material based on distinct pod morphology (Motamayor et al. 2008). It is also important to mention that well-documented groups and genetic lineages, such as Criollo and Amazonian heritage, have been used as a branding tool throughout the chocolate industry (Hughes 2010; Devy et al. 2018b). However, postharvest processing dramatically influences the final flavor profile and overall quality for processed cacao beans regardless of genetic potential (Castro-Alayoa et al. 2019).

Pathway 3: origin

The International Cocoa Organization (ICCO) has identified and approved major specialty cacao producing countries that export fine or flavor cacao either exclusively or partially (figure 5). Origin-based identification is common throughout the industry, with the implied relationship between quality and origin reinforced by the ICCO. The Royal Tropical Institute has also identified specialty cacao producing regions, based on an evaluation of factors such as tree age, disease resistance, variety, yield, and mixing with commodity cacao (van der Kooij 2013).

The ICCO states that specialty cacao identification is subjective but recognized by: "genetic origin of planting material, morphological characteristics of the plant, flavour characteristics of the cocoa beans produced, chemical characteristics of the cocoa beans, colour of the cocoa beans and nibs, degree of fermentation, drying, acidity, off-flavours, percentage of internal mould, insect infestation and percentage of impurities" (ICCO 2019a).

Horticultural development through international transport of selected cultivars and hybridization has hindered the formation of any accurate relationship between genetics and origin from a scientific point of view (Motamayor et al. 2008). However, it is common for specialty chocolate producers to differentiate products based on origin as well as offer distinct farm gate pricing (table 2). While the origin is certainly wielded as a branding tool, disproportionate advantages or disadvantages are allotted to particular origins, for example, in the case of West African cacao deemed of lesser quality simply based on regionality (Leissle 2013; García-Cáceres et al. 2014; George 2016a), regardless of actual quality. Origin-based identification may support monetary benefit or detriment to producers when selling products based on origin demand (Hughes 2010). Loureiro et al (2016) summarized findings for selected attributes related to cacao quality based on origin.

Diverse flavor characteristics attributed to the combination of genotype and local environmental conditions have allowed for the development of unique flavor niches within the market (Amores et al. 2007). Although there are no official industry definitions for such terminologies, similar descriptors are often used in product marketing. For example, a single estate may refer to cacao produced not only within the same origin but also within an individual farm or cru, resulting in more control over the entire chain of production from plant to product. The concept of terroir in cacao has been explored by Nesto (2010), describing the lack of clarity for varietal and origin nomenclature to be misleading, and taking into consideration the local resources that impart flavor potential and overall quality. This includes the combined effects of genetic background and postharvest practices, as well as climate and soil, which may contribute to flavor differences (Sukha et al. 2014), with the expectation of flavor variation between lots.

Pathway 4: certification

Many specialty cacao producers choose to participate in certification schemes, such as organic, conservation-focused, bird-friendly, or fair trade certification (Nelson and Phillips 2018). These capture a very small share of the total market, for example, fair trade cacao at around 0.5%, and organic estimated at less than 0.5% of total production (ICCO 2019b ICCO 2006). Some of these organizations have created more in-depth quality assessment protocols following internal quality standards for organizational needs, not necessarily synchronized with specialty cacao quality attributes (USAID -Equal Exchange-TCHO 2017), although certification labels have been found to have a positive impact on purchase intention and quality perception for chocolate (Silva et al. 2014).

Many certification programs operate by offering a price premium to participating farmers in exchange for practicing specific production methods that support organizational goals. For example, a bird- or forest-friendly farming organization can create payments for environmental services to maintain environmental standards (Waldron et al. 2015). Additionally, USDA Organic certification requires farmers to follow specific USDA standards, which include restricted applications of only approved substances, production, and processing methods, in addition to USDA verification (USDA 2018). Neither of these strategies necessarily indicate investment towards fine flavor quality, but a rather social or environmental investment, similar to some direct trade strategies (Pay 2009).

The production of cacao is ideal for sustainable agroforestry systems, as trees are long-lived, have fairly non-intrusive maintenance requirements, and do well under shady, intercropped, understory conditions (Ota et al. 2019). In the specialty cacao industry, diversity in flavor profiles is typically encouraged, which has allowed flavor-focused cacao sourcing, potentially supporting increased cacao biodiversity conservation and promotion, as seen in HCP conservation projects (HCP 2017). An HCP certification status does indicate that certified products meet fine quality expectations (HCP 2019b).

The fair trade certification model suggests that participating farmers will receive better income and access to resources in addition to a fair trade premium, which is an extra sum of money, offered on top of the selling price, intended for organizational development (Fairtrade Certified 2017; Fairtrade International 2019). This system of premiums is one response to the on-going issues surrounding many cacao farmers in developing countries living below the poverty line (Fountain and Huetz-Adams 2018). However, these premiums may still not be sufficient, considering 58% of Fairtrade certified cacao farmers in the Ivory Coast experience earnings below the extreme poverty line (True Price 2018). In response, over the past few years, larger commodity cacao brands have made promises to better support cacao producers in West Africa (Squicciarini and Swinnen 2016).

Pathway 5: direct trade

Cacao farmers typically do not have access to financial reserves and are not protected against unexpected market volatility, which can be exceptionally vulnerable to weather and political conditions (Fountain and Huetz-Adams 2018). In addition, the share of the revenue for commodity cacao farmers has been rapidly decreasing over the past few decades (George 2016b), combined with poor accessibility to market information (Jano and Mainville 2007). Direct sourcing is presented as an alternative strategy to the commodity cacao and fair trade markets, both of which present imperfect supply chains, prone to boom and bust cycles (Clough et al. 2009; Oomes et al. 2016).

Many specialty cacao and craft chocolate industry members choose to source cacao products directly from the farm or local intermediaries, benefiting from increased product consistency and quality control, by directly working with the farmers and processors (McCabe 2015). In these cases, the chocolate producer or intermediary is often making determinations regarding quality, based on independent or internal quality requirements. Direct trade for specialty cacao operates outside of the system in which supply chains have typically operated since the 1980s (Donovan 2006). The globalization of markets allows manufacturers and retailers that control supply chains to create demand, a system that favors larger producers, exporters, and manufacturers (Fairtrade Foundation 2016).

Directly traded specialty cacao beans can demand higher price premiums and more bargaining power when compared to commodity cacao, potentially contributing to the improvement of farmer livelihoods (Jano and Mainville 2007). Additionally, targeted craft chocolate consumers may be likely to prefer purchasing from companies that work directly with farmers (Leick 2018). Increased transparency may also encourage accountability for responsible pricing for the cacao industry as a whole (Dandelion Chocolate 2016; Marou Chocolate 2018; Taza Chocolate 2018; Askinosie Chocolate 2019). However, the production of fine or specialty cacao does not guarantee any particular lifestyle or living conditions for smallholder farmers (Díaz-Montenegro et al. 2018).

However, the perceived superior consumer and producer benefits of direct trade supply chain transparency and sourcing still begs further investigation, and direct trading strategies do not always guarantee a buyer (ICCO 2015). Increased farmgate and FOB prices do not necessarily reflect increased farmer welfare, and the cost of production will differ by local resource availability. The publication of transparency reports by craft chocolate makers has greatly contributed to bringing attention to the craft chocolate industries' desire to prioritize farmer welfare and environmental resource conservation, with many utilizing Associative Sustainable Business Models (Gallo et al. 2018).

2.5 Discussion

In terms of quality, reliably measurable quantifiers for flavor quality can provide producers and new or lesser-represented members of the industry with accessibility to specialty cacao markets. A better understanding of specialty cacao genetics would also support the development of specialty cacao markets and could be used as primary tools to determine specialty cacao potential for conservation purposes in combination with sensory analysis (HCP 2017). Origin-based identification contributing to the monetary benefit or detriment for producers would better serve to help consumers understand diverse flavor characteristics attributed to the combination of genotype and local environmental conditions, and the development of unique flavor niches within the market. Direct trade prices offered by specialty cacao buyers above world trade commodity cacao and fair trade farm gate prices, in addition to increased transparency, can encourage accountability and responsible pricing for the cacao industry as a whole. Certification practices can also contribute to improved production practices in terms of conservation or farmer welfare, as well as establish a standard for specialty cacao quality expectations.

The market price for specialty cacao remains highly variable (table 2), and the production of fine or specialty cacao does not guarantee any particular lifestyle or living conditions for farmers. Additional standards for processing and pricing expectations would support transparency through the ability to communicate distinct quality quantifiers. The cultivation method certainly influences overall quality, including tree age, understory cropping, nutrient and water management, pruning, pollination, and other treatments that influence flavor potential (Kadow et al. 2013; Saltini et al. 2013; Hegmann et al. 2017). Additionally, postharvest practices have also been found to be more effective for fetching higher prices for producers than the variety of cacao produced (Villacis et al 2020). Facilitating access to protocols and standards for postharvest production practices specifically for specialty cacao markets may be beneficial for further supporting producers. Fermentation is one of the most important postharvest treatments to impact final flavor (Schwan and Wheals 2004), in addition to drying (Schwan and Fleet 2015), and should not be overlooked in terms of importance for the distinction of specialty cacao. More information about preharvest, harvesting, postharvest, quality control, transportation, and shipping practices can be found in the Chocolate and Cocoa Industry Quality Requirements Guide (CAOBISCO/ECA/FCC 2015) and by Afoakwa et al (2008). Postharvest management, including pod maturity at harvest and pod storage, is also influential, and a review on the influence of postharvest processing on chocolate flavor is available by Santander Munoz et al (2019).

Global chocolate production is dominant in Europe and North America, although a growing domestic market in South and Central American origin countries has continued to develop in recent years (Squicciarini and Swinnen 2016). The craft chocolate and specialty cacao industry recognizes the global value chain of chocolate which has been overlooked in industrial chocolate systems. Despite the Mesoamerican roots of what we currently describe as chocolate, chocolate consumers are often disassociated with the concept of chocolate production coming at the end of a long production chain that begins at cacao origins. Bean to bar chocolate calls attention to the role of farmers in the production process, which has been poorly detailed throughout the industry. The deterritorialization of cacao origins can be overcome through distinct quality standards and marketing, premium pricing, and origin-specificity, as well as with vertical integration and the production of craft chocolate in specialty cacao producing countries.

Research Limitations

Due to the limited availability of industry transparency reports, the results may not be representative of industry members who choose not to publish transparency reports. Additionally, farmer benefits due to direct trade agreements are not often certified through a third party and we rely on communications from specialty cacao buyers.

Case-Study of Specialty Cacao in Ecuador

In Ecuador, 75% to 95% of cacao production is produced on small and medium sized farms (Jano and Mainville 2007), including the internationally recognized specialty cacao, Nacional, which was supported by a complex system of named quality grades, until around the 1960s (Bentley et al. 2004). Ecuador is considered the world's largest producer of specialty cacao, responsible for 60% of global specialty cacao, and 6% of total global cacao exports (261,000 of 4,251,000 MT) in 2015 (ICCO 2016).

Cacao is a major agricultural export for Ecuador, and the primary cacao producing regions in Ecuador include Esmeraldas, Pichincha, Manabi, Los Rios, Bolivar, Guayas, Santa Elena, Sucumbios, and Orellana (figure 6). Ecuador ranks among the top 10 largest economies in Latin America and is similarly positioned among other cacao producing countries in the region economically, and in terms of food security.

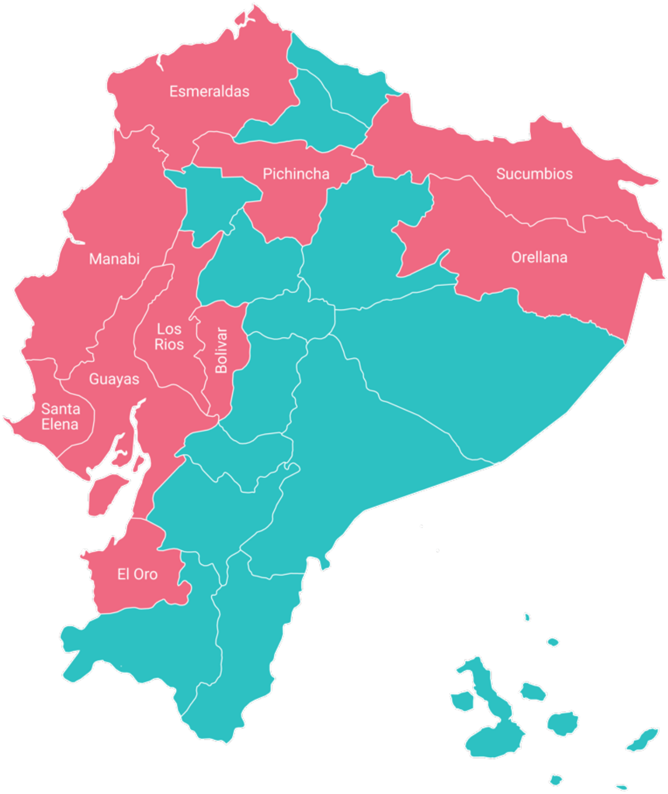

Figure 6. Primary cacao production regions in Ecuador.

Farmers growing traditional cacao varieties benefitted from agroforests, employed to buffer high- and low-temperature extremes, provide natural mulch, and maintain a growing environment that favors the healthy growth of this fine flavor variety (Middendorp et al. 2018). However, Nacional types yield 550 kg·ha^{-1} on average (Sánchez-Mora et al. 2015), while the high yielding cultivar grown in Ecuador, 'CCN 51', can yield 1,000 kg·ha^{-1} on average, and over 3,000 kg·ha^{-1} under intensive management (Amores et al. 2011). The average global yield is just slightly above 400 kg·ha^{-1} (Kozicka et al. 2018) (table 1). Although the yield of Nacional cacao trees is much lower than introduced high yielding varieties, environmental and other non-market benefits, combined with a quality grading system supported by price premiums, had historically provided farmers with incentives to supply fine flavor cacao for a higher market price (Bentley et al. 2004).

Ecuadorian cacao exports had historically earned a premium, due to recognition of the high quality of Nacional beans, however, this comprehensive quality grading system for Ecuadorian cacao has since changed. Large manufacturers prioritizing uniformity (Bentley et al. 2004), as well as the untimely spread of deleterious disease, led to a gradual increase in the production of low-aroma, high-yielding cacao (Jano and Mainville 2007). Poor price differentiation, mixing grades (Blare and Useche 2013), varieties, and quality levels (Jano and Mainville 2007), reflected by a reduced export rating (ICCO 2019a), further led to a general perceived decline in the quality of Ecuadorian cacao (Bentley et al. 2004).

Surveys have identified that farmers are willing to invest in the production of traditional agroforestry varieties for a price reward (Blare and Useche 2013) or conversely, may fail to invest due to constraints along the marketing chain such as poor communication of quality and price factors (Jano and Mainville 2007). In addition, farmers seeking higher prices must employ a combination of post-harvest practices and meet quality expectations. As distinct price premium and quality grading systems become less accessible, farmers may transition to high yielding, nonaromatic commodity cacao, grown in full sun to maximize yields and short-term economic gain. Diverse Nacional agroforest parcels are often larger and contain older trees with more biodiversity, and farmers are aware of soil health and biodiversity conservation benefits (Bentley et al. 2004). Farmers who continue to produce high-quality specialty cacao may be incentivized by environmental and other non-market benefits of using agroforestry systems while searching for viable economic incentives within specialty markets.

In a recent study analyzing the effect of varieties on prices received by cacao producers in Ecuador, farmers producing Nacional cacao were more likely to have more years of experience in cacao farming, be part of a producer association, have had received cacao production training and access to an extension agent, grow older trees, on average 23 years older, with a lower planting density and more intercropping, and were less likely to use fertilizer than farmers growing ‘CCN-51’ (Villacis et al 2020) (table 3), similar to findings reported by Díaz-Montenegro et al. 2018.

Table 3. Comparison of Average Values for Household and Farm Characteristics between Nacional and ‘CCN 51’ Cacao Farmers Interviewed. Adapted from Villacis et al. 2020, all factors are significantly different. Y/N indicates (Yes = 1 and No = 0).

	Nacional	**‘CCN 51’**
Farmer experience in cacao farming (years)	29.00	18.11
Head of household is part of a producer's association (Y/N)	0.34	0.05
Household has received any cacao production training (Y/N)	0.51	0.32
Household has access to an extension agent (Y/N)	0.32	0.21
Age of trees (years)	29.33	6.66
Planting density (trees/ha)	814.79	1020.64
Intercropping used on farm (Y/N)	0.33	0.22
Fertilizer applied (Y/N)	0.19	0.45
Certification participation, including cooperative (Y/N)	0.13	0.00
Postharvest treatments including fermentation and drying (Y/N)	0.65	0.80
Total fresh weight produced (ton/ha)	0.44	0.80
Total fresh weight produced per tree (kg/tree)	0.59	0.82

The example of Nacional cacao in Ecuador describes the potential of specialty cacao to gain international recognition and price premiums based on quality, genetics, and origin, with potential for direct trade and certification schemes to further support production or advise cocoa policy. Additionally, smallholders engaged in direct trade received higher prices for specialty cacao; had increased access to training opportunities, technical assistance, and improved social networks; and were more likely to practice environmentally friendly farming practices, compared with smallholder producers selling through mainstream markets.

Farmer cooperatives, which accounted for about 5% to 10% of total exports from Ecuador in 2015 (Ahmed and Hamrick 2015) have also played an important role in leveraging bargaining power for farmers and strengthening the cooperative sector in Ecuador, as a mechanism to enhance the development opportunities for smallholder cacao producers, and facilitating the establishment of direct trade relationships (Middendorp et al 2019). Overall, farmer surveys have revealed that the industry must offer more market stability, accessible quality standards, and consistent premiums to ensure a mutually beneficial approach to the long-term sustainable development of the specialty cacao industry and specialty cacao producing regions.

This case study supports the findings that facilitating access to protocols and standards for postharvest production practices specifically for specialty cacao markets may be beneficial for further supporting producers. Additionally, improving standards for processing and pricing expectations would support transparency of expectations for quality and equality through negotiation platforms for cacao producers.

2.6 Conclusion

This research is the first to establish that specialty cacao is consistently paid at a higher premium than commodity cacao; and that high flavor attributes, aesthetic, and physical qualities, in combination with genetics and origin specificity, are critical identifiers of fine flavor and specialty cacao beans; often cited independently. Additionally, further research that validates the effects of specialty cacao markets on social equity and ecological sustainability may yield strategies that can facilitate greater impact on the overall global chocolate market, including farmer welfare, biodiversity, and other community and environmental justice issues.

The identification, quantification, and validation of the premium pricing strategies described by specialty cacao buyers revealed that, although the prices paid for specialty cacao were highly variable between each year, country of origin, and buyer, they were consistently higher than that of commodity cacao prices, showing for the first time that average prices paid for specialty cacao were significantly higher than the world market and fair trade prices, as well as 95% more than the average global farm gate price. Ultimately, cacao farmers are agricultural entrepreneurs managing complex businesses that require reasonable access to independent, unbiased, and objective farmer-driven information on price transparency, market averages, and quality grading systems. Additionally, despite high upfront costs of production, specialty cacao producers are often asked to shoulder the burden of production and maintenance of consistent quality. Farmers wield the least amount of leverage and resources when sales and prices rely on buyers. Following in the footsteps of third-wave coffee industry members, specialty cacao buyers can better support the long-term success of specialty cacao producers by taking on the burden of higher potential risks. For example, buyers can offer cacao producers more robust contracts with upfront payments to guarantee sales and allow for more flexibility in terms of quality and production at the whim of unpredictable weather or political events.

Through a thorough review of the literature and industry reports, five primary pathways that are characteristically common for specialty cacao were identified: (1) quality, (2) genetics, (3) origin, (4) certification, and (5) direct trade. As more cacao producers enter the market, there is a need to further establish a common language for the industry and better define terminologies, as current market trends have bolstered special attention to worldwide cacao quality. Universally accepted parameters can be used as a format to describe and align the industry for the international market to grow and flourish responsibly and superbly. Furthermore, considering the significant influence of postharvest processing in specialty cacao quality, the industry would benefit greatly from the further establishment of processing protocols. Providing farmers with the tools to more easily assess and achieve cacao quality would help in leveling the playing field for producers and buyers when it comes to trading specialty cacao. Cacao quality assessment protocols for specialty cacao should use tools that are both accessible to farmers and yield repeatable results. Significant power differentials through social and economic inequalities as a result of poorly defined standards allow buyers more bargaining power than producers, which warrants change from buyers to level the playing field. The work by Sukha (2016) and Seguine and Sukha (2015) are excellent examples of interdisciplinary collaboration to support the development of standardized quality assessment tools in the specialty cacao industry.

Implications for Theory

This research revealed potential direction for future studies on the effects of specialty cacao on the global chocolate markets and proponents of the supply chain. Buyers of craft chocolate and specialty cacao may value farmer and environmental welfare, therefore developing transparent and direct trade networks is a big step towards more ethical sourcing for the chocolate industry as a whole. The craft chocolate industry occupies a small and specialized niche within the global chocolate industry. In addition to catering to a specific subset of the consumer level fine chocolate base, these markets may provide cacao farmers with more sustainable resources than the traditional cacao marketplace. As the craft chocolate and specialty cacao industries expand in market share, benefits from improved standardization of terminology and more comprehensive parameters that capture factors such as genetics, origin, trade, cultivation method, and certification are expected. Advocating for craft chocolate makers and chocolate industry members to publish transparency or sourcing reports may encourage others to follow their lead and help to set a standard for more predictable pricing.

This research also showed for the first time that most of the reported specialty cacao purchases came from the Dominican Republic rather than West Africa, Indonesia, or Brazil, where the overwhelming majority of global cacao is produced. Although craft chocolate makers and specialty cacao distributors primarily sourced from South and Central American countries, the relationships between improving farmer livelihoods and the production of specialty cacao in Ecuador described by previous research are still likely not applicable at a global scale. Local politics, culture, geography, climate, cost of production, and other factors will certainly play a major role in shaping future industry developments. Research that specifically addresses the needs of each local specialty cacao industry would support more effective industry development.

Implications for Management

Specialty cacao demonstrates the potential to address ongoing industry concerns within sustainability science through the increased popularity of premium pricing and direct trade, to encourage sustainable production practices. This emerging industry has the potential to support the future of the chocolate industry as well as the sustainable development for cacao-producing regions through environmental, social, economic, and sensory excellence. Additionally, research on the development and influence of farmer-accessible online and remote platforms, especially in the wake of the global connectivity and transparency revolution and its rippling effects on in-person business, is suggested.

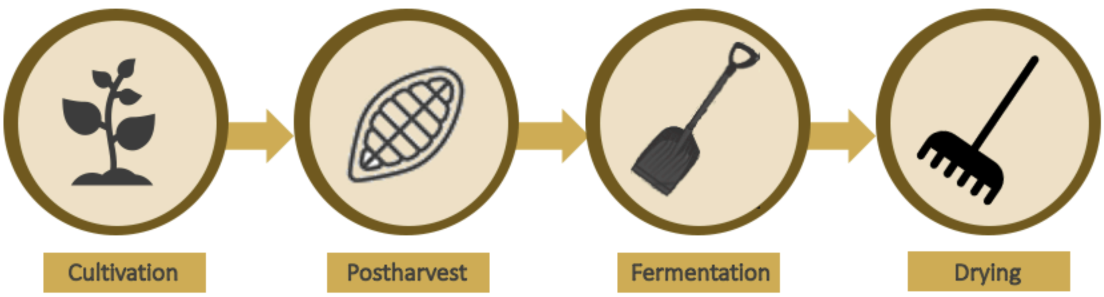

Figure 7. Stages of cacao production at origin.

Table 4. Quality parameters and factors as described in the scientific literature.

Stage of Production		Quality Parameters	Source
Cultivation	Genetics	Identified[1] high pulp aroma or organoleptic quality such as Criollo[2] or Nacional[3]; sum of volatile and non-volatile aroma components[4]; relationships between anthocyanin and chlorophyll[5], anthocyanin pigmentation[6], and theobromine to caffeine ratio[7]; bean color[5], low epicatechin content[8]	1 Daniels et al. 2012 2 Solorzano et al. 2012 3 Castro-Alayo et al. 2019 4 Hegmann et al. 2017 5 Anita-Sari et al. 2016 6 Motamayor et al. 2013 7 Aprotosoaie et al. 2015 8 Kim & Keeney 1984
	Origin	Identified[1] and approved as major fine cacao producing country by ICCO[2]; varieties in majority of production by region[3]	1 Daniels et al. 2012 2 ICCO 2019a 3 Kongor et al 2016
	Agronomy	Control of pests and disease, lack of contaminants such as cadmium and nutrient availability and soil quality [1,2]; fruit maturity[2]; certifications such as organic[3] ethics[4] or HCP[5]	1 Sukha 2016 2 Loureiro et al. 2016 3 Nelson and Phillips 2018 4 Leick 2018 5 HCP 2019
Postharvest	Pulp Conditioning	Lack of disease development or damage, and wet bean quality[1]	1 Sukha 2019
	Fermentation	Succession of yeasts and bacteria, and adequate heat proliferation cycle[1]; pH and microbial interactions[2]; duration[3]; adulterate or additives[4]	1 Sukha 2019 2 Lima et al. 2011 3 Counet et al. 2004 4 HCP 2019
	Drying	Evaluating physical, chemical, and sensory parameters[1,2]; final mositure[3]; duration and exposure to contaminants and materials[3]	1 Barrientos et al. 2018 2 Sukha 1997 3 Sukha 2019
	Storage	Lack of mold or bacteria development or exposure to contaminants, and insect infestation[1,2]; duration[3]	1 Sukha 2016 2 Daniels et al. 2012 3 Sukha 2019
Final Product	Dried Bean	Exceptional flavor characteristics and physical appearance (including a lack of undesirable traits such as mold, breakage, contamination, and insect damage)[1], superior flavor and texture[2], uniformity and moisture[3,4], pH between 5.1 and 5.4[5], traceability[6,7]	1 CAOBISCO/ECA/FCC 2015 2 Engeseth & Ac Pangan 2018 3 Sukha 2016 4 Daniels et al. 2012 5 Loureiro et al. 2016 6 Donovan 2006 7 Sukha 2019

Table 4 continued.

Factor	Description	Source
Dried bean quality	Exceptional flavor characteristics, food safety, and wholesomeness, cocoa butter characteristics, color potential, yield of edible material, bean count, individual bean weight, bean size, yield of shell, aesthetics and physical appearance, free of defects such as mold, breakage, contamination, odor, foreign matter, and insect damage[1,2,3]; flavor and texture[2,3]; moisture content (6.5-7.5%), consistency[5,6,7];	1 CAOBISCO/ECA/FCC 2015 2 CoEx 2017 3 Bioversity International 2019a 4 Engeseth and Ac Pangan 2018 5 Sukha 2016 6 Daniels et al. 2012 7 ISCQF 2019
Ethical sourcing (labor, etc)	Direct sourcing[1]; price premiums (FG, LC, FOB)[2]; fair labor practices and fair trade certification[3,4,5,6]; poverty alleviation[7]; transparency[8];	1 Leick 2018 2 Jano and Mainville 2007 3 Nelson and Phillips 2018 4 Pay 2009 5 Fairtrade Certified 2017 6 Fairtrade International 2019 7 Fountain and Huetz-Adams 2018 8 Gallo et al. 2018
Bean origin	Traceability, geographical indicators and certification[1,5,6]; genotype and genetic makeup[2,3,4]; reputation[5]; local environmental conditions[6]; single origin, single estate or terroir[7]; producer relationships[8];	1 CAOBISCO/ECA/FCC 2015 2 Argout et al. 2011 3 Boza et al. 2014 4 Hegmann et al. 2017 5 ICCO 2018 6 Amores et al. 2007 7 Nesto 2010 8 McCabe 2015
Cultivation method (environment)	Organic certification, environmental conservation focused[1,2]; bird friendly[2], forest friendly[3]; genetic and biodiversity conservation and promotion[4];	1 Silva et al. 2014 2 Nelson and Phillips 2018 3 Waldron et al. 2015 4 HCP 2017
Cultivation method (consumer health)	Organic[1], pesticide free2,	1 USDA 2018 2 Nelson and Phillips 2018
Taste	Presence and intensity of ancillary flavors, presence and intensity of acidity, bitterness, astringency, salt, sweet, and cocoa, lack of off flavors, diverse or unique flavor[1,2];	1 CAOBISCO/ECA/FCC 2015 2 ISCQF 2019

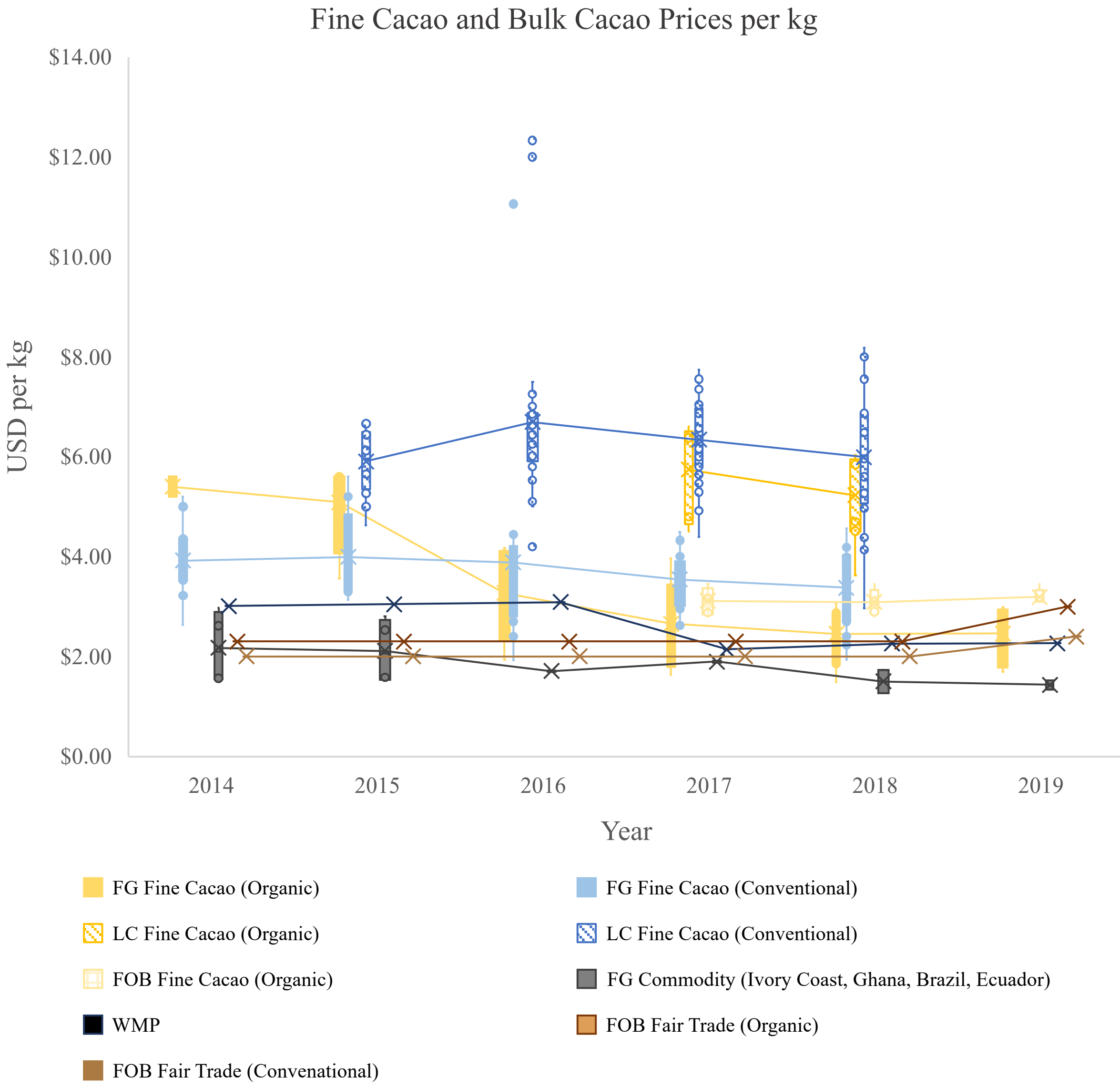

Figure 8. Average price paid per kg cacao by craft chocolate makers and specialty cacao buyers for fine cacao, and fair trade, and commodity world market price (WMP) for commodity cacao between 2014 and 2019.

2.7 References

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Statement of data availability

Available on Harvard Dataverse: Landed Cost, Farm Gate Price, Free on Board, and World Market Price for direct trade, fair trade and commodity traded cacao as of 2019, based on self-reported transparency reports, public announcements, and market reports (USD). https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:.7910/DVN/D2T3YW

Chapter 3. Craft Chocolate Distinctions

Breaking the Mold: Craft chocolate makers prioritize quality, ethical and direct sourcing, and environmental welfare

3.1 Abstract

The commodity chocolate industry has been long recognized for supporting unsustainable and unethical production practices. In contrast, the craft chocolate industry is well-positioned to move the chocolate industry in the direction of more ethical sourcing strategies, improved environmental production practices, and higher quality products as a whole. Craft chocolate businesses also often adhere to ethical and economical guidelines, providing farmers with significantly higher farm gate prices and more resources than their commodity counterparts. However, poor standardization and understanding of industry needs raises questions regarding the integrity and longevity of this industry. With a survey of craft chocolate makers from around the world and an assessment of craft chocolate bar origin and maker, our data confirms for the first time that many craft chocolate producers prioritize responsible business practices including ethical sourcing (29%) and use of direct trade to source higher quality ingredients (38%). In addition, a majority of chocolate makers (60%) believe routinely used quality assessment techniques do not meet the needs of bean to bar chocolate makers or could use improvement and primarily source beans from South and Central America (over 65%), in direct contrast to commodity cacao systems, which predominantly source from West Africa. These results show how the craft chocolate industry is a remarkably distinct entity within the chocolate world, prioritizing sustainable development, and promoting farmer welfare and environmental conservation and identifies gaps to support industry cohesion.

Keywords: craft chocolate, sustainable development, direct trade, ethical chocolate, South America

3.2 Introduction

Craft, specialty, or artisan chocolate production is the small scale production of superior chocolate products using fine flavor or specialty cacao beans (CCMA 2013). Craft chocolate businesses also often adhere to ethical and economical guidelines, including the use of Associative Sustainable Business Models (Gallo et al. 2018), for the betterment of farmer livelihoods, or ensuring ethical sourcing of materials at origin. Over the past 20 years, this industry has experienced exponential growth, possibly around two times that of commodity cacao, according to some industry experts (Homman, 2016; Santander Munoz, et al., 2019).

However, poor standardization and understanding of industry needs raises questions regarding the integrity and longevity of this industry. Branding built through craft-chocolate quality and ethical principles can be liberally applied to non-craft chocolate products, weakening the identity and undermining value (Gallo et al. 2018). Specialty bean origins are often used as a marketing tool to distinguish craft chocolate products and provide consumers with additional insight into the higher quality standards that are associated with these products. Craft chocolate producers are primarily responsible for educating consumers about this relatively new industry. Additionally, unreliable market conditions and unclear quality standards can negatively impact the fine cacao producers intended to benefit from participating in the craft chocolate value chain (Bentley et al. 2004).

The chocolate industry as a whole is recognized for unsustainable production practices as well as ethical human welfare concerns, with millions of smallholder living under the poverty line, without access to alternative income strategies. The craft chocolate industry is well-positioned to move the chocolate industry in the direction of more ethical sourcing strategies, improved environmental production practices, and higher quality products as a whole.

As the craft chocolate industry develops, understanding the current state and needs of craft chocolate makers can aid in building a better foundation for future research goals and support systems. The objective of this research is to provide timely information about the state and needs of the global craft chocolate industry. This research surveyed seven areas of relevant inquiry: location and size of the business, source of raw materials (cacao beans), primary and secondary methods utilized to determine the quality of raw materials, level of satisfaction with raw materials, amount purchased and price point, and specific challenges faced by the business owners. These topics were chosen because together they allow for a realistic depiction of the concerns and priorities of craft chocolate makers around the world.

Craft chocolate bar origins were investigated to shed light on the current sourcing strategies practiced by craft chocolate makers. The distribution of specialty cacao producers involved in craft chocolate was also investigated. Craft chocolate bar origin can be used to better understand the barriers to entry for cacao farmers seeking to enter these markets.

3.3 Materials and Methods

A list of more than 800 craft chocolate makers, was compiled from online lists supplied by Bar & Cocoa, bean.bar, Ecole Chocolat and the Fine Cacao and Chocolate Institute (FCCI), (Bar & Cocoa 2019; bean.bar 2019; Ecole Chocolat 2019; FCCI, 2019). Only participants who self-identified as craft chocolate makers were included in the survey, as a result of 477 emails yielding a self-selecting sample of 108 participants. Responses were collected through an online survey, conducted between 25 January 2019 and 28 March 2019, using Google Forms.

Craft chocolate bar origins were identified from the C-Spot craft chocolate database, a highly inclusive repository of craft chocolate distributors and bar descriptions (C-Spot 2020). Only chocolate bars categorized as "Retro American", "Classic", "Rustic", "Old School", "Mainstream", "Neo Modern", or "New School" were used for this analysis. Bars that were identified as "Industrial" were not included. A total of 360 craft chocolate makers were identified, and 1439 craft chocolate bars were assessed by type, origin, and source (global distribution of chocolate maker).

3.4 Results

Survey Results

Demographics

The largest group of those surveyed operated out of the United States (26.50%), with a majority on the East Coast (12.04%) and the remainder distributed elsewhere. Respondents from South and Central America were the next largest group (23 respondents; 21.30%), followed by Europe (18 respondents; 16.67%), Japan (10.90%), Australia/New Zealand region (6 respondents; 5.56%), Mexico (4 respondents; 3.70%), Philippines/Thailand/Vietnam region (3 respondents; 2.78%) and South Korea/Taiwan region (3 respondents; 2.78%). Regions with three or fewer responses are not included in these results.

Size of Business

Small business proprietorship is common within the craft chocolate industry. The majority of craft chocolate makers surveyed are small businesses, employing less than 10 people, (75.00%), with 22.22% employing between 10-99 people and only 2.78% with more than 100 employees.

Satisfaction with Bean Quality

Craft chocolate currently operates within a distinct market, creating value through higher quality products, and promoting farmer welfare, to a more targeted consumer base (Leissle 2017). A major characteristic of craft chocolate products is a strong focus on fine flavor notes, striving for uniqueness and product diversity, with specialty cacao beans (Leissle 2013; Roos 2018; FCIA 2019).

A lack of universally accepted criteria for fine cacao quality assessment means that individual users often assess fine and specialty cacao beans based on independent or internal quality requirements. When asked if chocolate makers find that "routinely used quality assessment techniques meet the needs of bean to bar chocolate makers", only 39.73% stated "yes", with 34.25% stating "no", and 26.03% stating "mostly or needs improvement" (for this question, n=73, including only clearly categorized answers).

One participant stated, there is a "*need for better consistency, unified standards, and shipping routine for maintaining quality of good beans*," -Sweden, and another said, "*cocoa beans cannot be judged simply by type. Beans are greatly affected by the fermentation and drying processes, and influence decisions when using the final product. For example, although some criollo beans are good, not all of them are*," -Japan.

Quality Assessment

Chocolate makers are most likely to assess fine cacao quality with a "dry nib taste test" (22.86%), "Fermentation Index (FI) cut test" (20.95%), or a "liquor taste test" (16.19%). Other common primary methods included using a "trusted source (consultant or intermediary)" (8.57%), "smell and surface visual inspection" (7.62%), making finished chocolate (6.67%), identifying "tree variety or genetics" (4.76%), and inferring quality with bean origin (2.86%). A much less significant portion (less than 2.00%) of participants indicated using a "ground nib taste test", "roasted nib taste test", "chemical analysis via lab", and FCCI quality assessment protocols.

Secondary methods used to assess quality included a "smell and surface visual inspection" (36.00%), "dry nib taste test" (31.00%), "Fermentation Index (FI) cut test" (22.00%), or a "liquor taste test" (21.00%). Other common secondary methods included associating quality with bean origin (14.00%), a "trusted source (consultant or intermediary)" (13.00%), making finished chocolate (10.00%), "chemical analysis via lab" (7.00%), and "tree variety or genetics" (7.00%).

Using these internal quality assessment methods, chocolate makers are seemingly satisfied with the quality of cacao beans that they have access to. When asked if they feel satisfied with the quality of beans they get, 85.19% stated "yes", 13.00% stated "mostly" and 3.00% stated "no". However, one participant stated, "*Even with high [flavor] potential cocoa beans, there are still cases where purchases are delayed due to insects, mold, odors, or significant damage to the beans,"* -Japan.

Sourcing and Purchasing

Utilizing directly sourced specialty cacao with high flavor attributes is common practice in the craft chocolate community, the growth of which has spurred increased cacao production intended for specialty markets (Suphawanichleela 2017). Fine flavor and specialty cacao beans are recognized by high flavor attributes, aesthetic and physical qualities, in combination with genetics, and origin specificity. Specialty cacao produced from fine flavor cacao varieties is ideal for production in sustainable agroforestry systems, supporting conservation initiatives and advanced sustainability efforts, including the method of cultivation or the production environment (Middendorp et al. 2018).

Sourcing refers to the method used to acquire specialty cacao beans. Most chocolate makers employed only one sourcing method when acquiring beans (53.70%), with 25% employing 2 methods, and 19.44% employing 3 or more methods. Chocolate makers source cacao using methods including "find and contract individual farmers for my products" (37.97%), "use an environmentally focused intermediary/distributor" (18.99%), "use a fair trade intermediary/distributor" (17.09%) and "order from a private company/distributor" (13.92%). With fewer producers indicating that they "grow my own products" (7.59%), or "hire a private cacao consultant" (4.43%). One participant stated, *"Working with a quality importer…[has] been a great help and resource to get ethical, quality, fine flavor beans,"* -USA.

Regional preference in cacao sourcing methods was evident (figure 1), although chocolate makers in all countries surveyed stated that they "find and contract individual farmers for my products." In addition, regional preference for the number of different sourcing methods used was also evident (figure 2). Japan is the least likely to diversify sourcing methods for cacao, with 80% of chocolate makers using only one method of sourcing, while the Australia/New Zealand region was the most likely to diversify, with 33% using two methods, and 50% using three or more methods (figure 3).

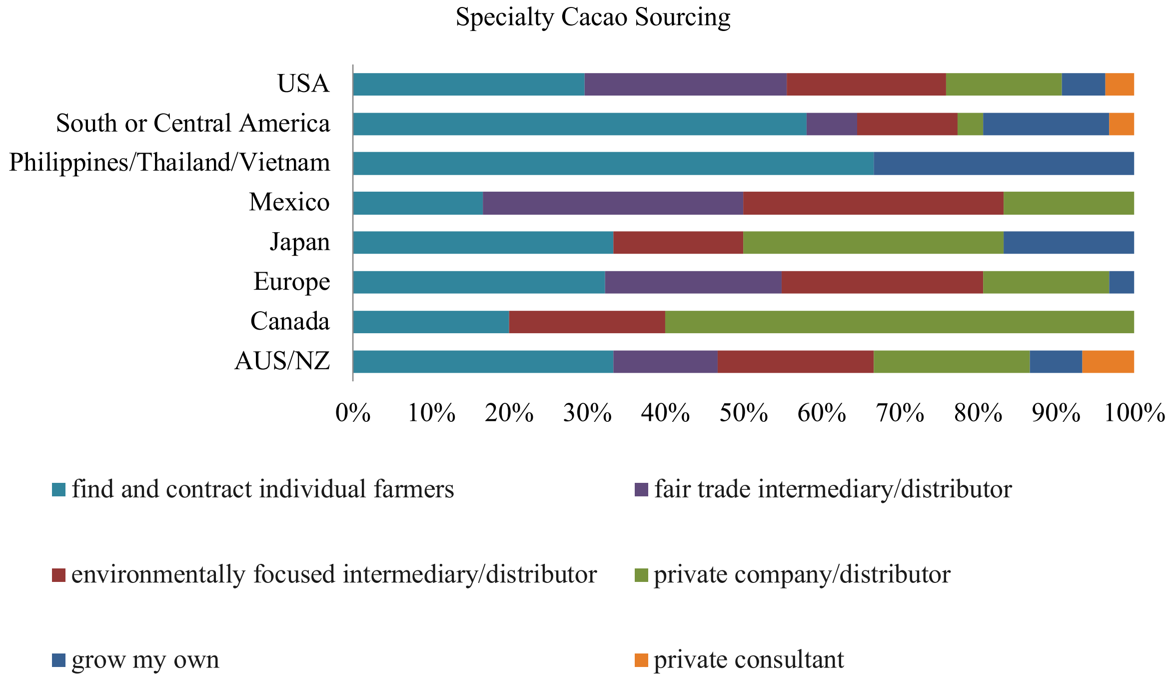

Figure 1. Cacao bean sourcing methods by region. Craft chocolate makers sourced cacao by finding and contracting individual farmers in all regions, with various sourcing methods throughout all regions.

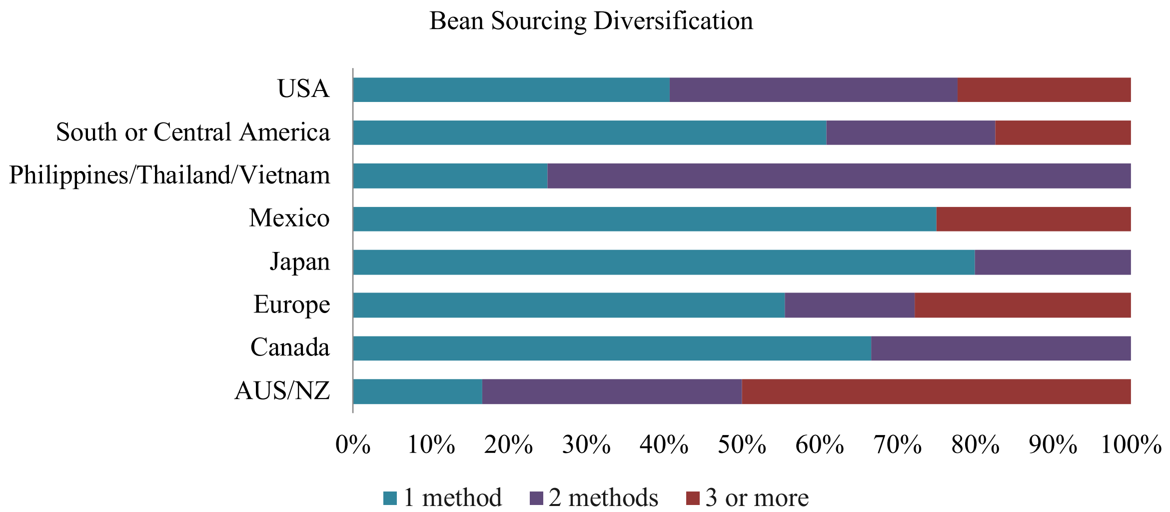

Figure 2. Diversity of cacao bean sourcing methods by region. Craft chocolate makers based out of the USA, Australia/New Zealand region or Europe were more likely to diversify sourcing strategies, while Japan was the least likely to diversify sourcing strategies.

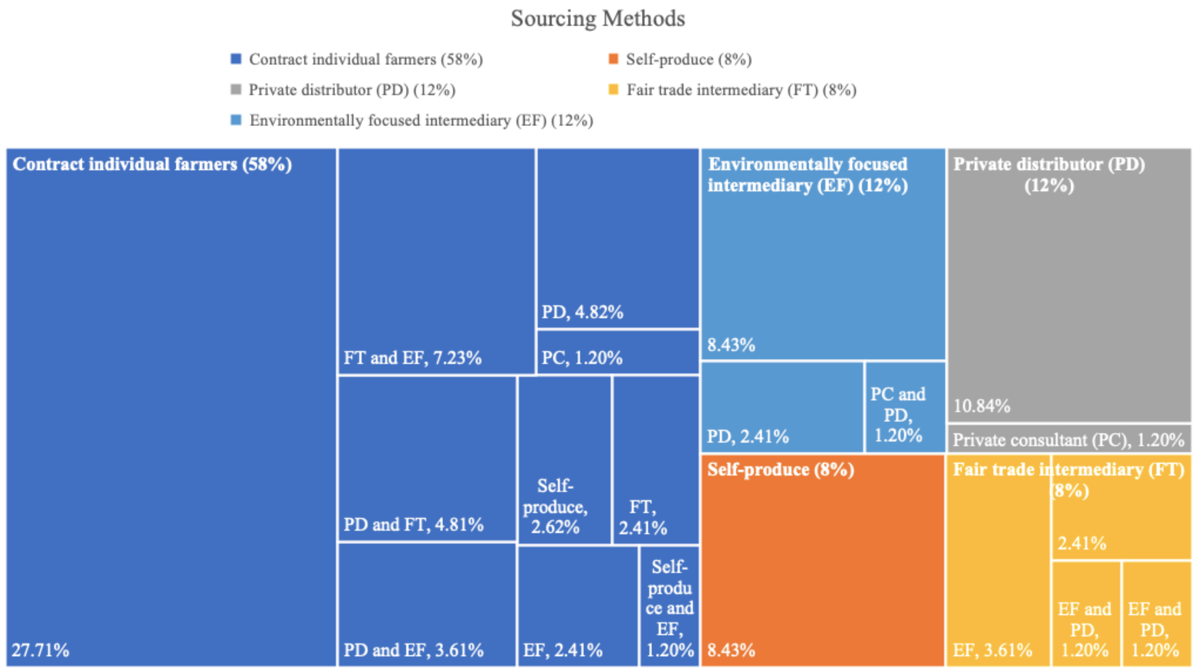

Figure 3. Specialty cacao sourcing strategies for use in craft chocolate.

The most important factor for chocolate makers when purchasing specialty cacao beans is "dried bean quality (42.00%), followed by "ethical sourcing (focus on labor at origin, etc.)" (29.00%), bean origin (11.00%), "cultivation method (focus on the environment)" (8.00%), "cultivation method (focus on consumer health)" (4.00%), and taste (2.00%). A much less significant portion (less than 2.00%) of participants indicated the factors of flavor and fresh bean quality (for this question, n=100, using only clearly categorized answers) (figure 4).

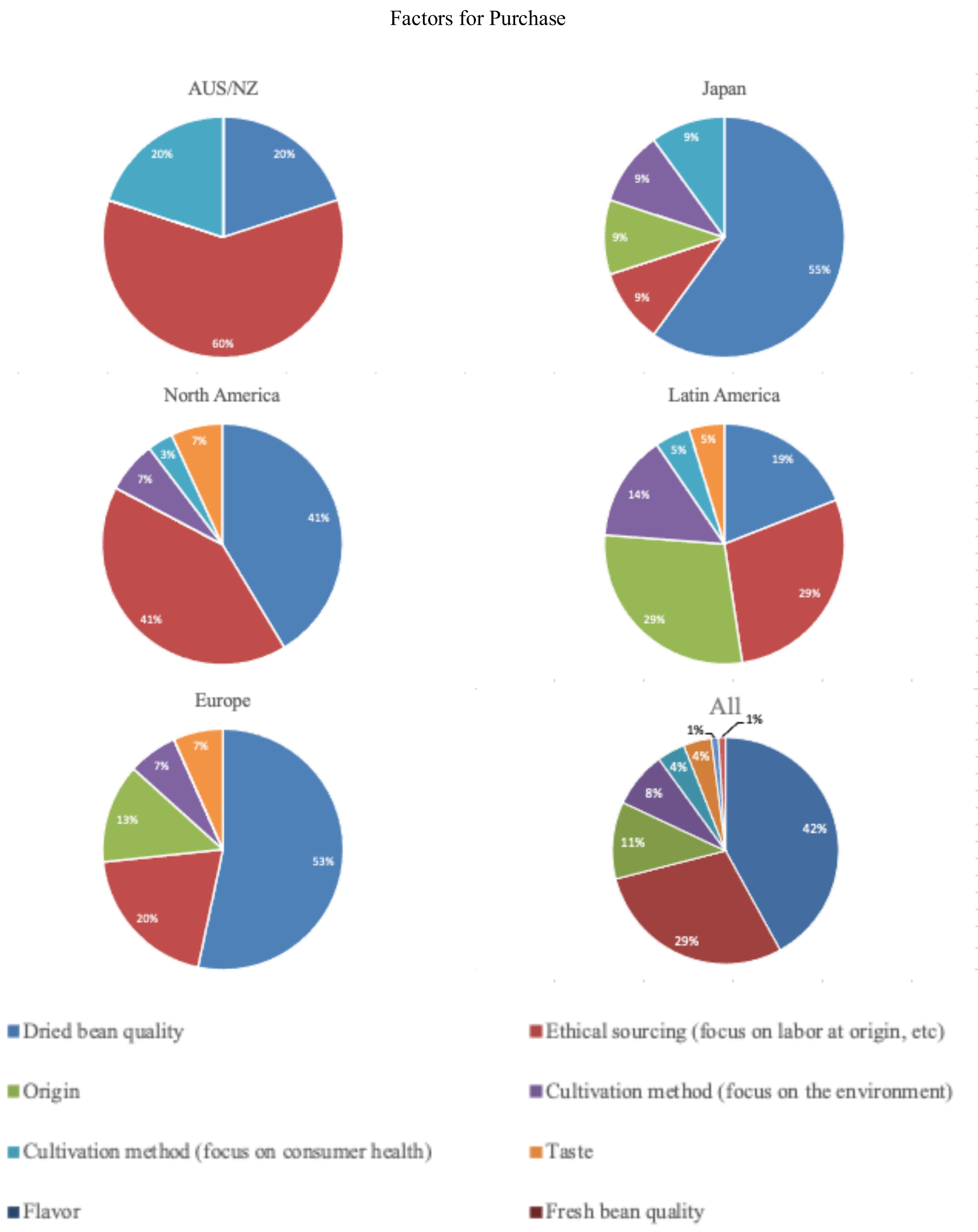

Figure 4. Specialty cacao buyers most important factors for purchase.

Industry Hurdles

Participants were asked to identify the most significant industry hurdles. The most significant hurdle, as stated by 18.69% of global participants is "consistency of quality", followed by "price point" (15.89%), "machinery sourcing" (13.08%), "sourcing quality" (13.08%), "importing and customs regulations" (12.15%), "customer education" (11.21%), "business management (6.54%), "sourcing quantity" (4.67%) and "timing for receiving products" (3.74%). One participant stated, *"I feel the biggest hurdle for our business is getting customers to realize what makes our chocolate "special" and why it costs more than a mass manufactured bar you can buy in the grocery store,"* -USA. Another participant said, "*There's a difference in how it works between cacao producing countries and non-cacao producing countries,"* -Philippines.

Regional difficulties are also evident, as the top three hurdles for participants from the US include "price point" (17.24%), "customer education" (17.24%), and "business management" (13.79%), while in Europe, the top three hurdles include "sourcing quantity" (22.22%), "consistency of quality" (16.67%), and "customer education" (16.67%).

For cacao growing regions, such as South America, the top three hurdles include, "machinery sourcing" (26.78%), "consistency of quality" (21.74%), and "price point" (13.04%). For Mexico, the top two hurdles include "consistency of quality" (50.00%) and "machinery sourcing" (50.00%), while the Philippines/Thailand/Vietnam region includes "business management" (24.14%), "sourcing quality" (31.03%), and "consistency of quality" (44.82%). One participant stated, "*the hurdles may be very different from country to country, more than from region to region*." -Brazil.

Craft Chocolate Bar Assessment Results

Craft Chocolate Bar Origins

The most common craft chocolate bar origins were from South America (figure 5), including Ecuador (13.97%), Venezuela (12.58%), Peru (8.69%), and the Dominican Republic (8.06%). Although west Africa is responsible for over 60% of global cacao production, only 4% of craft chocolate bars had West African Origins (n= 1439). West African chocolate included Ghana (2.22%), Ivory Coast (1.53%), Nigeria (0.14%), Liberia (0.14%), Sierra Leone (0.07%), and Togo (0.07%).

Craft Chocolate Producers Distribution

Distribution of craft chocolate makers was investigated by identifying craft chocolate bar producers (figure 6). Craft chocolate makers are heavily concentrated in the United States (32.30%), followed by France (11.92%) and Italy (10.35%). The EU as a whole consisted of the overall majority of craft chocolate makers (43.14%) (n=360).

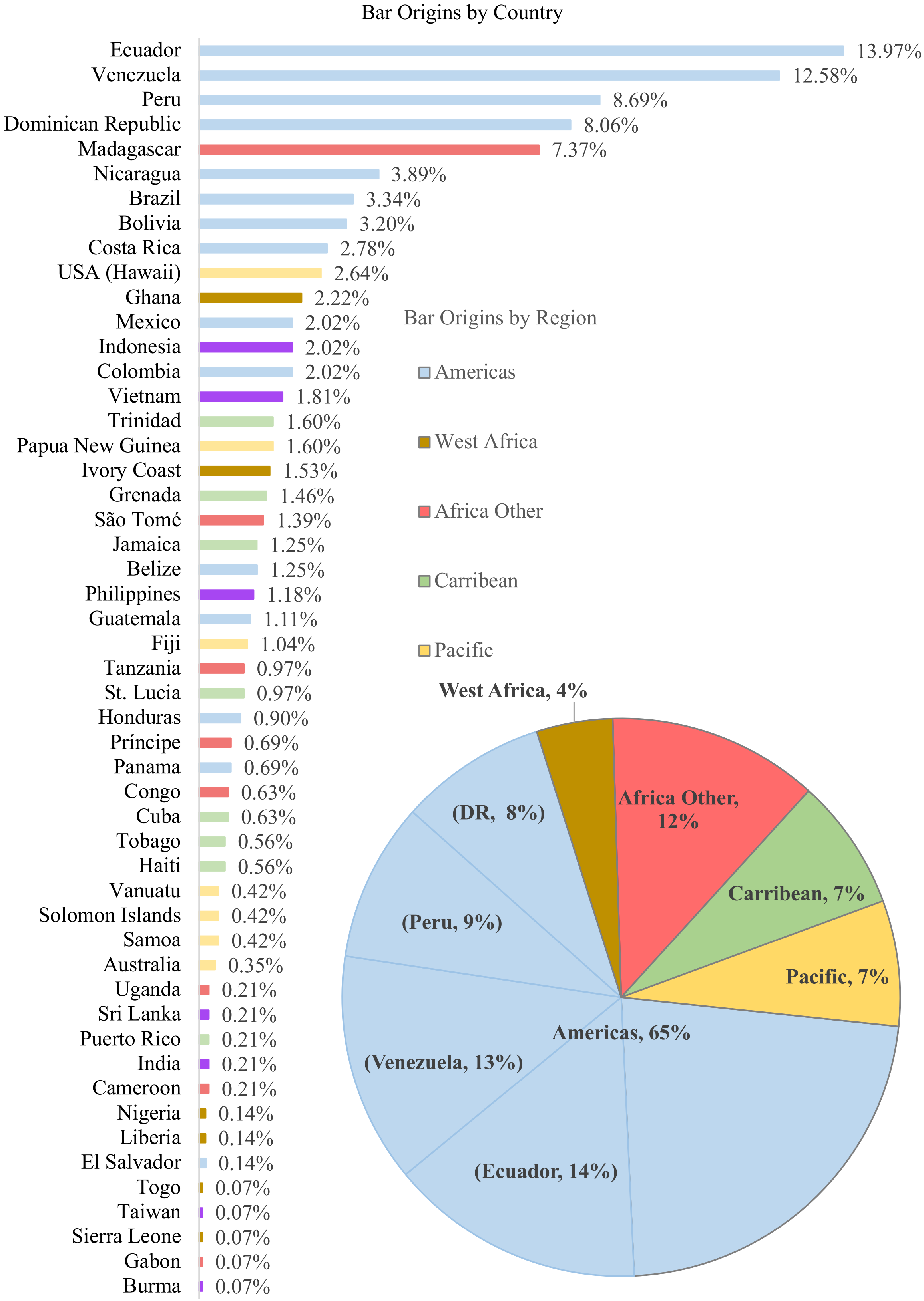

Figure 5. Craft Chocolate bar origins distributed by country and region. The majority of craft chocolate bars had South/Central America Origins, with the highest percentage from Ecuador, Venezuela, Peru and the Dominican Republic. Countries in parenthesis are part of the sum.

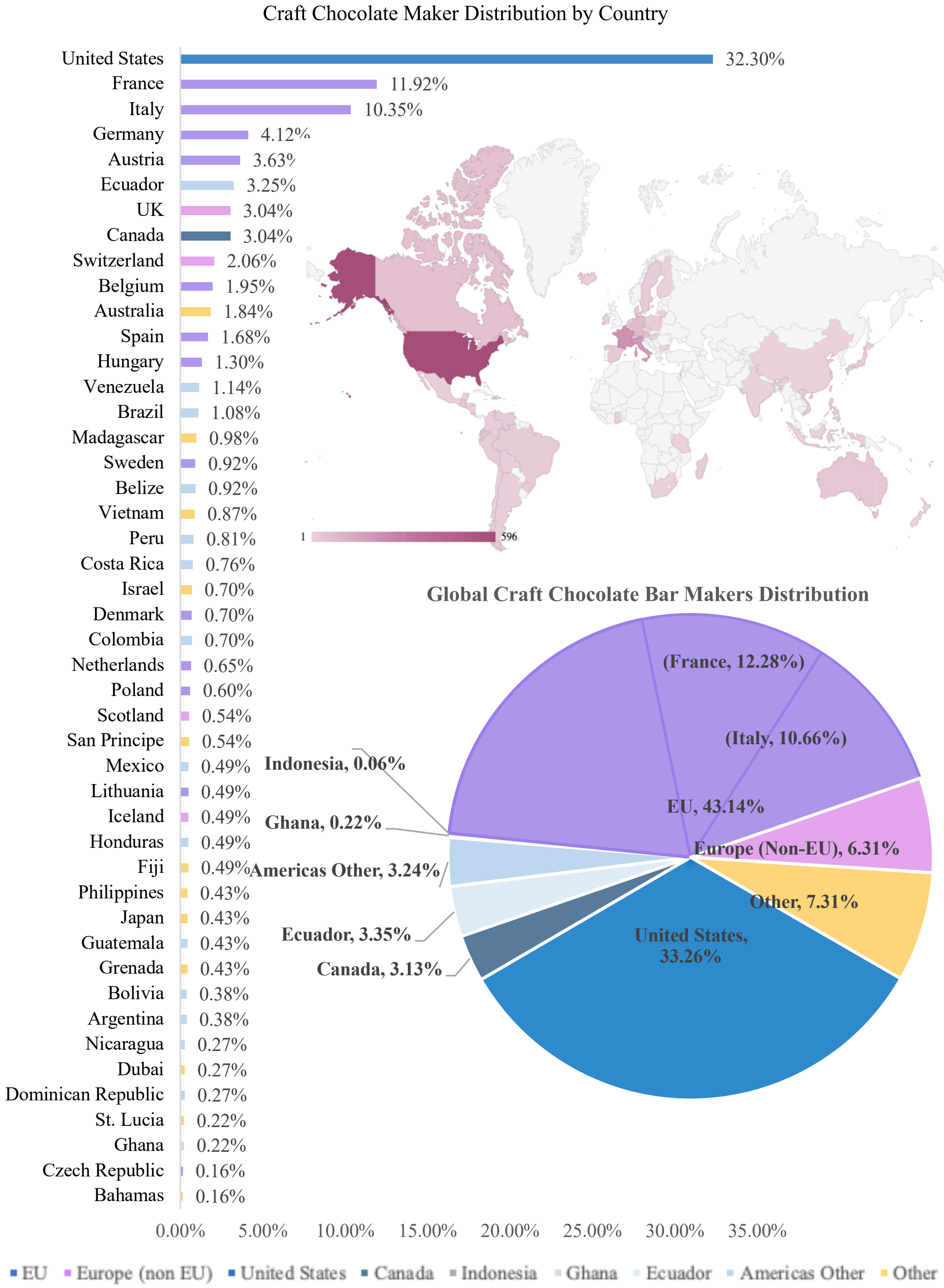

Figure 6. Craft Chocolate bar makers distributed by country and region. The majority of craft chocolate bars makers were from the EU, with the highest percentage from France and Italy. The United States had the highest number of craft chocolate makers by single country. Only countries with three or more bars are shown. Countries in parenthesis are part of the sum.

3.5 Discussion

Artisan and craft food production typically describes authentic product craftsmanship made in small batches for local markets, although large organizations may liberally also use the term "craft" in product marketing (Suphawanichleela 2017). Mainstreaming for craft chocolate occurred only recently as a result of a first and second wave of new craft chocolate producers in the late 1990s and late 2000s, respectively. The industry began to take off, particularly in the United States, in the mid to late 2000s with the pioneering efforts of Scharffen Berger in 1997, Askinosie in 2005, and Theo in 2006, among other global brands (Giller 2017). Published estimates designate around 480 specialty chocolate producers around the world (Martin 2017), although recent research suggests that the number of self-identified specialty and craft chocolate producers in 2019 is closer to 800 (Bar & Cocoa 2019; Bean&Bar 2019; Ecole Chocolat 2019; FCCI 2019).

Craft chocolate production makes up a very small share of the total chocolate market, estimated globally at around one percent (Homman 2016), comprised of many small-scale producers. Issues that specialty and craft chocolate producers face differ from those faced by industrial chocolate producers due to the small size of the community, high effort in specialization, in addition to unique supply and demand characteristics (ICCO 2019).

The need to better define and organize the industry has been apparent for many years and has manifested in organizational developments such as the Fine Chocolate Industry Association (FCIA), the Fine Cacao and Chocolate Institute (FCCI), and the Craft Chocolate Makers of America (CCMA). Although CCMA is no longer active, this early industry group defined craft chocolate producers as those crafting chocolate made from "scratch" by an independent, small company, using "between 1 MT and 200 MT of cocoa beans per year," and at least 75% owned by the company itself or the company employees (CCMA 2013). Similarly, craft chocolate producers may also be described as those who start with cocoa beans to produce finished chocolate ("bean to bar" makers), and are not one of the "Big Five" multinationals (Allen 2010, McCabe 2015); are a bean to bar practice established "during the recent wave of innovation, since around 1997" (Leissle 2017); as well as producers that "make chocolate bars from the bean, including makers who have their bars produced in a third party factory, but not those who only use couverture or add vegetable oils to their chocolate" (Bean&Bar, 2019). Additionally, this process may yield "superior products made from premium chocolate and natural ingredients" (HCP 2019).

Fine and specialty cacao industry working groups have also identified the need to better harmonize quality parameters, including specific conditions that occur during the cultivation and post-harvest stages of cacao production. A proposed harmonized international standard for specialty cacao has been under development in tandem with physical quality standards for submissions for the ICA and CoEx programs (CoEx 2017; Bioversity International 2019a). Although global cacao industry standards institute widely accepted quality parameters (ISCQF 2019) such as moisture content, Fermentation Index (FI) or cut test results, and overall flavor defects (Romero-Cortes et al. 2013; Seguine and Sukha 2015), specialty cacao industry members often assess a fine and specialty cacao beans based on independent or internal quality requirements for individual users. A summary of global cacao industry standards is made available by CAOBISCO/ECA/FCC (2015). More information is available regarding the characteristics of finished chocolate flavor development, including reports by Engeseth and Ac Pangan (2018) as well as Santander Munoz et al. (2019).

Farmers are at a disadvantage when the industry norm involves poorly defined standards and quality assessment protocols that rely on inaccessible tools or individual buyer preference. Industry development in the form of established standards for quality, reputation, and competitiveness are necessary and forthcoming (Jano and Mainville 2007). Additional resources to understand the current need and status of standardized quality assessment tools in the specialty cacao industry are made available by Sukha (2016) and Seguine and Sukha (2015).

In this survey of craft chocolate makers, specialty cacao quality assessment was also highlighted as in need of industry development. One craft chocolate maker shed some light on the current state of quality assessment within the industry stating, "*I think there needs to be a better way of grading the taste profile of dried beans so farmers can be rewarded economically, in a systematic way, for practices that improve the taste*," -Mexico, and another participant said, "*We need to invest more in farmers to reach more consistency in quality and quantity,*" -Honduras. In terms of industry specific needs, one participant stated a need to, "*develop international standards for smaller volumes*," -Switzerland, and another explained, "*flavor production varies depending on the variety and fermentation method, it would be better to develop improved processing technologies and systematic flavor assessments*," -Japan.

Specialty cacao is often sourced using direct trade practices, at prices above world trade commodity cacao and fair trade farm gate prices. Craft chocolate makers also endorse increased industry transparency, accountability, and responsible pricing for the cacao industry as a whole. Many craft chocolate producers take pride in sourcing materials that contribute to better living conditions for farmers or addressing environmental impacts (Gallo et al. 2018). Industry members have been known to highlight farmer welfare and environmental resource conservation efforts through public transparency and cacao sourcing reports. Producers also often choose to source cacao products directly from the farm or local intermediaries, benefiting from increased product consistency and quality control. Directly working with the farmers and processors and practicing more transparent trade presents an alternative strategy to the industrial or commodity cacao and fair trade markets (McCabe 2015). This research highlighted the fact that craft chocolate producers prioritize their relationship with farmers and consider the farmer-producer relationship central to their authenticity as craft chocolate makers. One participant stressed the importance of "*develop[ing]a real change in the value chain of the farmers [in] developing countries,"* -Mexico. Several participants described their main concerns to include the "*social impact*" of chocolate-making, "*direct trade, shared values, traceability,*" and that "*farmers…be rewarded economically*." One participant stated explicitly, "*The farmer is the most important part of the chocolate chain and it is essential to improve their living conditions*" -South America.

Cacao grown in diverse agroforestry systems can support high levels of biodiversity, store above-ground biomass, and better support landscape carbon stocks (Middendorp et al. 2018). Craft chocolate makers with distinct sustainability interests often seek specialty cacao grown in diverse agroforestry systems in order to meet current social and environmental needs. Premium pricing strategies and direct trade is used to encourage sustainable production practices and demonstrate the appeal of environmental and other non-market benefits from agroforestry systems, in conjunction with clear quality standards (Blare and Useche 2013). One survey participant explained, "*Even if I liked the dry bean quality I wouldn't buy the beans if the farmer wasn't using good labor practices and sustainable farming methods,"* -USA. Another participant described the potential regional challenges to prioritizing sustainable production systems, suggesting that "*there [are] two different view perspective[s.] I am a local Ecuadorian Chocolate maker [and it] is easy [to] check…all the techniques my farms [use]* *for sustainable agriculture, I think [this can be an issue] for the foreigners,"* -Ecuador. Farmer participation in specialty cacao markets, including price premiums or economic incentives of agroforestry systems, environmental and other non-market benefits has been demonstrated in multiple surveys, including Bentley et al. (2004), Jano and Mainville (2007), and Blare and Useche (2013), examining Ecuadoran farmers transitioning between the production of shaded agroforest fine (specialty) cacao and full-sun, high yielding cacao systems.

In contrast, commodity cacao production systems often rely on the expansion of full-sun, monocropped cacao frontiers, frequently occurring at the expense of local forestlands and biodiversity. Lasting damage due to unsustainable development is detrimental to future agricultural production opportunities or advancements of the predominantly smallholder farmers. Many commodity cacao farmers live below the poverty line (Fountain and Huetz-Adams 2018; Tothmihaly and Ingram 2018), and receive a shrinking share of revenue, from sixteen percent of the marketed product in 1980, to six to seven percent in 2013 (George 2016), with some estimates as low as three and five percent (Fairtrade Foundation 2016). Farmers may also face extreme price volatility, increased susceptibility to drought conditions, and potential soil nutrient or organic matter losses (Rice and Greenberg 2000; Ruf et al. 2014).

Although larger commodity cacao brands have made promises to better support cacao producers in West Africa (Squicciarini and Swinnen 2016), problems with the ethical supply chain for cocoa products is well recognized throughout the industry, as farmers in cacao producing countries are often living below the poverty line (Fountain and Huetz-Adams 2018). One survey participant suggested, "*Buyers in [bulk cocoa] are not willing to pay high prices for high quality cocoa...if a cacao farm is spending a lot of money for great post-harvest processes and cannot find is market to sell well their cacao, [they] will not continue, because* *[it] will be unsustainable and will turn into low quality cacao and processes in order to be more competitive. Then, industrial chocolate has changed the authentic cacao flavors by compromising and controlling the delicate aromas cacao have, based on origin, crops, genetics, etc*." -South America. Although the fair trade certification model is built to better support farmers in terms of income and access to resources (Fairtrade Certified 2017; Fairtrade International 2019), a majority of fair trade certified cacao farmers in the Ivory Coast still survive from earnings below the extreme poverty line (True Price 2018).

Flavor diversity seeking approach to conservation was also found to be common throughout the specialty cacao community, supported by a recently surveyed chocolate maker stating, "*We should all strive for more genetic diversity from natural selection*,"- The Caribbean. Another chocolate maker stated, "*We feel terroir has a big impact on our cacao. It's difficult to keep the taste exactly the same, despite the fact that our method and recipe is consistent. We use whole bean, no separating, so the beans really affect our flavor. Fortunately, our customers have come to expect that*," -Guatemala. With another stating, "*I think cacao postharvest processing could be far more refined…[and] the introduction of specifically cultivated yeasts in cacao fermentation could also be highly beneficial,"* -India. Origin-based identification is a tool often used by craft chocolate makers to differentiate products and help consumers understand diverse flavor characteristics, a defining attribute of the craft chocolate industry. The combination of genotype, local environmental conditions, producer relationships, production systems, and marketing support the development of unique flavor niches within the market.

Craft chocolate producers prioritize fine flavor notes, product diversity, and utilize business models that allow sourcing materials that contribute to better living conditions for farmers or addressing environmental impacts. Craft chocolate and specialty cacao distributors directly address challenges of social responsibility such as the lower share of revenue earned by farmers of the total marketed product, including estimates as low as three and five percent (Fairtrade Foundation 2016). A 2015 transparency report published by Uncommon Cacao stated that 72% of Maya Mountain Cacao (MMC) revenue per MT goes directly to farmers (Uncommon 2015).

Members of the bean to bar chocolate industry are also aware of techniques being applied in related industries. Innovative and outwardly focused, some craft chocolate makers are already looking to adopt techniques from specialty coffee or viticulture in their own production or supply chain. One respondent suggests that cacao supply networks might benefit from modeling and taking *"inspiration from specialty coffee,"* -EU. Another respondent looked towards techniques applied in the wine industry, suggesting that the cacao industry can "*learn a lot from viticulture and the scientific and technological advances there,"* -India.

The growing bean to bar movement describes a finished chocolate product (consumer ready) that is manufactured with fine flavor in mind, typically with direct traceability to the origin of the materials used in production (Giller 2017; Masonis et al. 2017). Bean to bar chocolate highlights this concept that all steps of chocolate production can be accounted for, and that these systems are typically multi-national, collaborative, and unique (Leissle 2013). Bean to bar chocolate production has been a popular way for craft chocolate producers to market products as distinct from industrial chocolate products (Nesto 2010). However, bean to bar and craft chocolate production are not mutually exclusive. Some "non-craft" organizations have taken an interest in participating in bean to bar, most notably Hershey's acquisition of Scharffen

Berger (Daniels et al. 2012) and Meiji's 'THE' chocolate line (Meiji 2019). This research has shown that bean to bar producers wish to distinguish themselves as such, and that they consider it important to convey their "craft" identity to their consumers.

Global chocolate production is dominant in Europe and North America, although a growing domestic market in South and Central American origin countries has continued to develop in recent years (Squicciarini and Swinnen 2016). Western Europe (Belgium, France, Germany, Italy, Switzerland, and the United Kingdom), the United States, and Japan are the main consumer markets for specialty and craft chocolate products (ICCO 2019). Industrial chocolate makes up a significant portion of the total chocolate market today, and for many years, a small number of manufacturers have dominated the industry. The biggest chocolate manufacturers, Mars, Mondelez, and Hershey's, account for over 77% of the chocolate market share in the US, while Nestle, Ferrero, and Lindt dominate similarly in Europe (Hersheys 2018; Fountain, Huetz-Adams 2018). Ferrero, Mars, Cadbury, Hershey's, and Nestlé, described as the "Big Five" (Allen 2010), have notably commanded global market share since the late 1980s.

To maintain relevance, chocolate manufacturers must keep up with the changing climate surrounding consumer sensitivity to chocolate quality as well as social and environmental processes of production (Barrientos 2011; Ota et al. 2019). The craft chocolate industry is uniquely positioned to demonstrate the viability of integrating sustainability and social responsibility goals into the chocolate world. Addressing these social and environmental challenges requires innovative business models, built through strong collaboration between entrepreneurs, farmers, and other stakeholders, as one respondent characterized it, "*Chocolate is a personal relationship that covers all considerations of quality sourcing and production and flavor,*" -Central America. In terms of industry improvements, one participant stated, there is a need to *“connect the mass market with high end craft chocolate [and] change perceptions of how much chocolate should cost,”* -USA, and another participant stated, there is a need to *“generate a database of chocolate makers and cocoa producers to encourage their meeting,”* -Italy. A participant from a producing country suggested, “*creat[ing] chocolate or liquor in the countries [where] cacao grows,”* -Mexico.

The strong focus on craftsmanship, social responsibility, and transparency by craft chocolate makers has highlighted the negative social and environmental impacts of chocolate production and propelled the industry to more urgently address these challenges. For example, craft chocolate makers or specialty cacao distributors often offer price premiums to farmers for specialty cacao for use in craft chocolate production, increasing the share of revenue for farmers (Daniels et al. 2012; ICCO 2019). Producers also address the demand for products that use perceived higher quality and traditional ingredients, as well as align with the values of consumers, to include ensuring that crops, sourcing, and methodology are more sustainable (Jewett 2017). Large industrial chocolate producers now face increasing pressure to issue various corporate sustainability efforts. For example, commitments from Hershey, Mars, Ferrero and Cloetta, and Nestle USA include sourcing 100% of their cacao from certified sustainable suppliers by the year 2020 (Krauss 2017) as a result of changing consumer demands.

However, without clear definitions and organization, industrial manufacturers have easily adopted terms and marketing techniques developed by craft chocolate makers, diluting the authenticity of the business model. For example, distinct identification of origin has been a major identifier for craft chocolate products and is considered an important factor for authenticity (Arias and Cruz 2018). This identifier is easily adopted by the larger and more resource rich industrial chocolate producers. A lack of organizational infrastructure means that quality and ethical standards are not protected, and craft-chocolate specific terms can be liberally applied to chocolate products that do not share these principles of sustainability and social responsibility. There is an urgent need to identify the current hurdles and set clearer standards to ensure craft chocolate makers maintain a seat at the table and continue to pave the way to a more exemplary and accountable supply chain.

3.6 Conclusion

Craft chocolate makers agree that clearer standards and better industry organization is necessary to ensure that craft chocolate makers can continue developing a more exemplary and accountable supply chain. The higher expectations for cacao quality are also apparent and requires diligence throughout the entire production chain.

The majority of specialty cacao produced for craft chocolate is sourced from South and Central America, and the United States holds the most craft chocolate makers per country. A significant portion of craft chocolate makers are based in the EU. The growing needs of consumers seeking more sustainable and socially responsible products have played an ancillary supporting role in supporting this industry. However, poor standardization, paired with the use of branding built through craft-chocolate quality and ethical principles liberally applied to non-craft chocolate products can weaken the identity of craft chocolate and the platform on which it stands. This survey has identified for the first time the most important factors for chocolate makers when purchasing specialty cacao beans, including quality, ethical sourcing (focus on labor at origin), origin, and cultivation method (focus on the environment).

Although the majority of commodity cacao is sourced from West Africa, the craft chocolate industry overwhelmingly sources from South and Central America. These regions differ in local challenges, culture, geography, global perceptions of the craft chocolate market and more. This research has quantified the current priorities and hurdles that craft chocolate makers face, adding to the body of knowledge, to further unite this industry. Understanding the limitations of the current systems and identifying regional differences is the first step in supporting the long term goal of a more sustainable and ethical chocolate supply chain.

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Chapter 4. Craft Chocolate and Cacao in Japan

4.1 Craft Chocolate in Japan

The Rise of Craft Chocolate in Japan: diverse origins, local flavors, and high focus on quality.

4.1.1 Abstract

Japan is the largest consumer market for chocolate confectionery in Asia, which includes the growing craft chocolate industry. Craft chocolate is well recognized for a focus on high flavor attributes, quality, and origin specificity. Consumers of craft chocolate expect fine flavor notes, product diversity, and direct sourcing strategies that contribute to better living conditions for farmers or addressing environmental impacts. However, there is limited literature on craft chocolate in Japan and the craft chocolate industry as a whole. The recent popularity of craft chocolate in Japan implores an investigation of this emerging market. Through an analysis of industry literature and Japanese craft chocolate makers data, this research presents an updated investigation of the Japanese craft chocolate industry how organizational ambidexterity is achieved. Early craft chocolate businesses were established around 2014, and there are currently about 100 self-identified craft chocolate makers in Japan today. Japanese craft chocolate consumers are interested in craftmanship, novel flavor profiles, unique experiences and packaging, and quality, food safety, and health attributes when purchasing craft chocolate. The most common origins for Japanese craft chocolate include Vietnam, Peru, Madagascar, Ghana, and the Dominican Republic. The average size of a craft chocolate bar in Japan is 42.93g and the average cost is 1214 JPY, almost 10 times higher than conventional chocolate bars. Additionally, the online presence and online purchasing options for Japanese craft chocolate brands are limited mostly to Japanese-literate customers through specialty shops, and some brands use exclusively social media for online presence.

Keywords: craft chocolate, Japan, bean to bar, chocolate, artisanal, Japanese chocolate

4.1.2 Introduction

Craft chocolate, also known as fine, specialty, flavor, or premium chocolate, is a global and rapidly growing industry. Well recognized for a focus on high flavor attributes, quality, and origin specificity, craft chocolate is defined as the small scale production of superior chocolate products using fine flavor or specialty cacao beans (CCMA 2013). Consumers of craft chocolate expect fine flavor notes, product diversity, and direct sourcing strategies that contribute to better living conditions for farmers or addressing environmental impacts (Jewett 2017). The market price for craft chocolate products is often determined by the origin, product quality, certification status, and demand, filling a premium quality niche (Gallo et al. 2018). Other tenets of the craft chocolate industry include facilitating increased transparency, accountability, and responsible pricing for the cacao industry as a whole.

Cacao (*Theobroma cacao* L.) trees are predominantly grown in equatorial regions around the world. Cacao beans are the raw material used for the production of chocolate, which is consumed worldwide. Specialty cacao is a type of premium cacao, with high flavor attributes, aesthetic and physical qualities, genetics, or origin specificity. The market for specialty cacao, used for the production of craft chocolate, has also seen exponential growth, two times that of commodity cacao over the past 20 years, according to some industry experts (Homman, 2016; Santander Munoz, et al., 2019). We can expect the craft chocolate industry to reach increasingly broader global markets, and Japan is among one of the main consumer markets for specialty cacao and chocolate (ICCO 2020).

For the context of this study, the terms “craft chocolate” and “bean to bar” are used interchangeably, to accommodate for the usage of these terms in Japan. The term “craft chocolate” is associated with the recent wave of innovation, since around 1997 (Leissle 2017), describing superior or premium chocolate made from high-quality specialty cacao beans, and "bean to bar" chocolate describes a subset craft chocolate, typically emphasizing bean origin and "terroir". Single origin may refer to a single estate within the same origin, or even within an individual farm or cru, or an entire country of origin. These origins are suggested to attribute unique flavor characteristics to a combination of genotype and local environmental conditions (Nesto 2010). Bean to bar chocolate also maintains an implication that the chocolate makers are more involved in the production process. Bean to bar and craft chocolate production are not mutually exclusive. However, in Japan, the terms "craft chocolate" and "bean to bar chocolate" are used interchangeably, and less often "premium chocolate" is also used.

Bean to bar chocolate makers acknowledge that the production of finished chocolate comes at the end of a long production chain that begins at cacao origins, involving systems that are typically multi-national, collaborative, and unique (Leissle 2013). Craft chocolate producers market their products as distinct from industrial chocolate products (Nesto 2010). Some traditionally industrial chocolate organizations have taken an interest in bean to bar production, most notably Hershey's acquisition of Scharffen Berger (Daniels et al. 2012) and Meiji's 'THE' chocolate line (Meiji 2019).

The Japanese chocolate industry in conjunction with other global markets have been steadily growing over the last few years, most recently to include specialty markets such as craft chocolate and premium bean to bar chocolate production (Squicciarini and Swinnen, 2016; Donovan, 2006; Daniels, et al. 2012). Western Europe (Belgium, France, Germany, Italy, Switzerland, and the United Kingdom), the United States, and Japan are the main consumer markets for specialty and craft chocolate products, and industrial or multinational chocolate makes up a significant portion of the total chocolate market today (ICCO 2019). The biggest chocolate manufacturers, Mars, Mondelez, and Hershey's, account for over 77% of the chocolate market share in the US, while Nestle, Ferrero, and Lindt dominate similarly in Europe (Hershey's 2018; Fountain, Huetz-Adams 2018), all among the "Big Five" (Allen 2010), notably commanding global market share since the late 1980s. Among the top ten leading cocoa confectionery brand manufacturers, based on net confectionery sales in 2019 (millions USD), are the Japanese owned Meiji Holdings Co., Ltd., and Ezaki Glico Co., Ltd. (ICCO 2020) (figure 1).

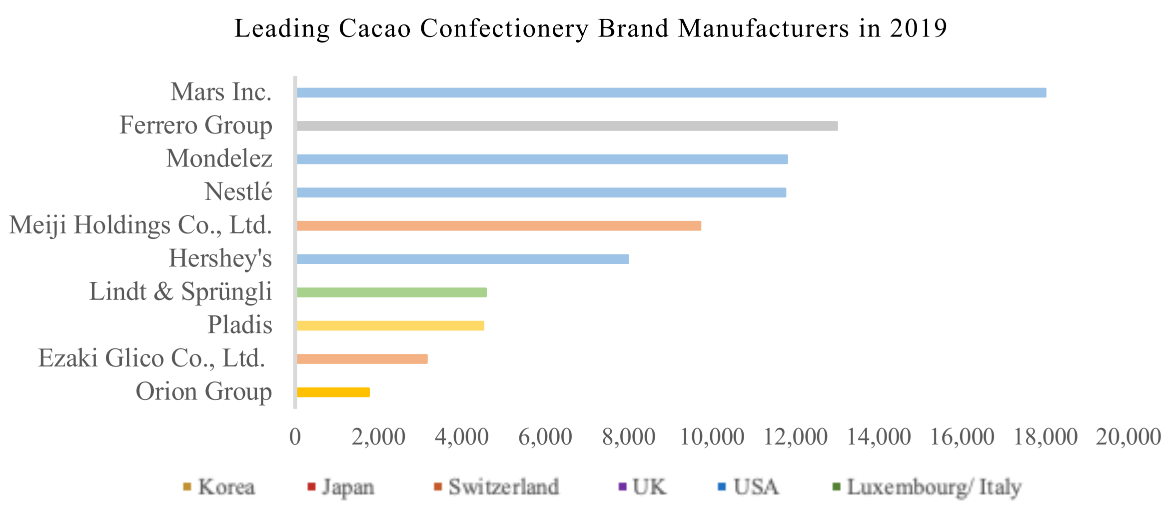

Figure 1. The top ten leading cacao confectionery brand manufacturers producing chocolate products in 2019, based on net confectionery sales (millions USD) (ICCO 2020).

Craft and premium chocolate was introduced to Japan as a luxury item, purchased as a gift and for special occasions such as Valentine's Day and "White Day", a gendered gifting custom one month following Valentine's Day (Ichikawa 2017; Komatsuzaki n.d.; Sakuma 2020; WCF 2011; Yoshimura 2020). Products demonstrating artisanship through high quality craftmanship and complex flavor, such as craft chocolate, have recently attracted a lot of attention in Japan (Sunwood 2018; McCabe 2015). The bean to bar industry in Japan caters to particular flavor profile and quality requirements (McCabe, 2015), and consumers are attracted to new and unique experiences with chocolate (Sakuma 2020). The appeal of craft chocolate to Japanese consumers also includes unique packaging (Sakuma 2020; Adelstein 2018), as seen by Ushio Chocolatl incorporating guest artists to design their wrapping, for example.

Japanese craft chocolate consumers are also interested in supporting causes that align with their values. For example, Japanese consumers may be more likely to value alleviating poverty over maintaining ecosystems, with negative consumer purchase intention when these elements are combined (Ota, et al., 2019). In the wake of the 2011 the Great East Japan Earthquake, consumers concerned about food safety became more interested in traceability for processing, manufacturing, and distribution, to include bean to bar chocolate production (Sakuma 2020). Japanese chocolate consumers are also more interested in health attributes when making chocolate purchasing decisions (Nieburg and Young 2016).

A study by McCabe (2015) described the Japanese "fine chocolate" market in 2013, based on a research endeavor carried out by Godiva in 1989. The findings describe fine chocolate "connoting high social class, because it came from Europe and reflected world travel and sophistication. It was often brought as a gift from abroad as a symbol of Western refinement," with aroma being the most important criteria for judging quality (McCabe 2015). The 1989 research was said to be carried out to address rising competition in Japan, as Godiva was thought to be the only fine chocolate brand available for consumers in Japan.

Despite being a major consumer of chocolate products with significant import volumes for cacao beans, (Japan Chocolate and Cocoa Association 2020) there is limited literature on chocolate in Japan and the craft chocolate industry as a whole. The sudden popularity of craft chocolate in Japan beginning in 2014 implores an updated investigation of the Japanese craft chocolate industry.

Through distinct quality standards and marketing, premium pricing, and origin-specificity, this industry recognizes the global value chain of chocolate which has been overlooked in industrial chocolate systems. Additionally, the demographics of Japanese craft chocolate businesses and the unique distribution channels to a specialized consumer base has highlighted the role of organizational ambidexterity of this industry from an emerging market context.

4.1.3 Materials and Methods

A literature review was used to identify synthesize relevant metrics and research on the Japanese craft chocolate industry using four databases: Web of Science, Scopus, Science Direct, and Agricola. A Scopus search using the terms ("craft chocolate" OR "fine chocolate" OR "bean to bar" AND “Japan*”) in addition to (「ビーン・トゥ・バー」OR 「クラフトチョコレート」OR 「プレミアム チョコレート」AND 「日本」) in the Title Abstract, and Keywords search fields yielded no results. A Web of Science search using the same terms in the Topic Search field yielded only two relevant results. A Science Direct search using the terms ("craft chocolate" OR "fine chocolate" OR "bean to bar" AND “Japan”) in addition to (「ビーン・トゥ・バー」OR 「クラフトチョコレート」OR 「プレミアム チョコレート」AND 「日本」) in the Terms search yielded two relevant results. An Agricola search included only two relevant results.

In addition, a review of the literature and preliminary analysis of secondary data selected by searching Google and the Google Scholar database was performed in October 2020 to complement references cited in the primary literature and unpublished studies. Due to the limited availability of academic research on the topic of the Japanese craft chocolate industry, industry publications were also incorporated into this review.

Article text was investigated for definitions of specialty cacao and craft chocolate. For inclusion into this review, only studies that met the following criteria were selected:

(1) chocolate/cacao industry focused publication or academic thesis, report, or scientific publication;

(2) examined craft chocolate as a distinct product from industrial chocolate; and

(3) written in English or Japanese.

Craft chocolate makers were identified through craft chocolate maker databases supplied by Bar & Cocoa, bean.bar, Bean-To.Bar Chocolate Finder, Chocolate CODEX. Ecole Chocolat, the C-Spot, the Fine Cacao and Chocolate Institute (FCCI), and Tachibana Group (Bar & Cocoa 2020; bean.bar 2020; Bean-To.Bar Chocolate Finder 2020; Chocolate CODEX 2020; Ecole Chocolat 2020; C-Spot 2020; FCCI, 2020; Tachibana 2020). Additionally, a web search for bean to bar chocolate makers in Japan in Japanese revealed craft chocolate makers not yet identified by these databases, resulting in a list of 96 total active, self-identified craft chocolate makers with a searchable online presence.

The information gathered on craft chocolate bar origins, price, and weight included only tablet type bars（タブレット）labeled to include at minimum 70% cocoa content and a specific country of origin, yielding a total of 1,883 data points.

4.1.4 Results

Craft Chocolate in Japan

Craft chocolate in Japan began to grow in popularity around 2014, with the inception of several of the major bean to bar makers in Japan, including Minimal Bean to Bar, Green Bean to Bar, and Vanilla Beans in 2014. Notable growth in consumer awareness and craft chocolate businesses was marked by the opening of the Dandelion Chocolate Japan Factory and Café flagship location in Kuramae in early 2016, among other local brands (figure 2). Dandelion Japan quickly then opened a retail shop and cafe in Ise in December 2016, Kamakura in February 2017, Kyoto in June 2018, and Omotesando in February 2019 (Solomon 2019), hosting the first Craft Chocolate Market in 2016, which attracted over 2,000 chocolate enthusiasts, also revealing growing consumer interest in craft chocolate in Japan.

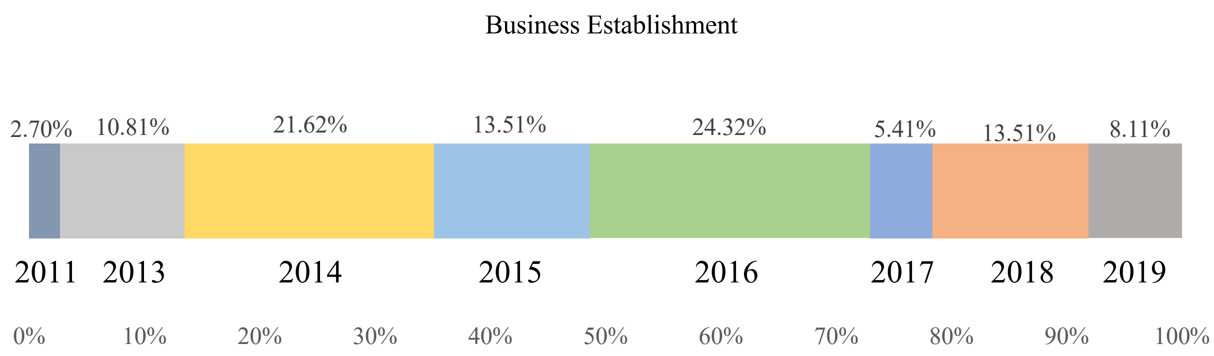

Figure 2. Year of business establishment for Japanese craft chocolate makers.

Google trend results for the terms 'bean to bar' (ビーントゥバー), 'craft chocolate' (クラフトチョコレート), 'premium chocolate (プレミアム チョコレート), and 'bean to bar' (in English) showed increased keyword searches for these terms in Japan beginning in 2014. Searches also peaked every year between 2014 to 2020 in the month of February, indicating increased interest around Valentine's day gifting customs (figure 3). In the 1989 and 2013 studies of premium chocolate in Japan, the most frequent occasion for giving fine chocolate in Japan was Valentine's Day (McCabe 2015), which is consistent with these findings.

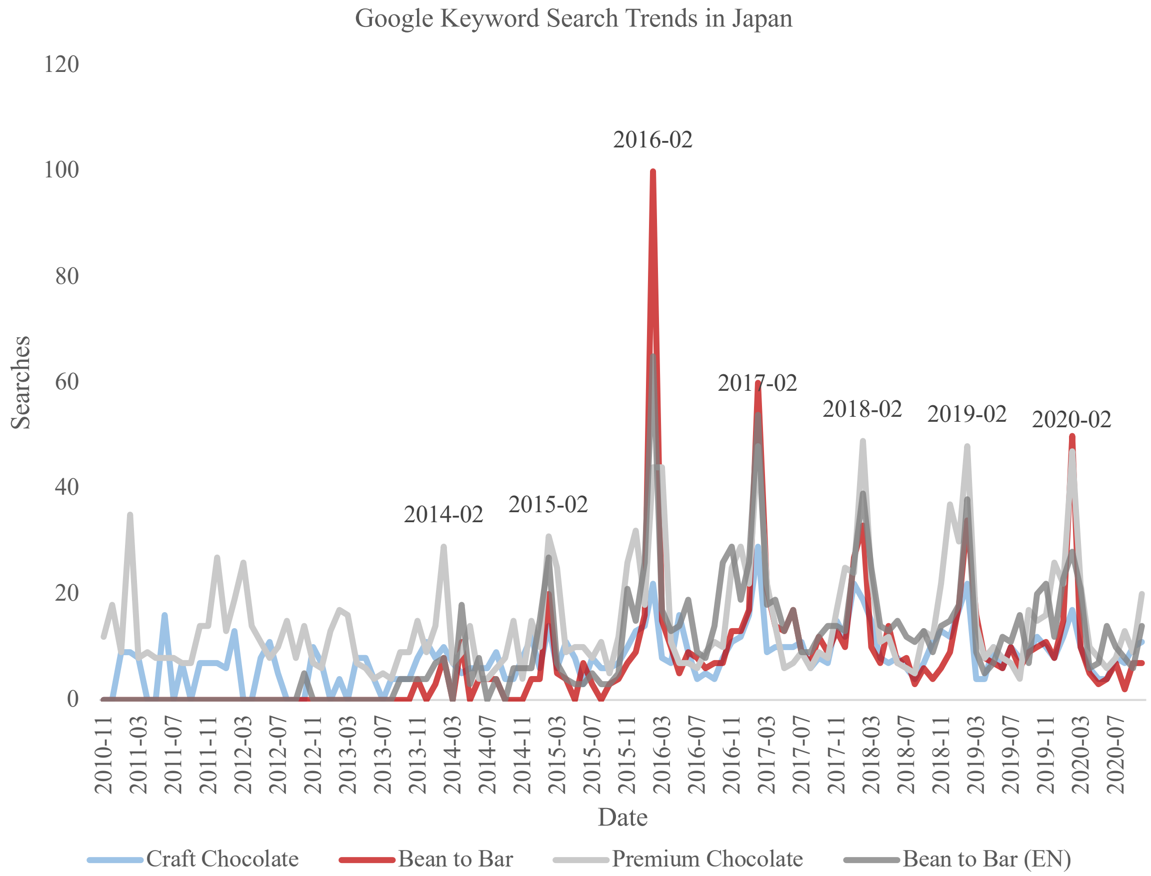

Figure 3. Google trend results for the terms 'bean to bar'(ビーントゥバー), 'craft chocolate' (クラフトチョコレート), 'premium chocolate (プレミアム チョコレート) and "bean to bar" (in English), peaked every year between 2014 to 2020 in the month of February.

Interviews with craft chocolate industry members as well as numerous blogs and industry reports have also suggested that the growth in popularity of bean to bar chocolate generated more recognition in Japan around 2014 (Komatsuzaki n.d.; Hirata 2018; Love Choco 2017). In a recent interview with Kanako Satsutani, the chocolate sommelier and Tomoe Savour Co., Ltd. representative described introducing bean to bar brands on a domestic mail-order site in 2013 before selling a limited offering at the Hankyu Department Store in Osaka in 2014. Satsutani said, as magazines subsequently began to feature various craft chocolate bars, the concept of "bean to bar" chocolate became more widely known (Sakuma 2020). Discussions about bean to bar chocolate also began appearing in the Japanese Salon du Chocolat (サロン・デュ・ショコラ), an annual chocolate event that showcases leading industry developments, in 2014 (Salon du Chocolat 2020).

Japanese Craft Chocolate Businesses

Many craft chocolate makers operate businesses where craft chocolate is the primary focus (78.72%), with some also dealing in coffee (9.57%) confectionery (5.32%), cafés (3.19%), or other products (3.19%) (figure 4) (n=86). Only 69.32% of businesses offered a platform for purchasing products online. Some businesses (11.76%) did not have a dedicated business website, rather opting to use social media platforms such as Facebook, Instagram, or Tabelog to reach their customers online (n=96). Additionally, only 15.63% of websites included content in English or with an online translator option (n=87).

This research identified 96 self-identified craft chocolate makers operating in Japan. However, some industry experts have recently suggested that there are currently over 100 bean to bar brands in Japan (Sakuma 2020), which indicates that some businesses may not have an easily searchable online presence.

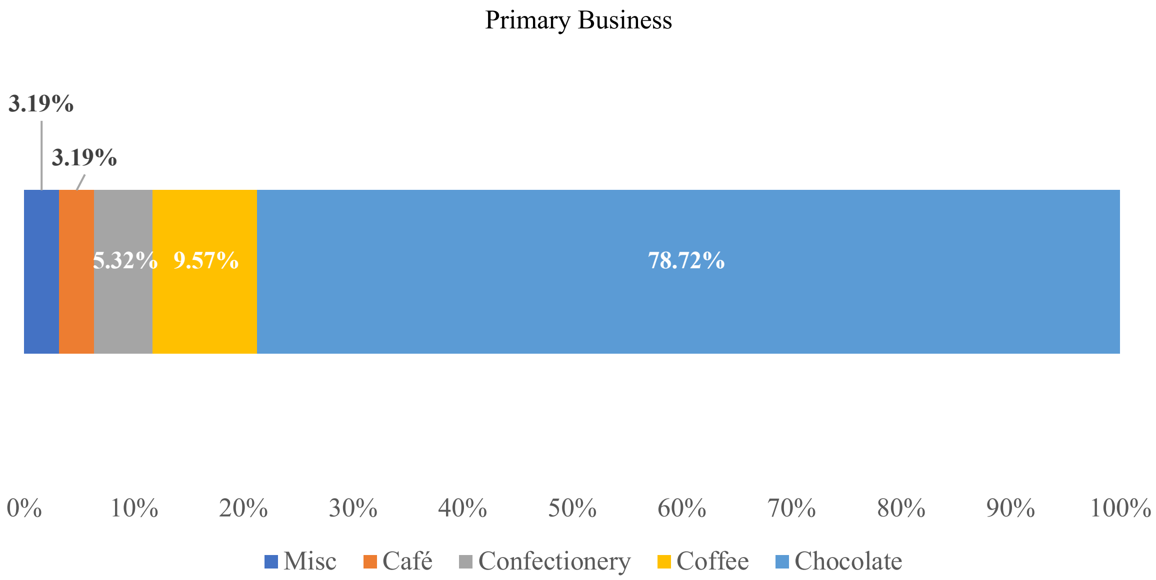

Figure 4. Primary business for craft chocolate makers.

Japanese Craft Chocolate Origins

Based on an analysis of all the Japanese craft chocolate bars identified in this research, popular origins for Japanese craft chocolate brands include Vietnam (10.30%), Peru (9.30%), Madagascar (8.97%), Ghana (6.98%), and the Dominican Republic (5.98%) (figure 5) (n=302).

In a 2018 interview, the founder of Minimal Bean to Bar Chocolate, Takastugu Yamashita said, "*prior to the introduction of bean to bar makers (like us), many cocoa bean producers only traded with major trading companies and manufacturers…I think they were using cacao beans with a uniform profile…However, with increased numbers of individual importers such as ourselves, the distribution of unique cacao beans has also increased*" (Kashigami 2019).

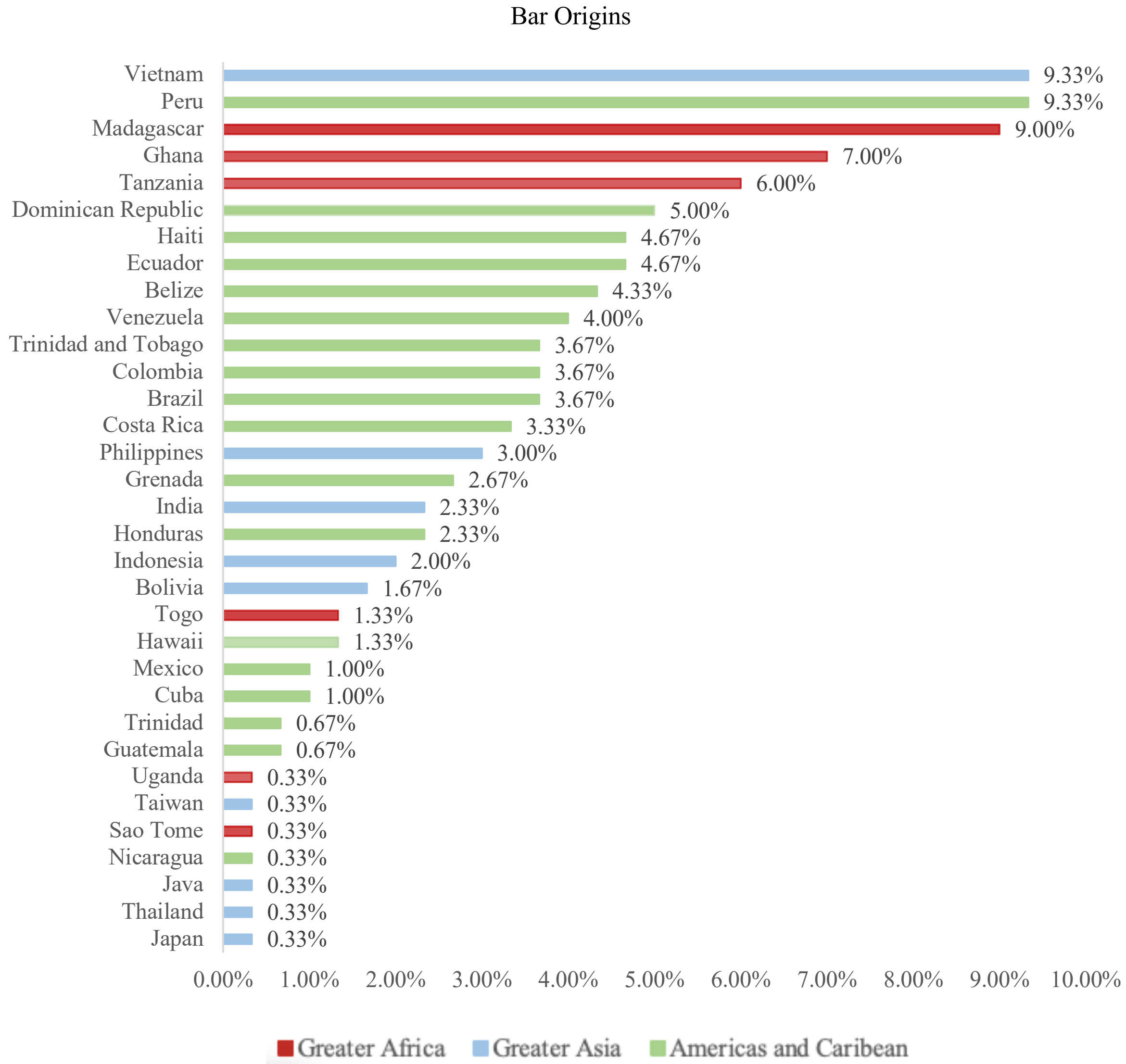

Figure 5. Origins for craft chocolate in Japan by number of origin bars. Popular origins include Vietnam (10.20%), Peru (9.21%), Madagascar (8.88%), Ghana (6.91%), and the Dominican Republic (5.98%). The analysis is based on an analysis of all Japanese craft chocolate bars identified in this research (n=302).

Prices for Japanese Craft Chocolate

The price per bar of finished craft chocolate bar was variable. Based on origin, the highest calculated averages (JPY per g) were Brazil (38 JPY), Bolivia (36 JPY), Colombia (35 JPY), and Costa Rica (33 JPY). The lowest calculated average origins were Mexico (20 JPY), Grenada at (64.8 JPY), Haiti (60 JPY), and Belize and Tanzania (54 JPY) (figure 6). The average size of a craft chocolate bar in Japan is 42.93g and cost is 1214 JPY (figure 7).

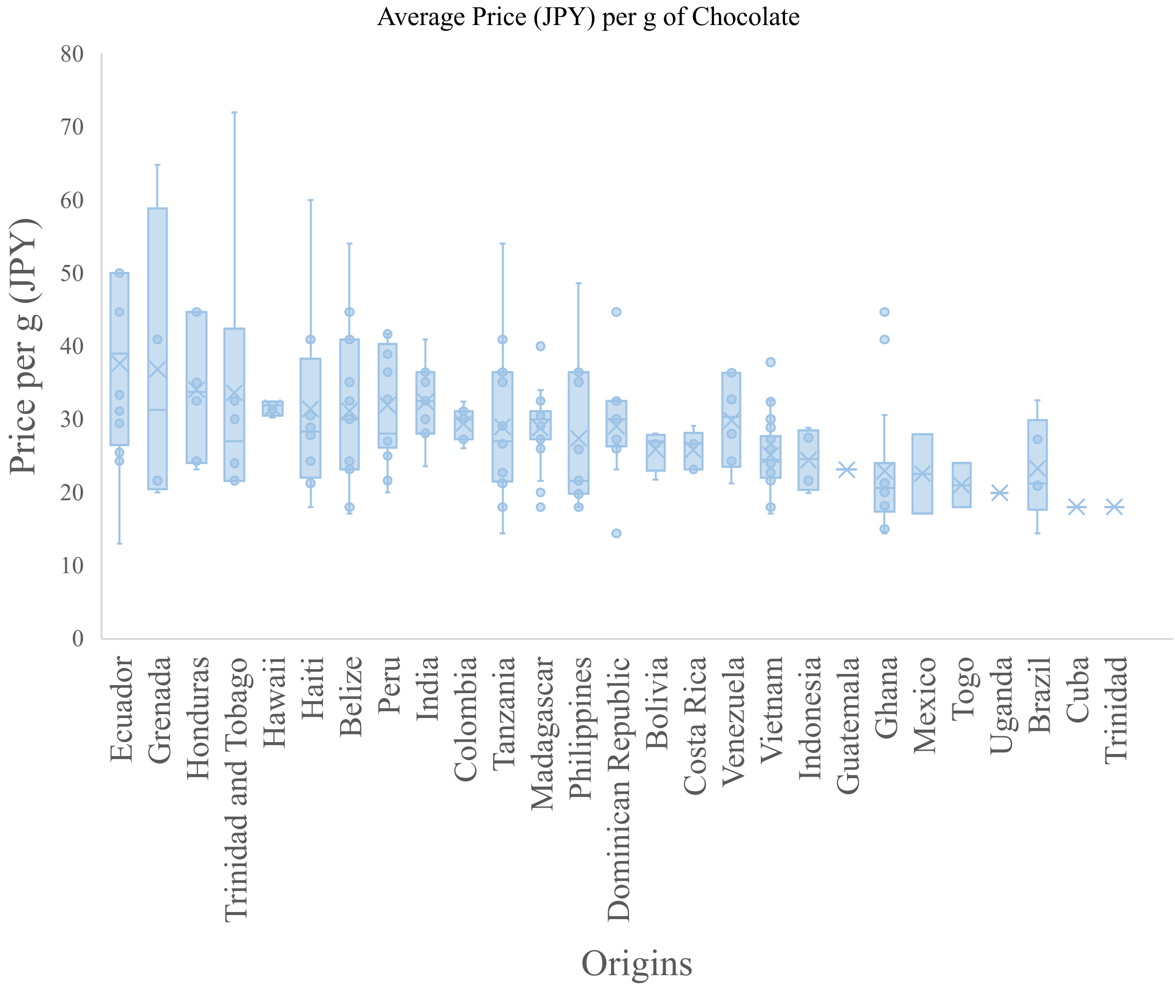

Figure 6. Price (JPY) per g of chocolate by origin in order from the highest average price to lowest.

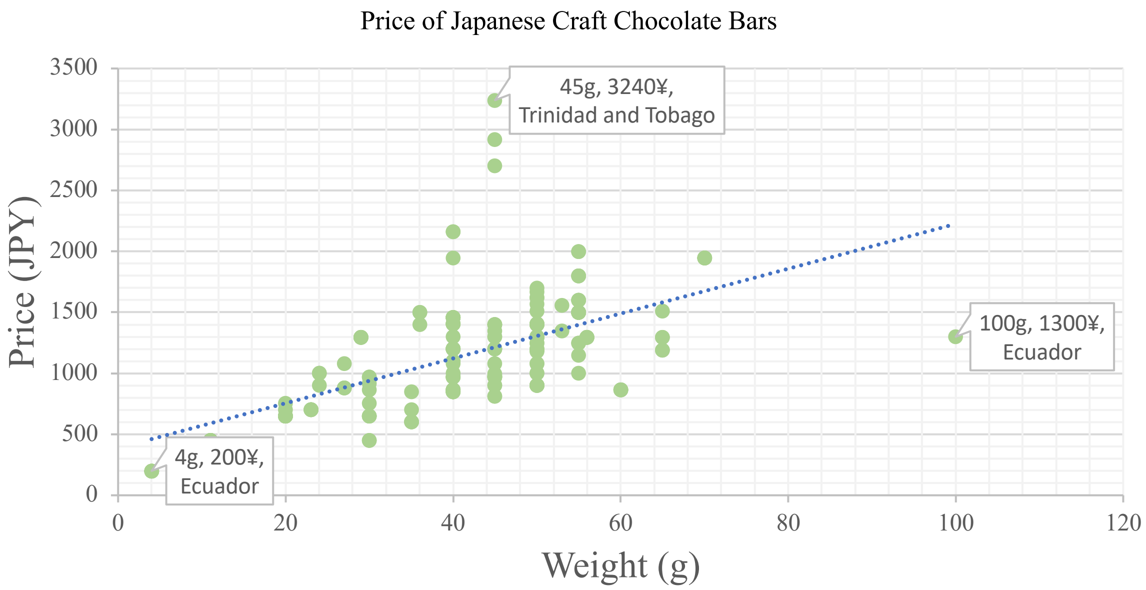

Figure 7. Price (JPY) of Japanese craft chocolate bars, distributed by weight.

Inclusion bars often incorporated diverse local flavors such as genmaicha and soba (Mizuura 2019) hojicha, matcha, sake, shimizumori (red pepper), sansho (peppercorn), white sesame, hemp seed, shiso, and yuzu, found among craft chocolate makers such as Cacaoken, Chocozeyo, Kongen Sweets, Love Lotus, Nanaya Matcha, Okinawa Cacao, Romance Chocolate, VANILLABEANS, and others.

4.1.5 Discussion

Some craft chocolate makers in Japan may source cacao beans to contribute to better living conditions for farmers or address environmental impacts and challenges of social responsibility such as the lower share of revenue earned by farmers of the total marketed product. For example, one of the most prominent specialty cacao buyers and distributors in Japan, Tachibana Shoten, states that their commodity cacao purchases are above the market price at $10,000 per MT (suggestively $200 above the market price) (Nieburg 2016).

Additionally, in 2013, Tachibana Shoten had been importing high-quality cacao beans from over 15 countries around the world, including Ghana and Vietnam (Ichikawa 2017). The proliferation of diverse cacao origins and varieties is a clear marker for growth in the market, and Tachibana Shoten now offers up to 20 origins and 30 varieties, including beans from Belize, Bolivia, Brazil, Costa Rica, Colombia, Ecuador, Ghana, Haiti, India, Indonesia, Madagascar, Mexico, Nicaragua, Papua New Guinea, the Philippines, Tanzania, Trinidad and Tobago, Togo, Uganda, Vietnam, and Venezuela (Nieburg 2016; Team Cacao 2020). Bean origin demarcation and strategic pricing for higher quality materials has facilitated a niche global value chain for the Japanese craft chocolate industry, which has been traditionally dominated by only a few confectionary producers.

Despite the Mesoamerican roots of what we currently describe as chocolate, Japanese consumers often associate chocolate with western countries producing chocolate (Mitsuda 2014). The bean to bar movement in part acknowledges the long production chain for cacao processing into finished chocolate, calling attention to the role of farmers in the production process, which has been poorly detailed throughout the industry. The deterritorialization of cacao origins with portrayals of the processed product as of European origin have certainly contributed to consumer perceptions that fine chocolate products originated in Europe (McCabe 2015). Origin-based identification, however, may contribute to monetary benefit or detriment for producers when selling products based on origin demand (Hughes 2010). Often wielded as a branding tool, disproportionate advantages or disadvantages are allotted to particular origins, for example, in the case of West African cacao unfairly deemed of lesser quality simply based on regionality regardless of actual quality (Leissle 2013; García-Cáceres et al. 2014; George 2016). Expanding more diverse origins to Japanese markets may provide an equity and education opportunity for the global chocolate industry.

The demographics of Japanese craft chocolate businesses are unique in that many small businesses make up the total market share, which is starkly different from the few industrial chocolate production companies commanding global market share since the late 1980s. Through specialized distribution channels that cater to a targeted consumer base, diverse business proprietorship, and distinct pricing strategies and quality requirements, this industry certainly employs organizational ambidexterity from an emerging market context.

Research limitations for this study include not accounting for white chocolate, which is a popular item in Japanese craft chocolate, for example, Parade All White (パレ ド オール ブラン), did not include blended origin bars, and searches were limited to businesses with an online presence. Additionally, although Google has been the most popular search engine in Japan for the researched time period, netizens of Japan are known to utilize Yahoo Japan and Bing as primary search engines as well. For example, in 2015, over 37% of users used Yahoo as a primary search engine, making it difficult to thoroughly capture the search trends during that time period (MIC 2018). Coincidentally, a keyword search for the term “craft chocolate” (クラフトチョコレート) coincided with “Meiji bean to bar” (明治ビーントゥバー), likely in response to the release of Meiji’s “THE” bean to bar line.

Japan is Asia’s largest consumer market for chocolate confectionery (ICCO 2020) and has a long history of global influence and growing popularity. The first domestically produced chocolate bars were sold in 1878 by Yonezu Fūgetsudō, based out of Ryōgoku, Tokyo. Up until the outbreak of the Second World War, chocolate was sold primarily to upper and middle class adults, valorized to have health benefits. In these early years, several western manufacturers also were established in Japan, including Fry’s (1897), Cadbury’s (1898), Menier (1898), Van Houten (1898), and Vi-Cocoa (1899). In 1926, Japanese confectionery company Meiji Seika began manufacturing chocolate, inviting experts from the United States and purchasing machinery from Europe. After the late 1950s, chocolate became much more accessible to consumers, as Japanese chocolate makers (including Morinaga, Meiji, Glico, and Fujiya) competed for market share, even offering prizes to children such as all-expenses-paid trips across the world (Mitsuda 2014). Today, Japanese craft chocolate makers are part of a growing global movement to change the future of chocolate to be more sustainable, ethical, and diverse.

4.1.6 Conclusion

The Japanese craft chocolate industry includes around 100 chocolate makers, spread throughout Japan. Chocolate makers include diverse cacao origins such as Vietnam, Peru, Madagascar, Ghana, and the Dominican Republic. Inclusion bars often incorporate diverse local flavors. The average size of a craft chocolate bar in Japan is 42.93g and the average cost is 1214 JPY, almost 10 times higher than conventional chocolate bars.

Japanese craft chocolate businesses were established most frequently around 2014-2016, most of which operate with craft chocolate as a primary focus. Although most brands have a dedicated website, some rely on social media platforms for online presence. Online purchasing options were not available for all Japanese craft chocolate businesses. Additionally, few websites included content in English or with an online translator option, limiting access to customers able to read and navigate online purchases in Japanese. Additionally, the online presence and online purchasing options for Japanese craft chocolate brands are limited mostly to Japanese-literate customers through specialty shops.

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4.2 Cacao in Japan

Tokyo Cacao: Japan’s first 'soil-to-bar' chocolate

Citation: Cadby, J. (2020, February 29). Tokyo Cacao: Japan’s first 'soil-to-bar' chocolate. The Japan Times. Copyright© 2020 by the Authors. Published by The Japan Times.

Figure 1. Tokyo Cacao chocolate with cacao pods, beans, and nibs.

4.2.1 Tokyo Cacao

Tokyo Cacao is pushing the boundaries of cacao production with the first ever chocolate bar of entirely Japanese origin. The chocolate lineup is produced from trees grown in the Ogasawara Islands, which fall under Tokyo’s jurisdiction despite being nearly 1,000 kilometers away from the metropolis.

Figure 2. The Tokyo Cacao team holds up cacao pods from its farm on Hahajima island.

From 2016-20, Japan's chocolate market grew at an annual rate of 4 to 5 percent, making the country Asia's largest chocolate consumer per capita. But the production of cacao beans, the most important ingredient for making chocolate, has historically been confined to warmer, tropical regions, particularly West Africa, Indonesia and South America.

After an eye-opening visit to a cacao farm in Ghana in 2003, growing the tree in Japan became a goal for Tokyo Cacao's president, Masayuki Hiratsuka. Following another research expedition to Vietnam in 2006 to further understand the production process, the chocolate company finally settled on the archipelago's Hahajima island.

Hahajima's location — outside of typical cacao-growing regions — necessitates additional measures to successfully grow the tree. "The process of producing cacao pods for beans requires a temperature and humidity control method unique to Japan," Shin Hiraoka, development officer at Tokyo Cacao, says. Cacao tree seeds were imported from Indonesia, and today Tokyo Cacao cultivates 502 trees.

Before becoming chocolate, cacao fruits, or pods, are harvested and broken open. Seeds are extracted from the pods for further processing, at which point the seeds are referred to as beans. According to Hiraoka, "the fruit pulp inside has a sweet and sour taste, with an aroma similar to lychee.

"Cultivation and harvesting is carried out by farm staff on Hahajima island … and fermentation carried out in a laboratory in Soka (Saitama Prefecture)," Hiraoka continues. "Depending on the harvest, we can collect anywhere between 10 to 100 kilograms of beans at a time."

Figure 3. Cacao pods.

Starting a cacao farm in Japan, however, was more difficult than anticipated. After five years of trial and error, which included the loss of 167 cacao tree seedlings to unknown causes; conditioning the local soil; and finalizing the construction of a sturdy grow house, it was finally possible to start making chocolate. However, perfecting the first Japanese-grown chocolate took several more years of development, the results of which only became available this past year.

The majority of chocolate produced for Japanese consumers can be traced back to the country of origin, but not necessarily the region or farm where the cacao beans are grown and processed. This system can make quality control more difficult and creates an inherent disconnect between farmer and consumer.

Bean-to-bar chocolate focuses on fixing this disconnect, and involves developing relationships with farmers and processors, and the bean-to-bar sourcing method often offers increased quality and traceability. Many craft chocolate makers fill the market niche for higher-quality products that emphasize high flavor notes and ethical sourcing, which aligns with how Japanese consumers approach chocolate.

“In Japan, I have heard chocolate being described as something special, a luxury item,” says Hiraoka. “I think the quality and lineup of chocolate in Japan has improved significantly, especially over the past 10 years, creating a demand for more and more specialized products.”

Bean-to-bar has recently taken Japan by storm, with new, innovative chocolate makers entering the market. Craft chocolate maker VANILLABEANS opened its first of four retail locations in 2014, followed by Green Bean to Bar Chocolate in 2015 and Dandelion Chocolate Japan in 2016.

While many bean-to-bar chocolate makers differentiate products based on cacao origins, Tokyo Cacao has entered the market with a chocolate of entirely new provenance, what it calls "soil-to-bar." Its flavor has "a refreshing acidity that hits the tongue and melts smoothly, with a fruity scent," Hiraoka says.

"We have prioritized romance over business sense," he continues. "Growing cacao in Japan was the dream."

4.2.2 Summary and Discussion

Cacao trees (*Theobroma cacao* L) are predominantly cultivated in equatorial regions around the world. Commercial production near or above the margin of 20° N was previously limited to the Hawaiian Islands in the United States. However, cacao is also produced in distinct locales outside of these traditional growing regions, including subtropical regions such as southern Taiwan, in Pingtung County, found around 22.5° N (Lin and Bestor 2020) and Nantou County (around 23.9° N).

Cacao has also found home in Japan, seen in Okinawa prefecture (沖縄県), located around 26° N, as well as on Hahajima Island (母島), part of the Ogasawara Archipelago (小笠原群島) located around 26.67° N and within the jurisdiction of Tokyo. Cacao production on the main island of Okinawa as well as Hahajima island utilize greenhouse structures in order to maintain adequate temperature and humidity conditions for cacao survival (Okinawa Cacao 2020b).

Local chocolate producers also incorporate local ingredients such as unique selections of cane sugar grown on different islands throughout Okinawa prefecture (Timeless Chocolate 2020) and Okinawan cinnamon (Okinawa Cacao 2020a).

Japanese craft chocolate makers and cacao producers are part of a growing global movement to change the future of chocolate. Additionally, Japanese producers are uniquely equipped with the resources, technologies, and access to markets in Japan that allow this localized industry to participate in a global crop in non-traditional ways.

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Chapter 5. Specialty Cacao Quality

Understanding Quality

Industry-wide standards and language that facilitates the communication quality standards are necessary to allow for better reporting and feedback on samples to improve postharvest practices, support producers to gain better access to specialty cacao markets, enhance transparency, and facilitate better awareness for consumers about high quality cacao and production practices.

Cacao producers may be disconnected from the expectations of specialty chocolate makers, retaining many of the strategies employed by bulk cacao chocolate operations. In addition, quality assessment protocols for specialty cacao that use tools that are both available to farmers and yield repeatable results are not currently easily accessible. Collecting information regarding the current state of the industry helps to understand the current needs and hurdles that craft chocolate makers face, to propel further development for this growing global industry.

There is an urgent need to develop standardized procedures and language to assess specialty cacao bean quality and to provide credible and verifiable protocols for assessing and communicating specialty cacao quality.

The processing methods that noticeably impact the physical qualities of beans include postharvest treatments, fermentation, drying, and storage. (figures 1-12)

Figure 1. Cacao pods (*Theobroma cacao* L).

Figure 2. Breaking cacao pods.

Figure 3. Cacao fermenting in baskets.

Figure 4. Turning fermenting cacao beans.

Figure 5. Cacao microfermentation bags.

Figure 6. Quality assessment of fermenting cacao beans.

Figure 7. Fermenting in tiered wooden boxes.

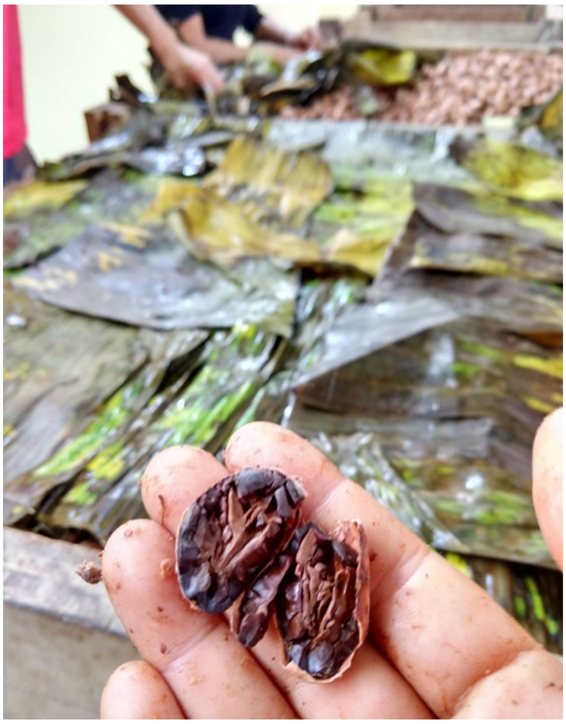

Figure 8. Fermenting cacao bean.

Figure 9. Cacao beans drying on heated racks.

Figure 10. Cacao beans drying on rolling racks.

Figure 11. Raking cacao beans under covered drying racks.

Figure 12. Assessing cacao quality with a cut test using a guillotine.

Figure 13. Tasters assessing cacao quality.

5.1 Cacao Quality Sensory Assessment

5.1.1 Introduction

The sensory analysis project is one part of the quality assessment project, investigating more effective methods to extrapolate final finished chocolate quality based on raw bean and roasted bean assessments. While resources for fine cacao assessment protocols currently exist, the need for repeatable results, accessible to all parties, with a focus on specialty cacao research, is quite necessary. The sensory analysis component borrows from specialty coffee quality assessment protocols, with modifications made in order to accommodate the needs of cacao.

The basic requirements are that the protocol uses metric weight units for measurement, (as opposed to volumetric imperial units in current recommended fine cacao quality assessment protocols), uses the tools available and regularly practiced by all parties for assessment purposes, and that the focus is on beans already understood to be above bulk cacao quality ("deal breaker" conditions such as severe mold and insect damage have already been addressed).

Protocols for quality analysis must use techniques and equipment that are accessible to cacao producers and provide a common measurement and language of quality specific to specialty cacao in order to support both producers and chocolate makers. Lastly, this is not a fully encompassing evaluation (there are no expectations to use cut test color tallies as qualitative indicators of quality), but rather focuses on taste and aroma, which are the crucial identifiers for craft chocolate.

Tastings involving coffee and specialty cacao industry members and Q graders were used to identify different techniques that could be best utilized for cacao quality analysis. These tastings include a group calibration, followed by an analysis (aroma, taste, flavor) of three origins of cacao beans, with several treatments. Treatments included raw nibs, roasted nibs, and finished chocolate.

There is a need to support farmers and chocolate makers with a mutual understanding of the standards for which their livelihoods depend. The goal of this research is to support the development of a common language, as well as a globally consistent approach to sample preparation, to strengthen cacao quality vocabulary, and to update references specifically tailored to the specialty cacao industry.

5.1.2 Materials and Methods

Group Tasting

Tasters included a selected group of craft chocolate makers, coffee Q graders, and wine and beer sommeliers. A total of 17 tasters underwent a short training and calibration specific to cacao sensory analysis. This included a description of the tastes and aromas listed on the evaluation forms, including samples.

The group calibration was performed in Tokyo at the Jiyugaoka Wine School and Cerrad Coffee as well as in Vermont at Coffee Lab International using a sample of beans that underwent treatments used in the analysis but were not included in the analysis other than for reference throughout the tasting, based on a discussion and evaluation process where tasters agreed on the intensity value for each category.

Treatments included roasted and unroasted beans from Costa Rica, Ecuador, the Philippines, and Vietnam (detailed descriptions of samples can be found in the appendix). A 1 kg minimum sample was used per treatment for a better representation of the batch as a whole, and gathered from the top, middle, and bottom of the sack. The resting/storage period for each sample was at least 1-3 months after drying and unroasted samples were between 7-8% moisture content at the time of sampling.

Raw nibs, comprised of fermented, dried nibs extracted from the seed coat were used for "raw" treatments. Roasted nibs comprised of fermented, dried nibs roasted within 24 hours of sampling at 120° C for 10 min, extracted from the seed coat were used for "roasted" treatments. "finished chocolate" treatments roasted nibs, conched for 17 hours, and tempered, processed into 70% chocolate tablets at the Dandelion Japan chocolate factory in Kuramae.

A MAGRA Guillotine was used to cut raw beans for nib extraction, and roasted nibs were extracted from the seed coat by hand. Samples of 5 g per nib treatment were weighed using a field scale. Finished chocolate samples of 5 g per taster were weighed before analysis. Ground nib samples were processed using a handheld burr grinder, immediately before analysis.

For the sensory analysis, 240 ml glasses labeled with a random four-digit code were used to hold samples and were arranged from least intense to most intense. Glasses remained covered until sensory analysis. Wet samples included 10 ml of hot water (90-95 ºC) and were mixed into a slurry immediately before analysis. Evaluators rinsed with water between samples, smelling each sample first within one treatment, then tasting.

Remote Tasting

A remote tasting protocol was used to reach chocolate makers unable to attend the group tasting. Raw beans were sent by post to 8 chocolate shops including samples for all participating staff members using refrigerated overnight shipping (tasting documents provided to the craft chocolate makers, [ンプル テイスティング] and sample descriptors [サンプルの説明], can be found in the appendix).

5.1.3 Results and Discussion

These sampling protocols were developed to allow chocolate makers provide feedback on various sampling methods for this research project. The experimental sampling method, "raw, wet, ground nibs" (water immersion), was noted to have potential as a tool to identify off flavors at earlier stages of quality analysis, perhaps at the farm level. Multiple craft chocolate makers remarked that this process was not inviting for taste sampling.

Tasters also remarked that both roasted and raw, dry, ground nibs were more powerful aromatically than full nibs, likely due to the smaller particle size and greater surface area to volume ratio.

Participants described similar attributes for finished chocolate samples. Finished chocolate tasting results can be found in the appendix.

5.1.4 Conclusion

The results of the sensory analysis projects were not conclusive, and this research would benefit from further investigation on these topics.

5.1.5 References

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5.2 Quality Assessment and Chemical Analysis

5.2.1 Introduction

Chemical analysis for cacao samples may facilitate the correlation of human sensory results to repeatable, quantitative data. Although human tasters are typically preferred for quality analysis, understanding the results on a chemical level would be greatly beneficial for developing standardized analysis protocols.

Chemical analysis components, through High Performance Liquid Chromatography (HPLC), were used to identify changes in cacao beans after treatments. The HPLC analysis was used to understand different sources and levels of acidity and sugars. Both quality indicators are expected to fluctuate due to changes made at the cacao producer level and throughout the chocolate production process (Clark et al. 2020).

5.2.2 Materials and Methods

Treatments included roasted and unroasted beans from Costa Rica, Ecuador, the Philippines, and Vietnam. Bean samples were assessed by a tasting panel for basic flavor characteristics and included cacao beans in the form of full cacao nibs and ground cacao nibs.

Both unroasted and roasted cacao beans were used for HPLC analysis. Roasted beans were placed in the oven at 120° C for 15 minutes and then shelled for sample preparation. Unroasted beans were shelled by hand. Unroasted and roasted cacao beans were ground between 400-800 µm with a ceramic hand mill, weighed into 10 g samples, added to 15 ml benzoic acid solution (5% solution), and were shaken in 50 ml tube for 5 min. Samples were then filtered with Advantec #2 (110 mm) and 1 ml of filtrate was centrifuged in 1.5 ml tubes at 13,100 × g for 15 minutes. The supernatant was collected and syringe filtered through a .25 µm Millex® filter and sealed with Parafilm® for transportation to Saitama University.

Statistical analyses were performed with a regression analysis and using the 'R' program (R version 3.4.4) for a one and two-way ANOVA.

Results from the HPLC analysis were compared to human sensory results for the same treatments and beans.

5.2.3 Results and Discussion

Unsurprisingly, roasting treatments significantly influenced the levels of phosphoric acid (p=.005**), glucose (p=.0003***), malic acid (p=.002**), and acetic acid (p=.03*), found in cacao beans (table 1). Roasting treatments reduced the acidity of cacao beans. These findings are consistent with those of Jinap and Dimick (1990), which described significant decreases in the concentrations of volatile acids, especially acetic acid, and reduced acidic flavor characteristics in cacao beans. Reduced concentrations of glucose due to roasting treatments were also consistent with findings by Mohamed et al. (2019) which described that roasting had the largest impact on favor precursor compounds and decreased concentrations for most of the sugars (glucose, sucrose, and fructose) due to a Maillard reaction with oligopeptides and free amino acids.

Table 1. ANOVA results for HPLC analysis of concentrations in roasted vs unroasted cacao beans for phosphoric acid, citric acid, glucose, malic acid, succinic acid, and acetic acid, with significance indicated by (*).

Phosphoric Acid	Citric Acid	Glucose	Malic Acid	Succinic Acid	Acetic Acid
0.005771 **	0.2425	3.884e-09 ***	0.002713 **	0.05284	0.03626 *

A regression analysis also showed a strong relationship between the perception of sourness and the glucose concentration of roasted cacao (R^2= .9994) and unroasted cacao (R^2=.9889). These findings may be attributed to the roasting process decreasing concentrations of acids and sugars.

5.2.4 Conclusion

The findings for the HPLC analysis of roasted and unroasted beans were consistent with previous findings and did not yield novel results. Additionally, with many variable occurring along the production chain, future work with HPLC analysis may require more control over treatments, perhaps in an artificial environment.

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5.3 Pod Storage and Maturity

Postharvest Pod Storage and Maturity Effects on Specialty Cacao Pulp Quality

Presented at the International Joint Conference on JSAM, SASJ and 13th CIGR VI Technical Symposium. Hokkaido University, Sapporo, Japan. 2019, September 3-6.

5.3.1 Abstract

Specialty cacao products demand a higher standard for quality in exchange for price premiums. Seeds and pulp contaminated with disease are unfit for use in specialty cacao. Pulp quality characteristics were investigated after pod storage and fruit maturity postharvest treatments. Disease damage, Brix, pH, pod weight, and seed with pulp weight were measured over three levels of cacao pod maturity (underripe, ripe, and overripe), under timed pod storage treatments. Pulp quality of fresh pods was compared to treated pods. Longer pod storage treatments were significantly more likely to incur disease damage. Brix, pH, and pulp moisture are primary measurable factors in early fermentation stages and were found to be significantly affected by storage periods and ripeness. Significant changes in pod weight and seed with pulp weight were also observed with increasing storage treatments and ripeness treatments. Shorter storage treatments to meet specialty cacao quality standards may improve access to markets.

Keywords: pod storage, pH, Brix, postharvest, specialty cacao quality, cacao pod disease, pod resting, cacao fruit ripeness, pod maturity, *Theobroma cacao*

5.3.2 Introduction

Specialty cacao beans produced for craft chocolate markets (Giller 2017), can be sold at much higher price premiums when compared to commodity cacao. This industry has great potential to contribute to the improvement of farmer livelihoods and demand higher farm gate pricing (Williams and Eber, 2019), improved standards for farmer and environmental welfare, and emphasize consumer education.

Processed beans (seeds) from the cacao tree (*Theobroma cacao* L.) are the primary ingredient used in chocolate production, and postharvest handling is the most important stage of production (Wood and Lass, 2008). The quality of the starting materials for use in the production of specialty cacao is paramount (Ali et al., 2014), and should be free of contaminants and disease, which cannot be removed during processing. Immature, overripe, damaged, and diseased pods are considered to be unfit for use in specialty cacao production (Levai et al., 2015), and previous research has not investigated these combined factors. Pod storage is a common postharvest practice and describes the interval of aggregation time taking place after harvest but before breaking (Meyer et al., 1989). Longer pod storage periods can encourage the proliferation of unwanted microorganisms from damaged and contaminated pods (Maclean, 1953; Tomlins, 1993), and contribute to the development of off-flavors and unwanted free fatty acids in cacao beans (Maclean, 1953; Tomlins, 1993).

Previous studies on the combined effects of pod storage and maturity have not been performed from the perspective of the specialty cacao industry, specifically considering the need for higher quality starting materials (seeds with pulp). In light of specialty cacao industry developments and changing market demands, the principal studies regarding pod storage and maturity are quite dated and tangential (Packiyasothy et al., 1981; Meyer et al., 1989; Biehl et al., 1989), in addition to being fairly limited in respect to location, specifically to Malaysia (Meyer et al., 1989; Biehl et al., 1989) and Ghana (Afoakwa et al., 2012a; Afoakwa et al., 2012b; Afoakwa et al., 2013a; Afoakwa et al., 2013b; Afoakwa et al., 2013c; Ofosu-Ansah et al., 2013; Meyer et al., 1989). Previous research, primarily dedicated to commodity cacao production systems, (Afoakwa, 2015; Afoakwa et al., 2015; Hinneh et al., 2017), have different standards for quality and cannot be applied to specialty cacao production (Eskes et al., 2012; Sukha, 2016).

The objective of this study is to validate low-investment opportunities to improve small-holder farmer access to specialty cacao markets through key factors that farmers can leverage as the specialty cacao industry continues to develop.

This research investigates a targeted understanding of postharvest treatments applied to specialty cacao, addressing the influence of pod storage and maturity on pulp quality, including disease contamination, Brix, pH, pod weight loss, and seed with pulp weight loss.

5.3.3 Materials and Methods

Field Data Gathering and Starting Materials

Fieldwork was carried out in the Davao region of Mindanao Island in the Philippines from October to December 2018, including over 30 unstructured interviews with farmers. Cacao pods used for combined pod storage and maturity treatments were harvested in mid-season December from a single, uniform, 24 ha farm consisting of grafted UF-18 cacao clones in Biao, the Davao region of Mindanao Island in the Philippines. Trees were approximately 21 years old, un-irrigated and maintained at 4-5 meters height, intercropped with coconut (*Cocos nucifera*), and lanzones (*Lansium parasiticum*) in moderate shade. Undamaged and disease-free pods of UF-18 were identified, harvested, and separated into ripe, underripe, and overripe treatments. Cacao pods used for pod storage treatments were harvested in mid-season September from a single, uniform, 13 ha farm consisting of grafted cacao clones in the Coto Brus region of Costa Rica. Undamaged, ripe, disease-free pods of CATIE-R4 and CATIE-R6 (Phillips-Mora et al., 2012) were identified and harvested. These clones are genetically similar.

All pods were harvested within an acceptable range of ripeness for commercial cacao production. Pods that displayed signs of disease were not used in data collection for measurements of Brix, pH, pod weight, seed with pulp weight, or seed weight. All pods were broken open and inspected for signs of disease and discarded after data collection. Disease was identified visually by noticeable differences in pulp quality (sliminess, color, odor) and obvious signs of microbial infection or contamination within the pod.

All analyses were performed with four replicates per treatment, including pod storage treatments investigated with the principal factors being pod storage (0, 96, and 144 hrs). Combined pod storage and maturity treatments were investigated with a 6 × 3 full factorial experimental design with the principal factors being pod storage (0, 24, 48, 72, 96, and 120 hrs) and pod maturity (underripe, ripe, and overripe).

Breaking and Juice Extraction

Pods were weighed immediately before breaking. Weight loss measurements were calculated by standardizing original pod weights using the adjusted relative pod and seed with pulp weight for treated pod measurements:

$$w_{ap} = w_{tp}/w_{op} \qquad (1)$$

$$w_{asp} = w_{tsp}/w_{op} \qquad (2)$$

where w_{ap} is the adjusted pod weight, w_{tp} is the treated pod weight, w_{op} is the original pod weight, w_{asp} is the adjusted seed and pulp weight, and w_{tsp} is the treated seed and pulp weight. After breaking, the seeds surrounded by pulp were separated from the placenta, weighed with a digital field scale, and then squeezed in a plastic mesh bag. Juice and seeds were separated and measured. Juice was sampled for Brix and pH values.

Brix and pH Measurements

Brix (Total Soluble Sugars-TSS) and pH measurements were taken from juice collected from cacao pods, using handheld meters. Brix measurements were taken with a refractometer (Extech ATC 0-32, USA), and pH measurements were taken with a portable pH meter (Sato, Model SK-620PH II, Japan).

Pod Storage

Pods were stored in mixed heaps in the field at an average temperature of 30 C° for different storage times (0, 4 and 6 days for stored only treatments, and 0-5 days for stored treatments separated by ripeness) and broken open at the end of the storage period using a clean, stainless steel blade. Pods that developed signs of disease were counted and discarded. Labeled pods were weighed daily to measure individual pod weight loss throughout the storage period. Due to this destructive sampling method, at the end of each storage treatment period, pods were discarded after breaking and data collection.

5.3.4 Results and Discussion

Field Research

Farmer interviews revealed that all of the farmers in this study implemented some form of pod storage, typically for three days. While the journey from the tree to the fermentation stage varied, pod breaking occurred when resources became available. Throughout the harvest season, pods were harvested by a schedule dependent on labor availability and costs, pest and theft pressure, weather conditions, farm size, postharvest transport options, aggregator collection schedules, religious beliefs, as well as a wide variety of other personal considerations. Farmers requiring additional assistance waited for labor for pod breaking or transportation options to move beans or pods to the next stage of processing to become available. Buyers also often operated on a unique schedule. Pods were often stored at an aggregation point on the farm until reaching a minimum volume for fermentation or were stored at an offsite fermentation facility.

Farmers with smaller farms and fewer resources were typically harvesting more immature fruits. Frequent and inexperienced harvesting typically produced higher numbers of underripe pods, as harvesters attempted to maximize yield efficiency. Conversely, infrequent harvesting typically yielded in a higher number of overripe fruits, as the pods were allowed to ripen longer on the tree before harvest. Transporting unopened pods involved carrying significantly more weight and volume than transporting wet seeds. However, transporting wet seeds is not always practical, making pod storage a popular practice. Breaking pods as close to the start of the fermentation period was preferred practice to ensure maximum weight for sale and reduce contamination. All farmers utilized thin plastic sleeves to protect pods against Cocoa Pod Borer (CPB), which remained on the pod until breaking (Figure 1). After harvest, plastic bags can maintain moisture against the pods, potentially exacerbating postharvest pod diseases.

The Impact of Pod Storage Treatments on Brix, pH and Pod Weight

The impact of pod storage treatments on Brix, pH, pod weight, and seed with pulp weight was investigated. The Brix measurements of cacao pods were highest immediately after harvest (average 17.5). Cacao pods that were stored for 4 days had significantly lower Brix measurements than fresh pods (average 15.8). Cacao pods that were stored for 6 days (average 13.6) had significantly lower Brix measurements than fresh pods, but not from pods stored for 4 days.

Figure 1. Cacao pods in the Philippines, in thin plastic bag to protect against CPB.

Figure 2. Cacao pods aggregated under covered area in the Philippines.

Figure 3. Cacao pods ready for transport to a fermentation facility in the Philippines.

The pH of cacao pods was highest after 6 days of storage (average 3.59). Cacao pods that were stored for 4 days (average 3.49) had significantly higher pH measurements than fresh pods (average 3.35) ($p<0.05$). Cacao pods that were stored for 6 days had significantly higher pH measurements than fresh pods ($p<0.05$), but not from pods stored for 4 days.

The weight of cacao pods, as well as the seeds with pulp within the pods, weighed significantly less after storage treatments ($p<0.05$). The weight of cacao pods and seeds with pulp was highest immediately after harvest and significantly reduced after 4 days of storage and 6 days of storage treatments. The weight of cacao seeds with pulp collected from pods was highest immediately after harvest, and significantly reduced after storage treatments. Pods stored for 4 days (average 0.021 of relative weight) and 6 days (average 0.044 of relative weight) weighed significantly less than fresh pods ($p<0.05$), although seeds with pulp in pods that were stored for 4 days did not weigh significantly less than seed with pulp in pods that were stored for 6 days.

The Impact of Pod Storage and Maturity Treatments on Brix, pH and Pod Weight

The impact of pod storage and maturity treatments on Brix, pH, pod weight, and seed with pulp weight was also investigated. Measurements of Brix for underripe, ripe, and overripe cacao pods were highest immediately after harvest (15.0, 15.3, and 16.0 average). Measurements for Brix of underripe, ripe, and overripe cacao pods were the lowest after 5 days of resting treatment (13.5, 13.3, and 12.6 average). Cacao pods that were stored for 1-5 days, regardless of ripeness, had significantly lower Brix measurements than fresh pods ($p<0.05$), but no significant difference was found between pods stored for 1-5 days, regardless of ripeness. A significant difference in Brix was measured between pod ripeness treatments only when pods were fresh (figure 4).

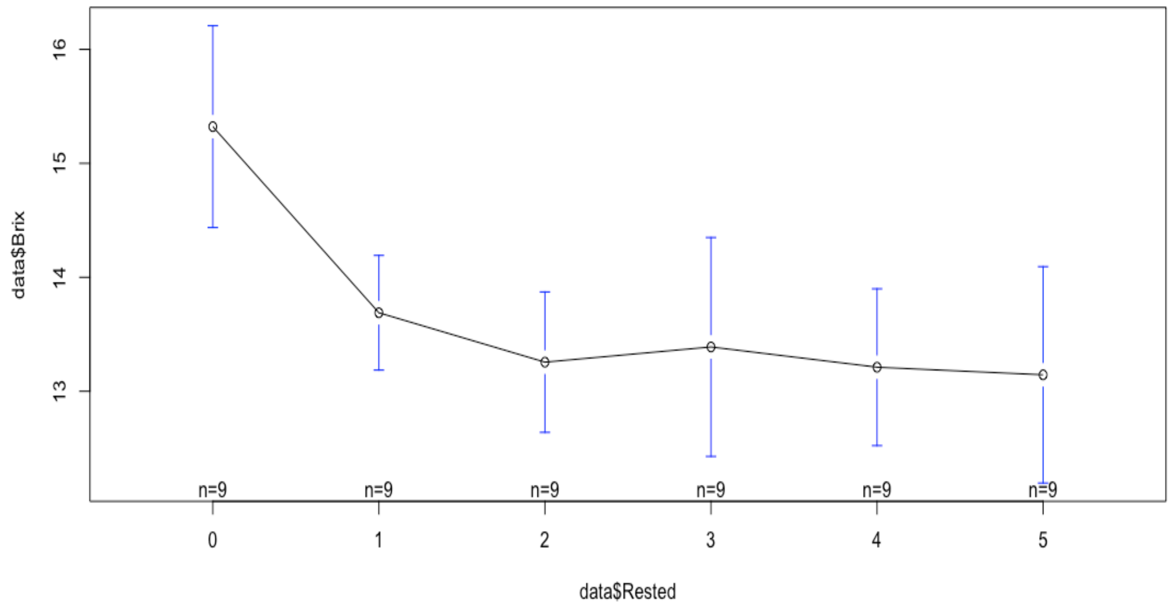

Figure 4. Measurements for Brix of underripe, ripe, and overripe cacao pods were the lowest after 5 days of resting treatment (13.5, 13.3, and 12.6 average)

The pH of underripe, ripe, and overripe cacao pods were highest after five days of resting treatments (3.47, 3.57, and 3.67 average). The pH of underripe, ripe, and overripe cacao pods were the lowest on day 0 (3.36, 3.40, and 3.45 average). A significant difference in pH was not found between pod ripeness treatments but was found between fresh pods (day 0) and pods treated with 1-5 days of storage ($p<0.05$). Cacao pods weighed significantly less for all storage treatments ($p<0.05$), but there was no significance found between maturity treatments. Extracted seeds with pulp weighed significantly less after 1 and 2 days of storage treatments, with ripe pods losing the least weight on average after 5 days, followed by overripe and then underripe pods, but with no significant difference found between maturity treatments. There was no significant difference in the weight of seeds with pulp removed for either storage or maturity treatments.

The Impact of Pod Storage and Maturity Treatments on Pod Damage and Disease

Cacao pods that underwent longer pod storage treatments were significantly more likely to display signs of disease (figure 5), which is highly undesirable in specialty cacao production (figure 6). In addition, overripe and ripe pods were more likely to show signs of disease than underripe pods overall (8.33% average, 7.38% average, and 3.33% average, respectively). Pods displayed significantly more damage due to disease after 4 and 5 days of storage (8.57% average), whereas fresh pods and pods stored for 1-2 days showed the least (4.76% average).

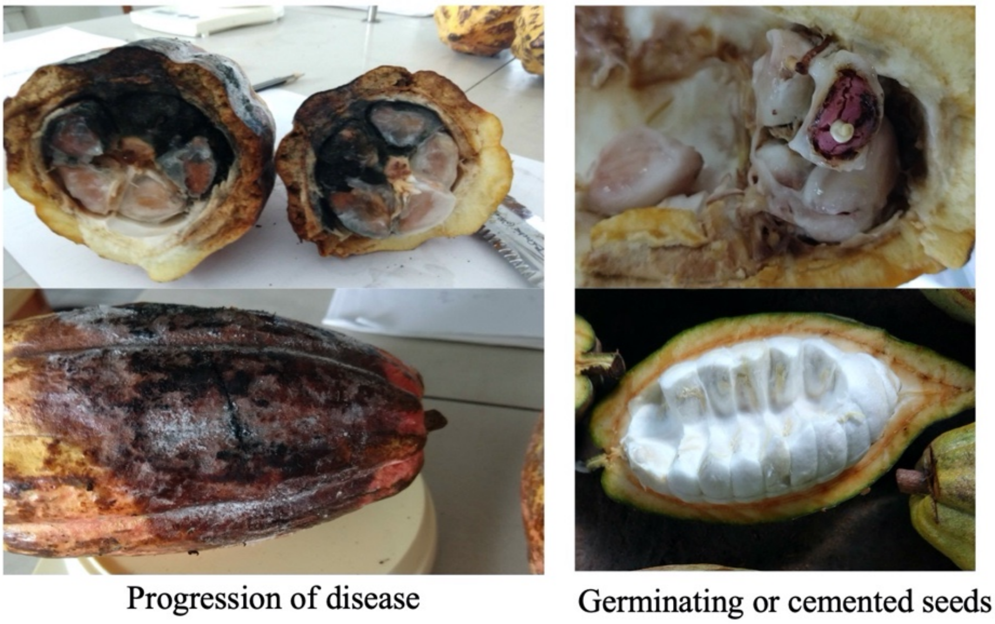

Figure 5. Pods demonstrating damage from disease (left) or otherwise poor qualities that are not ideal for specialty cacao production (right).

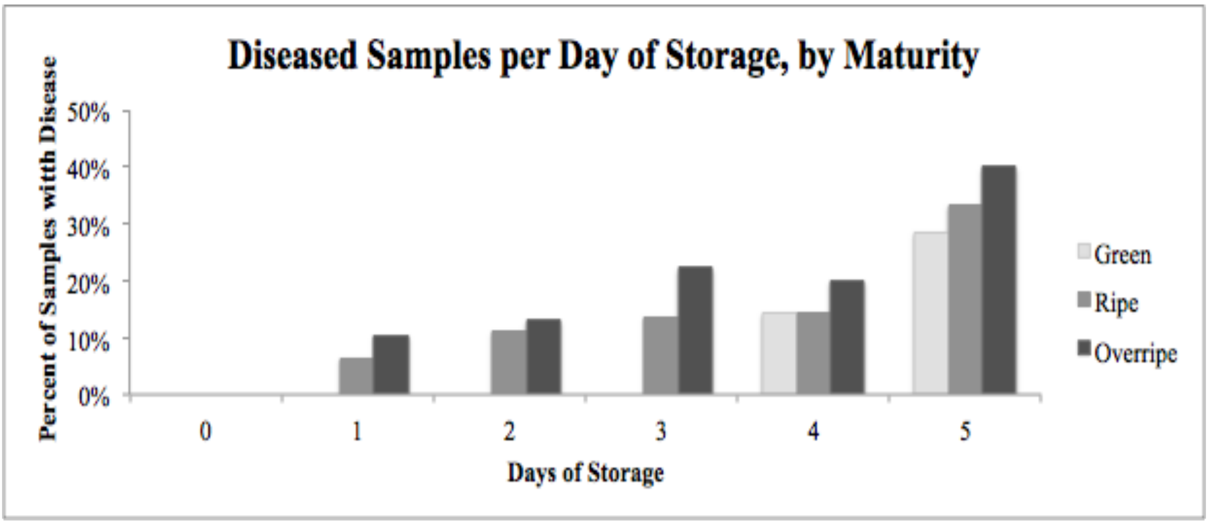

Figure 6. Pods separated by maturity treatments were observed during storage periods, and instances of disease were recorded. Longer storage periods, especially for overripe pods, resulted in higher instances of disease.

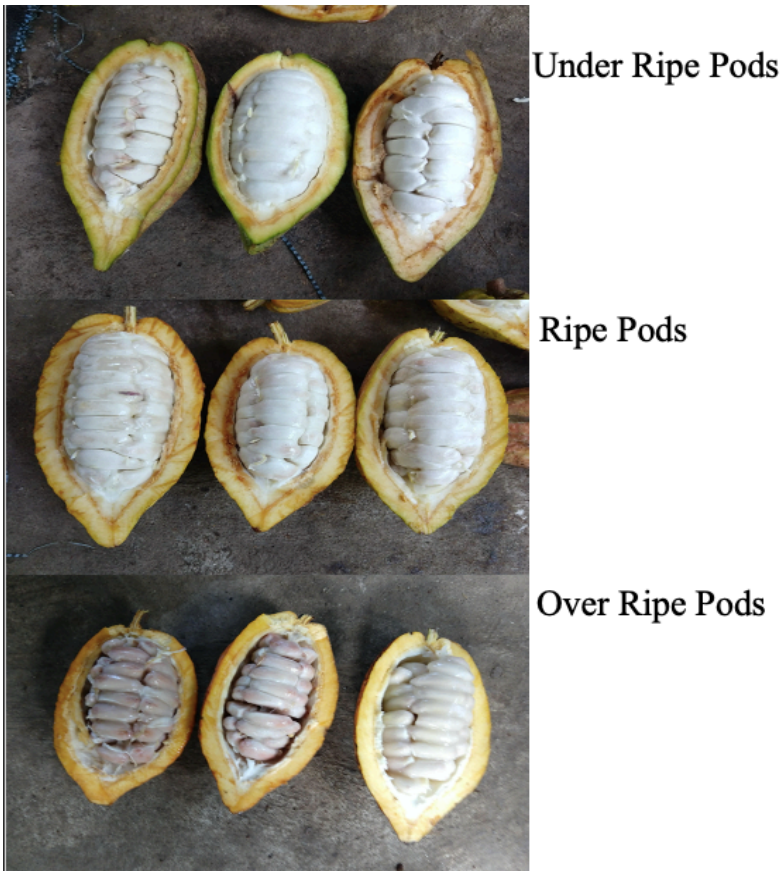

Figure 7. Cacao pods: comparing pod ripeness within an acceptable harvest.

Factors Influencing Pulp Quality

The fruit of the cacao tree commonly is an indehiscent drupe that will remain on the tree unless harvested or overtaken by disease (Wood and Lass, 2008). Cacao is also a non-climacteric fruit, meaning that further ripening will not occur after pods are harvested from the tree (Paul et al., 2011). As fruits mature on the tree, the pulp undergoes changes in sugar ratios, seed storage proteins, fermentable carbohydrate components, and water content (Biehl et al., 1989; Rawel 2019).

For cacao destined for chocolate production, the surrounding pulp undergoes fermentation, inflicting chemical change inside the seed, developing flavor precursors, later identified in chocolate production (Wood and Lass, 2008). A successful fermentation requires an environment that is hospitable to the colonization and proliferation of important yeasts and bacteria from the beginning of the process (Ardhana, 2003). The factors that most influence the success of these microbial communities are the pH, water, and sugar composition (figure 4) and concentration of the pulp (Wood and Lass, 2008).

Seeds are enveloped in a mucilaginous pulp and are neatly arranged in a cluster around a central placenta. The pulp makes up about 30 to 40% of the fresh bean weight, depending on rainfall, and contains sugars, acids, and water (Schwan and Wheals, 2004; Enriquez and Soria, 1968). The sugar content of the pulp found in fresh pods is expected to range from 10 to 20%, with a low pH supported by 1 to 2% citric acid, and protein content typically around 0.4 to 0.6% (Dias et al., 2007; Lima et al., 2011; Schwan and Fleet, 2015). The volatile and non-volatile acids that influence pulp quality include citric, lactic, and acetic acids. Citric acid is found in the pulp, about half of which is lost through the departure of sweatings and metabolic activity during fermentation. Lactic and acetic acids are produced, diffused, and metabolized as a result of the fermentation process (Wood and Lass, 2008).

The sugars that influence pulp quality include glucose, sucrose, and fructose. Packiyasothy et al. (1981) reported levels of sugar remaining constant throughout pod maturity, with variations in proportionally higher levels of sucrose in early development, transitioning to proportionately higher levels of glucose with fruit maturity. Variations in the proportions of sugars are largely attributed to pod maturity and the genetics of the tree and have been reported to contain about 60% sucrose, and about 40% as a mixture of glucose and fructose, depending on maturity and freshness (De Vuyst et al., 2010; Lefeber et al., 2010). The water content of the pulp is typically around 82 to 87% and will vary depending on fruit maturity, the genetics of the tree, seasonal variations, and conditions after harvest.

The fermentation cycle consists of two main stages, an anaerobic stage, dominated by yeast, enzymatic, and lactic-acid-producing bacteria (LAB) breakdown of the pulp, followed by an aerobic stage, dominated by acetic-acid-producing bacteria (AAB) and dynamic temperature output (Schwan and Wheals, 2004) (figure 8). Cacao pulp quality factors, including Brix and pH, influence the beginning stages of fermentation, where conditions must be hospitable to the colonization and proliferation of important yeasts and bacteria. Pulp moisture also supports an anaerobic environment, which is critical in the first stage of the fermentation process. Fermenting pulp with higher water content can restrict gas exchange by filling gaps between seeds, creating a more anaerobic environment in early stages (Dias et al., 2007; Schwan and Wheals, 2004). As pulp drains away, replaced with air gaps, increased airflow supports aerobic conditions, which is often accompanied by manual heap aeration to encourage the aerobic stage of the fermentation cycle.

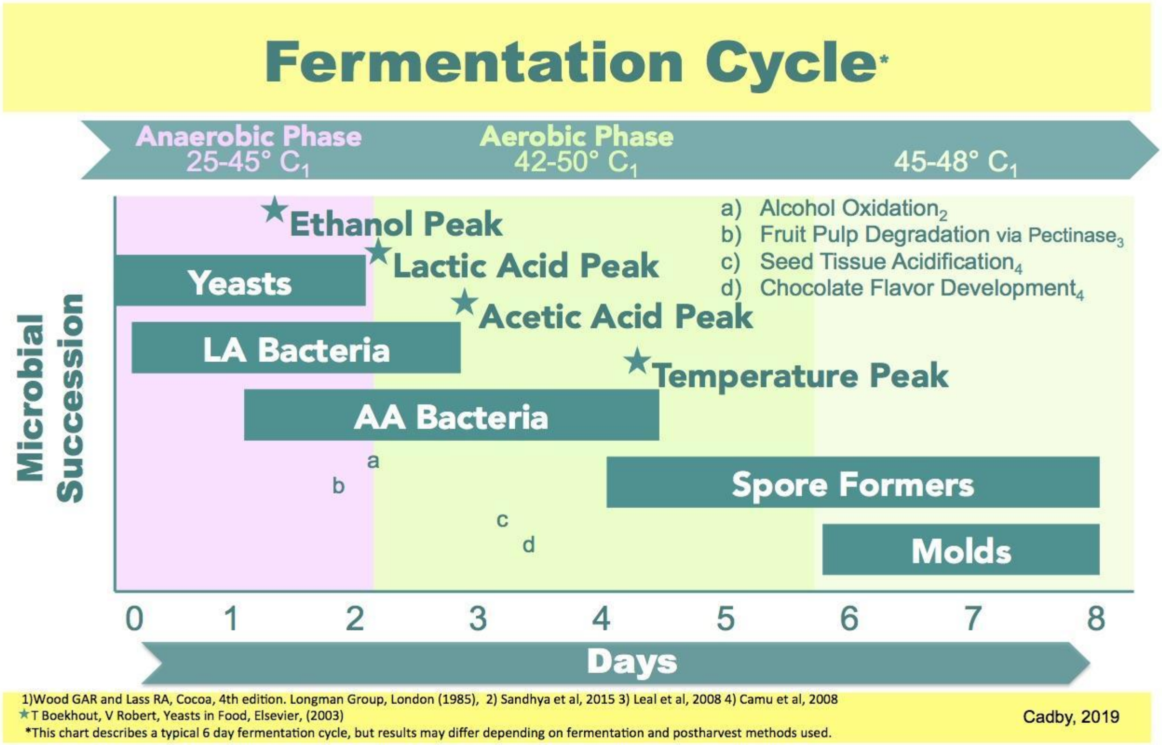

Figure 8. The cacao fermentation cycle is influenced by pH, and sugar, and water content. The sugar content and pH of the cacao pulp plays a role in facilitating a hospitable environment for microbial succession. Pulp water content can facilitate the anaerobic environment in the early fermentation stage, to propel the succession of key bacterial populations.

Pod breaking describes opening the thick cacao pod rind for seed extraction (Wood and Lass, 2008). This procedure is significant because breaking the rind exposes the seeds to potential inoculants, which will alter the fate of the beans during fermentation and introduce other contaminants.

Influence of Postharvest Practices

Postharvest processing for cacao generally refers to pod storage, pulp pre-conditioning, fermentation, and bean drying treatments (Lima et al., 2011). Pod storage is a practice often cited as a postharvest strategy used in bulk cacao operations, intended to speed up the fermentation process or reduce nib acidity after fermentation (Meyer et al., 1989). The key outcomes from storage treatments include, decreased pulp volume, total sugars, pulp water, and acidity due to respiration (Biehl et al., 1989), and increasing trimethyl pyrazine which contributes to cocoa flavor (Hii and Borem, 2019). Pod storage treatments occur depending on processing preferences, labor, time, equipment resources or the availability of an aggregator, with highly variable postharvest management practices fairly typical on the farm (Jano and Mainville, 2007), and can take place anywhere from a few hours to a fortnight, depending on the circumstances (Wood and Lass, 2008). Commodity cacao production research supports longer storage treatments, applied as a tool to reduce nib acidity and produce higher flavor potential (Afoakwa, 2013b), typically recommended between three to seven days (Afoakwa et al., 2012a; Afoakwa et al., 2012b; Afoakwa et al., 2013b; Afoakwa et al., 2013c; Meyer et al., 1989). Postharvest treatments such as pod storage used for commodity cacao provide larger manufacturing companies more uniform beans, standardized for their markets, with stronger cocoa flavor (Giller, 2017; Roos, 2018).

Many farmers may not be applying postharvest treatments with the goal of reducing nib acidity, but rather as a circumstance of production conditions. In this case, understanding the influence of postharvest treatments on pulp quality may instigate low cost, logistical changes that allow farmers to improve the quality of starting materials for use in specialty cacao production. Poor efficiency and consistency is found with storage treatments, including 15 to 25 % potential pod loss from spoilage (Meyer et al., 1989), time lost to the days required for pod storage (Biehl et al. 1990), and increased potential for over-fermentation, Free Fatty Acids (FFA) or Ochratoxin A (OTA) formation. In fact, storage periods of more than seven days are not recommended due to the risk of proliferation of the mycotoxin ochratoxigenic fungi (Santander Munoz et al., 2019; Afoakwa et al., 2012a). Such pod storage treatments can further exacerbate damage and prevalence of the Cocoa Pod Borer (CPB) in parts of Southeast Asia where this problematic insect pest is prevalent (Babin, 2018).

Frequent and inexperienced harvesting typically produces higher numbers of damaged and "green" or underripe fruits. Immature pods contain seeds that are not fully developed and difficult to separate. Lower levels of sugars and moisture found in the pulp of unripe pods can also be problematic, often clumping together and not fermenting well, which leads to poor flavor, slow drying, and mold development. On the other hand, infrequent harvesting typically yields in a higher number of overripe fruits, as the pods have been allowed to ripen longer on the tree before harvest (Packiyasothy et al., 1981). Dry pulp and lower levels of sugars found in overripe pods accompany beans that may have germinated within the pod, potentially damaging the seed coat. Entry points from damaged seed coats or inexperienced harvesting provide an ideal entry point, allowing molds, insects, and other contaminants to negatively influence quality, and damage trees and pods (Wood and Lass, 2008). Harvesting practices can influence the quality of starting materials for postharvest processing, determining the proportions of immature, overripe, or damaged and diseased pods. Ripe pods display seeds that are fully developed, but not germinated, and easily separated (Santander Munoz et al., 2019).

Figure 9. Extracting cacao seeds in the Philippines.

Specialty Cacao Industry Specifics

The growing specialty cacao industry prioritizes cacao that has been manufactured with diverse and fine flavor in mind, with higher standards for the processing methods and materials used in production (FCIA, 2019). This is supported by a philosophy that all steps of chocolate production are performed with the intention of creating a premium product. Many craft chocolate producers also buy specialty cacao directly from producers, increasing farmer share in the value chain and seek to prioritize farmer welfare and environmental resource conservation goals. The delicate flavor notes desirable in fine, or specialty chocolate, are a major distinguishing characteristic from commodity cacao, and originate from the variations in postharvest processes (Kadow et al., 2013).

Commodity cacao production starting materials (seeds with pulp) and measurements for quality and success differ from specialty cacao needs (Eskes et al., 2012; Sukha, 2016), including independent goals for meeting quality standards (Levai et al., 2015), and allowable mold, at a maximum of 3% allowable by the ISO (Sukha, 2016). For specialty cacao, only beans collected from just-ripe, healthy pods should be included in the fermentation, and should not include black, diseased, or clumped beans (Santander Munoz et al., 2019).

Some types of cacao may benefit from pulp pre-conditioning aimed to increase pH and reduce acidity for fermented and dried beans (Santander Munoz et al., 2019). Alternative pulp-preconditioning strategies to achieve similar outcomes to pod resting include mechanical and enzymatic de-pulping, juice extraction, and seed spreading. The goal of such practices is to influence the water and sugar content in the pulp, to influence microbial dynamics and subsequent metabolic processes, including substrates for yeasts and bacteria (Schwan, and Wheals, 2004; Aprotosoaie et al., 2015). For example, bean spreading offers an alternative method to pod storage to reduce nib acidification for cacao with high pulp moisture (Pettipher, 1986), while requiring less time and risk of contamination (Biehl et al., 1990) and may be worth considering for further investigation. A thorough review of cacao postharvest practices, including the effect of cocoa pod storage on the physical and chemical characteristics of cacao seeds, can be found by Santander Munoz et al. (2019).

5.3.5 Conclusion

This research was necessary under the conditions of specialty cacao, as previous research did not incorporate the quality of the starting material used in specialty cacao production systems to include mature and disease-free starting materials (seeds with pulp). Although cacao pod samples and treatments were collected and conducted from two different tropical landscapes, similar results indicated some consistency to the impacts of postharvest treatments. Different varieties of cacao may contain different constituents in pod and pulp make up, so further research is necessary to investigate potential deviations. The potential of specialty cacao to support improvements in farmer livelihoods due to price premiums can be bolstered with additional access to resources such as the current research.

Longer storage periods are associated with continued development or the introduction of disease and contaminants that are undesirable in specialty cacao. Postharvest treatments influenced pulp quality, with longer storage times associated with higher instances of damaged starting material. Storage periods over one day displayed reduced water content, significant losses in Brix, pod weight, and seed with pulp weight. Storage and ripeness treatments also significantly increased pulp pH, with higher pH seen among longer storage treatments. Postharvest treatments of pod storage and pod maturity significantly impacted pulp quality in early stages of cacao processing, with overripe and ripe pods more likely to show signs of disease than underripe pods overall. Pods displayed significantly more damage due to disease after four and five days of storage, whereas fresh pods and pods stored for one to two days showed the least.

If the objective of pod storage treatments is to reduce pulp acidity and water content, shorter storage periods, less than two days, appeared to be equally effective in reducing pulp acidity and moisture for these varieties, while also shortening the window for contamination and off-flavor development, as opposed to the current recommendation of three to seven days. Research under the context of specialty cacao is sparse, and more information specific to industry needs would be helpful. Understanding the role of postharvest treatments such as pod storage and pod ripeness in influencing pulp quality can aid specialty cacao producers to better control quality outcomes as well as provide valuable insight to farmers to increase the value of their products to meet the standards of specialty cacao without a significant upfront investment.

5.3.6 References

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Chapter 6. Identifying Industry Vulnerabilities

6.1 Direct Trade and Small Business Proprietorship

Vulnerabilities of the Craft Chocolate Industry Amidst the COVID-19 Pandemic

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6.1.1 Introduction

Craft chocolate is a model within the global chocolate industry, promoting accountability, transparency, and ethical practices, while often citing unfair labor or poor agricultural practices recognized in conventional chocolate. However, amidst the COVID-19 pandemic, the craft chocolate industry is particularly vulnerable, and specialty cacao farmers may be asked to pay the price.

Craft chocolate, also known as fine, flavor, specialty, artisan, or premium chocolate, is recognizable by high flavor attributes, quality, and origin specificity of the cacao utilized. Those in the craft chocolate industry often practice direct trade to source high-quality specialty cacao beans (Gallo, Antolin-Lopez, & Montiel, 2018). Specialty cacao beans are generally destined for use in craft chocolate production and traded directly, commanding a significantly higher price per ton compared to commodity cacao (Daniels, Läderach, & Paschall, 2012).

The disruptions caused by the COVID-19 pandemic are now exposing the unique vulnerabilities of craft chocolate, and specialty cacao and industry members may face inequalities exacerbated by the global crisis. Direct trade strategies and small-business practices are particularly consequential to the viability of the craft chocolate industry.

6.1.2 Materials and Methods

The materials and methods for the following analysis are an example of how connectivity and access to information are critical to raise global awareness of the unique challenges for the specialty cacao industry.

Craft chocolate and specialty cacao industry surveys reporting the ongoing COVID-19 pandemic were investigated along with industry announcements and bulletins found online. Additionally, specialty cacao farmer and craft chocolate industry interviews in Spanish and English were examined for first-hand accounts on industry vulnerabilities amidst the COVID-19 pandemic. A review of the literature and preliminary analyses of secondary data were aggregated using Google and the Google Scholar database for all publications related to COVID-19, specialty cacao, and craft chocolate as of September 2020 to complement references cited in the primary literature and unpublished studies.

6.1.3 Direct Trade

Many craft chocolate makers source specialty cacao from origin using direct trade agreements with farmers to produce higher-quality beans (McCabe, 2015). The unique standards for quality in craft chocolate production require considerably more diligence in maintaining control throughout the entire value chain, with some chocolate makers rejecting 94% of the beans sampled for craft chocolate production (Chuang, 2020). With international and domestic restrictions disrupting travel to cacao origins, reduced producer interactions have effectively removed a major quality control and communication channel.

Additionally, specialty cacao buyers often operate on private contracts (Giller, 2017) that may be difficult to honor with decreased revenue from the loss of craft chocolate sales. Reduced operations for these businesses would equate to a loss of buyers for farmers who may not be prepared to quickly find and negotiate new contracts with specialty cacao buyers at a comparable price. Producers are already facing uncertainty for export sales in the short term, with buyers asking to renegotiate existing contracts, and in the long term, potentially going out of business or waiting to recoup costs before making additional purchases (Martin & Ganem, 2020). The travel restrictions due to the pandemic affect the ability of craft industry members to sustain in-person trading relationships. An overreliance of specialty cacao producers on few buyers suggests that selling into craft chocolate supply chains is not a sustainable option for farmers, who may be less willing to invest in specialty cacao production due to constraints along the marketing chain, as previously observed in Ecuador (Díaz-Montenegro, Varela, & Gil, 2018).

Logistics and distribution systems were known to be difficult already before the pandemic, and government-mandated road closures and travel restrictions as well as accessibility to affordable petrol have intensified in many cacao-producing countries (Well Tempered, 2020). The specialty cacao industry also interfaces uniquely with less accessible communities, such as indigenous communities in the South American Amazon who have historically experienced disproportionate inequalities that are further revealed and exacerbated by the COVID-19 pandemic and may have greater difficulties delivering on contracts.

6.1.4 Small Business Proprietorship

The upfront investment in labor and capital required to produce craft chocolate is also much higher than that of industrial chocolate, due to craft chocolate makers operating on a much smaller scale, using manual labor to perform tasks that would be automated in industrial systems, with diverse flavor batches and high attention to detail (Giller, 2017). Craft chocolate businesses often partner with hotels and airport shops, which saw a decline in clientele due to reductions in tourism and travel. Small craft chocolate businesses are often reliant on foot traffic and industry events to reach customers and may not be equip- ped to rapidly transition to e-commerce strategies that allow for no-contact sales amidst the COVID-19 pandemic.

The results of a flash poll, entitled "Coronavirus and its impact on small chocolate businesses," conducted by the Fine Chocolate and Cacao Institute (FCCI, 2020) included data gathered from 125 chocolate companies, primarily from North America (52.8%), with the rest coming from Europe (22.4%), and grouped South America/Caribbean (15.2%) and Asia/Australia regions (9.6%).

Major findings include that nearly 80% of craft chocolate businesses have been affected or expect to be affected at a level of "significant" or "existential threat" due to the global pandemic (FCCI, 2020). About 17% of these businesses experienced over a 90% decrease in sales (FCCI, 2020). Small chocolate businesses experienced a loss of sales due to reduced sales to customers in person (87%) and sales to businesses (79%) (FCCI, 2020). Additionally, 59% of respondents "are or anticipate increasing [their] digital marketing efforts" over the foreseeable future (FCCI, 2020, 15:02). These results do not reflect the fragility of the chocolate industry as a whole, but specifically the small fraction (less than 5%) that encompasses craft chocolate.

6.1.5 Conclusion

Specialty cacao producers are often asked to shoulder the burden of production, maintenance of consistent quality, and reliance on buyers while wielding the least amount of leverage and resources. Specialty cacao buyers have done well to encourage transparency and accountability systems, including publishing annual sourcing reports that describe on-farm production practices, highlight farmer profiles, and divulge prices paid to farmers for specialty cacao. Following in the footsteps of third-wave coffee industry members, offering cacao producers more robust contracts that guarantee sales and allow for more flexibility in accommodating quality issues along the supply chain may mitigate the burden on farmers.

Additionally, programs that support online communication and sales opportunities for craft chocolate industry members, such as the "Stay Home With Chocolate" initiative (an online collaborative platform to boost craft chocolate businesses) and the "Online Cacao and Chocolate Summit" have been successful in generating online outreach mechanisms for craft chocolate businesses. Online industry panel events featuring specialty cacao producers have also provided a platform for stakeholders to interact and share perspectives on the pandemic. The fragility of the craft chocolate has been recognized by industry members for years and the global crisis has further highlighted the need for investments in farmer relief, improved access to technology for business needs, and farmer empowerment for negotiations with buyers to mitigate risks.

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6.2 Labor Intensity, Regional Politics, Risk Tolerance, and Accessibility

Can COVID-19 Melt the Craft Chocolate Industry?

6.2.1 Abstract

The craft chocolate and specialty cacao industry has been driving the global chocolate industry towards more sustainable farming and ethical and transparent sourcing practices by prioritizing farmer welfare, environmental resource conservation, and consumer education. However, the craft chocolate and specialty cacao industries are uniquely vulnerable to the immediate and long term impacts of the COVID-19 pandemic, many cacao producers located in food security "hot spots" are expected to be disproportionately affected. Craft chocolate businesses have been especially hard hit by losses in revenue and specialty cacao producers are facing unique challenges compared to their commodity cacao counterparts. Factors that influence the future of these businesses include: labor intensity, regional politics, risk tolerance, and accessibility. Immediate impacts include loss of revenue and access to markets, which are directly influenced by travel restrictions. Long term impacts include changes in business strategies, including the use of e-commerce and elevating consumer education to sustain sales. The global crisis highlights the need for investments in the specialty cacao and craft chocolate industry to provide farmer relief, improve access to technology for business needs, and support farmer empowerment in negotiations to mitigate risks.

Keywords: Craft chocolate, specialty cacao, COVID-19, Latin America, Chocolate

6.2.2 Introduction

At times it feels as if the world has come to a standstill. A cataclysmic event for the global system has forever changed the way humans operate and envision 'business as usual'. The COVID-19 pandemic affects all segments of the population, and is particularly detrimental to already vulnerable groups, including people living in poverty, older persons, persons with disabilities, youth, and indigenous peoples. Additionally, the social crisis created by the COVID-19 pandemic has the means to increase existing and burgeoning inequalities, exclusion, discrimination, and global unemployment in the long term (UN DESA 2020).

The United Nations World Food Programme estimates that an additional 130 million people could face acute food insecurity by the end of 2020, due to the global crisis brought on by the COVID-19 pandemic (WFP 2020). Although the non-immediate impacts are still unknown, many cacao producers are located in food security "hot spots" and are expected to be disproportionately affected (table 1). Cacao is a major agricultural crop, supported by millions of smallholder farmers around the globe, often living under the poverty line, faced with a highly volatile market, and with few options for alternative income streams.

Through sustainable business models and customer education, craft chocolate is well-positioned to propel the global chocolate industry to be more accountable, transparent, and ethical. Specialty cacao, also called fine, craft, flavor, or premium cacao, used for craft chocolate production, hardly constitutes a dent in the global supply chain, making up less than 5% of total cacao production (FCIA 2019; Daniels et al. 2012). However, traditionally "non-craft" organizations taking interest in participating in bean to bar, most notably Hershey's acquisition of Scharffen Berger (Daniels et al. 2012) and Meiji's 'THE' chocolate line (Meiji 2020) suggests increased interest and practice in craft chocolate production. This industry metamorphosis, influenced by the focus on ethical priorities that can have multidimensional impacts to support future sustainable development for cacao producing regions, shows how the craft chocolate industry is moving the needle for the chocolate industry as a whole. This growing industry is pioneering a more sustainable agricultural supply chain largely driven by consumer preferences for high quality food experiences and sustainable, ethical food sourcing.

Table 1. Global Food Security Index for fine and commodity cacao producing countries and two major cacao importing countries for reference in December 2019 (GFSI 2020).

Origin	GFSI	Primary Production
Ivory Coast	62.4	Commodity
Ghana	62.8	Commodity
Ecuador	61.8	Fine
Dominican Republic	64.2	Fine
Peru	63.3	Fine
Venezuela	31.2	Fine
Japan	76.5	--
United States	83.7	--

Craft chocolate, also known as fine, flavor, specialty, artisan, or premium chocolate, is recognizable by high flavor attributes, quality, and origin specificity of the cacao utilized. The craft chocolate industry is made up of many small businesses that claim to prioritize farmer welfare and environmental resource conservation, practicing direct trade to source high-quality specialty cacao beans (Gallo et al. 2018).

Beans traded as specialty cacao are typically recognized by high flavor attributes, aesthetic and physical qualities, genetics, and origin specificity (Giller 2017; Díaz-Montenegro et al. 2018), and market prices are highly variable, typically determined by the origin, product quality, certification status, personal relationships, and demand. Specialty cacao beans are generally destined for use in craft chocolate production and traded directly, commanding a significantly higher price per ton compared to commodity cacao (Daniels et al. 2012).

Incorporating the extensive biodiversity of food and agriculture into food systems may facilitate agroecological resilience to include stabilizing yield, insuring against extreme weather, and generally promoting agroecosystem sustainability, as seen in some South American countries such as Colombia, Ecuador, Peru, and Bolivia (Zimmerer and de Hann 2020). A recent report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security called for comprehensive policy reforms to build food system resilience, including promoting agroecology and shorter agricultural supply chains (HLPE 2020), a core trade model of craft chocolate and specialty cacao industry.

During the food price crisis of 2007-08, which resulted in global food prices rising 50% on average, high food prices became especially problematic for those with already limited incomes. Global agricultural supply chains, increasingly controlled by the private sector, were characterized by heightened corporate concentration and based on specialized, industrial food production for global markets. The consolidated power of large transnational agribusiness firms revealed new vulnerabilities and cemented the model of the global agrifood supply chain, based on commodity production and trade, weakening land rights for the world's most vulnerable food producers (Clapp and Moseley 2020). The COVID-19 pandemic is more complex than previous food crises in that it is not characterized by a sudden rise in food prices or food shortages, but rather an abrupt shock to entangled food systems that exacerbated multiple issues such as unstable food supply chains, job losses, and highly uneven food price dynamics (Clapp and Moseley 2020). The uniquely direct supply chain trade model of the craft chocolate and specialty cacao industry and pointed ethical emphasis on farmer welfare through augmented farmgate pricing strategies facilitate an excellent example of future food security approaches.

However, the craft chocolate and specialty cacao industries are uniquely vulnerable to the immediate and long term impacts of the COVID-19 pandemic, and ultimately, farmers producing cacao and craft chocolate makers producing chocolate are making strategic business decisions that may be influenced by the following factors: labor intensity, regional politics, risk tolerance, and accessibility.

Figure 1. Four factors incorporating the unique vulnerabilities for the craft chocolate and specialty cacao industry in the immediate and long term due to the COVID-19 pandemic.

6.2.3 Results

1. **Labor Intensity**

Craft chocolate is defined as "superior products made from premium chocolate and natural ingredients" (HCP 2019). In order to achieve this level of quality, craft chocolate makers and specialty cacao buyers often utilize an alternative model of direct trade to source higher-quality ingredients directly from the origin. With direct trade, buyers can build relationships with specific producers, to add depth to their products through marketing unique producer stories, and facilitate deeper involvement in production, including providing oversight and resources to growers, education and communication particularly with low-tech farmers, and closer monitoring of the entire process (from bean to bar). Direct sourcing often requires travel to the beans' origin, a practice that essentially came to an abrupt halt with international and domestic travel restrictions due to the COVID-19 pandemic, which effectively removed a major quality control and communication channel.

Specialty cacao production systems that support sustainable farming practices such as diverse agroforestry systems and growing traditionally fine flavor cacao varieties, which characteristically display lower yield and higher disease susceptibility, substantiate a higher cost of production (Bentley et al. 2004). Throughout the COVID-19 pandemic, demand for industrial chocolate remained stable, and a disruption in the demand for commodity cacao is not expected. Craft chocolate businesses, however, experienced significant losses in access to markets. Farmers growing specialty cacao may find the risks associated with foreseeable reduced demand for specialty cacao to be too high, leading to a transition into commodity cacao markets. Surveys have identified that, historically, farmers in Ecuador may be less willing to invest in specialty cacao production due to constraints along the marketing chain (Díaz-Montenegro et al. 2018), and may prefer to transition to high yielding, nonaromatic commodity cacao, grown in deforested full sun to maximize yields and short-term economic gain. Maintaining crops and implementing post-harvest practices for specialty cacao production requires labor force and capital that may not be feasible for many farmers, especially through challenges that arise due to the COVID-19 pandemic.

Additionally, the labor investment to produce craft chocolate is also much higher than that of industrial chocolate, due to craft chocolate makers operating on a much smaller scale, with diverse flavor batches and high attention to detail. Significant use of manual labor to perform tasks that would otherwise be automated in industrial chocolate systems also add to the total cost of production. As a perishable product, the substantial upfront investment in the labor force and capital for craft chocolate exposes the vulnerabilities of this industry in the immediate and long term.

2. Regional Politics

Commodity cacao used for industrial chocolate manufacturing is primarily sourced from Ghana and the Ivory Coast, with West Africa responsible for over 60% of global cacao production (Bymolt et al. 2018). However, specialty cacao used for craft chocolate production is primarily sourced from Ecuador, Venezuela, Peru, and the Dominican Republic. In addition to these regions differing in local challenges, culture, geography, and global perceptions within the craft chocolate market, the support systems in Central and South American countries are not united by such large and globally integrated cacao specific governmental oversight groups such as Ivory Coast's

Coffee and Cocoa Council (CCC) and the Ghana Cocoa Board (COCOBOD). Furthermore, previous experience in dealing with regional epidemics such as outbreaks caused by the Ebola Virus Disease may have prepared Western Africa's major cacao producing countries to better deal with the COVID-19 pandemic (figure 2), although the effects will become more visible and tangible over the next few months (World Bank 2020).

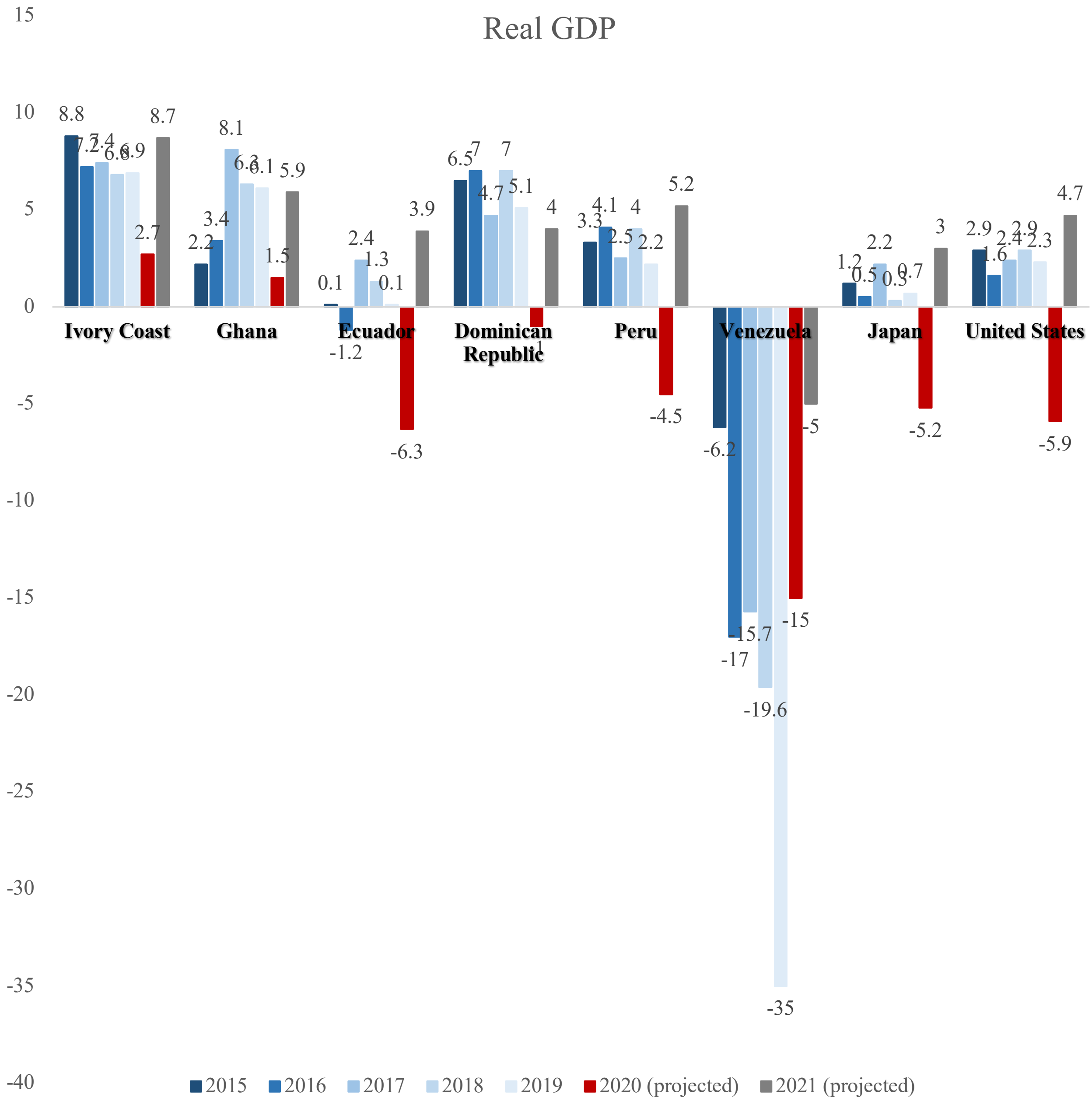

Figure 2. Historical and projected GDP for cacao producing countries (IMF 2020).

Logistics and distribution systems were already known to be difficult pre-pandemic, and government-mandated road closures and travel restrictions have intensified in many cacao-producing countries, with accessibility to affordable petrol intensified. Commodity cacao is typically sold through futures contracts with the involvement of distribution partners. With direct trade practices, specialty cacao buyers operating without an intermediary must navigate the challenges associated with changing distribution and export restrictions for each individual supplier. Additionally, Latin America is expected to experience significant food insecurity in the coming months (FAO 2020) further impacting the stability of these markets, and governments may continue to place additional restrictions on the movement of seasonal workers.

The COVID-19 pandemic reaching Latin America has taken a significant toll both in human and economic terms to include decelerated economic growth leading to a reduction in trade and an increase in poverty. By the end of September, the region had 28% of global cases and 34% of global deaths (Pienknagura et al 2020), and Latin American and Caribbean cacao exports dropped 16% since last year (FAO 2020). Brazil, Peru, and Ecuador report some of the highest COVID-19 rates of incidence and deaths in the region, and these countries also face synergistic threats from multiple infectious diseases. As a consequence, the regional effects of the pandemic plays a significant role in the long term impacts on the global specialty cacao industry as a whole, where local challenges, culture, geography, and global perceptions within the specialty cacao and craft chocolate industry will inevitably influence outcomes.

3. Risk Tolerance

Specialty cacao producers are already facing uncertainty for export sales in the short term, with buyers asking to renegotiate existing contracts, and in the long term, with buyers potentially going out of business or waiting to recoup costs before making additional purchases. Producers may also be expected to bear the risks of quality issues that may arise from delays during transportation. The higher standards for quality in craft chocolate production require considerably more diligence in maintaining control throughout the entire value chain, with some chocolate makers rejecting 94% of the beans sampled for craft chocolate production (Chuang, 2020). With the average imported volume of specialty cacao already much smaller than commodity cacao systems, shipments may need to wait longer with transportation restrictions and supply chain interruptions. Shipments awaiting travel to their final destination under poor storage conditions may prove to be yet another uncontrolled factor in specialty cacao quality, and it is not clear who will take on the responsibility for those potential losses.

The craft chocolate industry is made up of many small businesses that may not be equipped to rapidly transition to e-commerce strategies that allow for no-contact sales amidst the COVID-19 pandemic. Additionally, many craft chocolate businesses utilize Associative Sustainable Business Models (Gallo et al. 2018) and operate with narrow margins that cannot accommodate the substantial loss of revenue. Specialty cacao buyers often operate on private contracts that may be difficult to honor with decreased revenue from loss of craft chocolate sales. Loss of operations for these businesses would equate to a loss of buyers for farmers that may not be prepared to quickly find and negotiate new contracts with specialty cacao buyers.

4. Accessibility

The craft chocolate industry has historically been reliant on industry events such as craft chocolate festivals and markets to reach customers. This is in part due to the customer education component of craft chocolate sales, which often relies on marketing the cacao origins (farm, country, or cru), and demonstrating quality or value with samples or rapport. In addition, this industry is largely driven by consumer preferences for high quality food experiences and sustainable, ethical food sourcing, and industry events provide a platform to reach this niche audience. The reduction of inter and intranational travel and non-essential farm visits may also contribute to a slower return to business, and many of these farm visits function as an essential branding tool.

The specialty cacao industry also uniquely facilitates business opportunities for less accessible communities, such as indigenous tribes in the South American Amazon. Craft chocolate makers that source specialty cacao from indigenous communities may be impacted, unable to access raw materials, or face challenges in communication. Indigenous communities that produce specialty cacao have historically experienced disproportionate inequalities that may be exacerbated by the COVID-19 pandemic, including limited access to information, medical resources, and technology.

Craft chocolate makers that relied heavily on foot traffic to frequent their brick and mortar businesses saw a rapid decline in sales due to mandatory stay at home orders. Many craft chocolate makers were also benefiting from partnerships with hotels and airport shops, which saw a rapid decline in clientele due to reductions in tourism and travel. These small businesses are also poorly equipped to rapidly transition to online platforms and may find it difficult to reach customers in the short term.

6.2.4 Discission

Industry Strengths

The existing system of networks to maintain transparency of the supply chain and prices offered in commodity cocoa production is not adequate to address the ethical and sustainability issues that are well known throughout this industry (Thorlakson 2018). In contrast, specialty cacao buyers have done well to encourage transparency and accountability systems, including publishing annual sourcing reports and which describe on-farm production practices, highlight farmer profiles, and divulge prices paid to farmers for specialty cacao. Due to the nature of direct sourcing strategies, these personal relationships have facilitated communication channels, including on health messaging to farmers and through farmer networks such as grower cooperatives and allow for more flexibility when forming buying contracts.

Following in the footsteps of third-wave coffee industry members, who also offer a specialty product targeted to a quality-sensitive segment of consumers, the craft chocolate industry has the potential to launch initiatives that would better support the long-term success of specialty cacao producers, by taking on the burden of higher potential risks. With the uncertainty regarding whether or not buyers will follow through with existing contracts or seek future purchases, specialty cacao buyers capable of offering cacao producers more robust contracts that guarantee sales and allow for more flexibility in terms of quality to accommodate for issues that may occur along the supply chain may also want to consider that option.

Furthermore, programs that support online communication and sales opportunities for craft chocolate producers to generate online outreach mechanisms for craft chocolate businesses and for farmers to access to independent, unbiased, and objective farmer-driven information on price transparency, market averages, and quality grading systems are necessary. This kind of industry support is critical for long-term survival.

Craft chocolate makers impart a strong focus on craftsmanship, social responsibility, and transparency, which has highlighted the negative social and environmental impacts of chocolate production and propelled the industry to more urgently address these challenges. This includes improved price premiums offered to farmers for specialty cacao, resulting in an increased share of revenue for farmers (Daniels et al. 2012; ICCO 2019); product production that uses perceived higher quality and traditional ingredients that align with the values of consumers; and reporting that ensures that crops, sourcing, and methodology are more sustainable (Jewett 2017). Large industrial chocolate producers now face increasing pressure to issue various corporate sustainability efforts, as shown by Hershey, Mars, Ferrero and Cloetta, and Nestle USA committing to sourcing 100% of their cacao from certified sustainable suppliers by the year 2020 (Krauss 2017) as a result of changing consumer demands.

In an era where government support, public technical assistance, and financial resources are spread so thin, it is imperative that businesses continue to implement policies that support sustainability goals. The craft chocolate and specialty cacao industry openly claims to allocate resources that address critical issues within the industry such as deforestation, illegal and child labor, land degradation, and ethical farmer welfare, and as such, merits special support; if this nascent specialty sector can survive the pandemic, it can continue to model possibilities for ethical chocolate. Within the commodity cacao industry, cacao producer relief programs are often funded through grants and non-profits (WCO 2020), and an industry-wide rhetoric of mysterious and untraceable supply chains has further placed the onus of addressing the environmental and ethical concerns related to cacao production on the farmers and cacao producers (Major 2020). Placing the burden of systemic change and risk on the most vulnerable members of the supply chain slows progress toward a more equitable and ethical food system and mitigating global poverty. To alleviate the burden on all cacao industry members, those with resources must urgently make changes to address these issues through comprehensive traceability and key performance metrics, in addition to data reporting and incentives that drive change. Despite recent investments from commodity cacao buyers in facilities and infrastructure, such as sustainable production tactics and certification programs, more is needed to leverage power for farmers including better farmer representation in industry investments and larger organizations taking an active role in facilitating transitions into sustainable production systems. Changes that address bottlenecks contributing to these pressing industry issues must also be properly managed through system-wide policy that encourages accountability through both governmental and private.

Regional Epidemics

The world has not experienced a global pandemic in modern history that has disrupted trade on the same scale as the COVID-19 pandemic. Although there have been regional epidemics that have negatively impacted local trade with negative impacts on agricultural producers, comparing resulting disruption from regional epidemics is not adequate for illustrating the lasting negative impacts on local craft chocolate and specialty cacao industries.

Specialty cacao is primarily produced in the South and Central American countries Ecuador, Venezuela, Peru, and the Dominican Republic. Comparisons on the impacts of recent regional epidemics, such as the Ebola outbreak in Western Africa impacting commodity cacao production systems that function in completely distinct cultural, geographical, and political framework in addition to scale of production, are not applicable to specialty cacao production systems and the ongoing COVID-19 pandemic. It is also difficult to infer potential impacts from regional epidemics focused on South and Central America over the last decade, including zika outbreaks in 2015-2016 (WHO 2016), dengue in the early 2000s, 2016, and 2019 (Brathwaite Dick et al. 2012; Love et al. 2017), and chikungunya in 2016 (WHO 2020).

The region is not new to epidemics, however, and is in fact suffering concurrent outbreaks with COVID-19. For example, the ten countries currently most affected by dengue, in terms of new cases per 100,000 inhabitants, are Nicaragua, Brazil, Honduras, Belize, Colombia, El Salvador, Paraguay, Guatemala, Mexico, and Venezuela (PAHO 2019). The continuous dengue epidemic in Ecuador, also concurrent with the COVID-19 pandemic, has experienced a further increase in cases and has become one of the largest dengue outbreaks in the region. The coast and the city of Guayaquil, Ecuador, simultaneously present 82.57% of the confirmed cases of COVID-19 and the highest number of dengue cases (84%) in Ecuador (Navarro et al. 2020). In Ecuador, cacao is mainly grown in the Coastal plain and Amazonia regions throughout 21 provinces, widely concentrated in the Coastal region, including Guayas (Argüello et al. 2019).

These viruses, however, are not at the global pandemic scale that has disrupted global travel and trade like the 2020 COVID-19 pandemic. For example, in January 2016, the Unites States issued interim travel guidance for pregnant women "out of an abundance of caution" to consider postponing travel to areas with ongoing local transmission of the Zika Virus, or to take precautions against mosquito bites if they must travel (Kindhauser et al. 2016), much less restrictive than the international travel bans seen with the COVID-19 pandemic.

Additionally, the resurgence of dengue, chikungunya, zika, and yellow fever outbreaks can be influenced by weather and climate conditions facilitating mosquito breeding habitats; these ongoing diseases spread mainly through the bite of infected Aedes or Haemagogus species mosquito, which coincidentally can breed in discarded cocoa pods. For example, predictions of El Niño-Southern Oscillation (ENSO) could correctly forecast early peaks in dengue incidence in Ecuador, with a 90% chance of exceeding the mean dengue incidence for the previous 5 years (Lowe et al. 2017); and in Peru, outbreaks of dengue, chikungunya, and zika are similarly associated (Ramirez and Lee 2020).

In terms of epidemics by way of the plant kingdom, an example may be found in the form of a hemibiotrophic fungus. Originating in the lower Amazon basin, witches broom, or 'escoba de bruja' is a devastating pathogen with a taste for cacao. Its reach throughout cacao producing nations has been historically damaging for industries in South and Central America, as well as the Caribbean. The first strike of witches broom in Suriname shattered the cacao industry in the late 1890s, sweeping out 80% of cacao production from beneath their feet. One by one, the witches broom disease turned to sink her deadly claws into Guyana, then Colombia, Ecuador, Trinidad, Tobago, Peru, Grenada, Panama, and in significant devastation, Brazil, toppling cacao producing regions like dominoes.

As the industry began to crumble under the weight of this seemingly unstoppable obliteration, farmers could either abandon cacao, struggle to survive, or wait for a miracle. Out of the ambition to give breath to a drowning industry, 'CCN-51' was developed by an independent plant scientist in the form of a robust, highly productive, and most importantly, disease-resistant hybrid cacao tree. These specimens were deployed to replace less disease-hardy varieties, most documented in the fine cacao producing regions of Ecuador in the late 90s. Today, many commodity chocolate products contain at least a percentage of 'CCN-51', which alone accounts for 36% of production in Ecuador in recent years, forever changing the landscape of the specialty cacao industry. The industry was also forever changed in that cacao production in Guyana, Ecuador, Trinidad, Colombia, and Grenada were catastrophically affected with yield reductions of 50–90% (Meinhardt 2008).

Global Cacao

Currently, there is no evident shortage of cacao in the supply chain, however, it is uncertain whether specialty cacao buyers will honor pre-existing contracts or continue to patronize specialty cacao producers in the coming months. With nearly 80% of small chocolate businesses facing a significant or existential threat due to the impacts of the COVID-19 pandemic (FCCI, 2020), many buyers may not be in a position to continue operations after their existing inventory runs out.

The specialty cacao and craft chocolate industries are less researched and documented, and often rely on the commodity cacao industry to anticipate changes and impacts. The main cocoa crop for commodity cacao does not begin until October to November, therefore the effects are expected to become more apparent in the coming months, although some news reports have already described cocoa exports stalled over COVID-19 safety protocols (Awere, 2020). Additionally, negative income shocks have historically led to increases in child labor (ICI, 2020), instability in WMP is anticipated, and Ivory Coast cacao producers are already expected to experience a drop in income (CIRAD, 2020).

6.2.5 Conclusion

Specialty cacao producers face significant challenges and are often asked to shoulder the burden of production, maintenance of consistent quality, and reliance on buyers while wielding the least amount of leverage and resources. The global crisis highlights the need for investments in farmer relief, improved access to technology for business needs, and farmer empowerment for negotiations with buyers to mitigate risks. Farmers should be provided with tools to better share their story and brand their products to enhance accessibility. Often times, the need for advancing technological innovation is suggested to be a more urgent need for cacao production. However, like many other instances of advancements in the chocolate world, the craft chocolate industry will need to advance production technology in order to become more sustainable and better support farming communities. It is also well recognized that facilitating educational opportunities for women and young girls can significantly improve the resilience and access to markets for agricultural producers.

Lastly, the significance of postharvest production cannot be overlooked in terms of importance for the quality of specialty cacao, and strategies and quality expectations must be better communicated. However, access to markets must be in place as well as incentives for producers to come to the table and participate in the sustainable development of this industry.

The craft chocolate and specialty cacao industries are uniquely vulnerable to the immediate and long term impacts of the COVID-19 pandemic and can be explored through the following factors: labor intensity, regional politics, risk tolerance, and accessibility. Specialty cacao farmers and craft chocolate businesses need better support and resources to build online platforms for sales and to improve communication. Governmental support that aids farmers by instituting initiatives to encourage consumption or facilitating stimulus options for smallholder farmers may also be helpful to ensure the survival of the industry. Mutual empathy can help lead to a better collective understanding of the challenges that these industries face, and opportunities to support each other in the coming months and years.

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Chapter 7. General Discussion

This research identifies for the first time the distinctive characteristics of the craft chocolate industry that show prioritization of ethical chocolate to promote farmer welfare and environmental conservation. Participants build direct relationships with farmers and emphasize production practices that promote conservation and biodiversity building, while utilizing sourcing methods and geographies unique from their commodity cacao counterparts. These research findings are novel in that they specifically investigate the craft chocolate industry and provide a quantifiable review of specialty cacao quality assessment preferences, the distribution of origins from which chocolate makers currently source, and the focus on ethical priorities that can have multidimensional impacts to support future sustainable development for cacao-producing regions.

Specialty cacao buyers prefer to use an alternative model of direct trade to source higher quality ingredients, and primarily source ingredients from South and Central America, in direct contrast to commodity cacao systems. These results show that the craft chocolate industry is a markedly distinct entity within the chocolate world, with a targeted consumer base that demands a product that meets their unique values for high quality food experiences and supporting sustainable development.

Previous scientific research has investigated specific genetic and organoleptic differentiators to identify varieties and origins of fine flavor cacao. Additionally, cacao industry reports have discussed internal quality requirements from the perspective of the buyer. Through a novel investigation of both the scientific literature and industry reports, this research takes a comprehensive look at specialty cacao, reporting for the first time a systems level overview of the definitions and gaps, to clarify the defining pathways that are representative of the system, and discuss the quality determinations that would facilitate accessibility to the specialty cacao industry for producers.

Although buyers often practice individual assessments, limited to farming entities they contract, many farmers are not provided with the tools, education, and other resources to elevate their bargaining power. However, many specialty cacao buyers have done well to encourage transparency and accountability systems, including publishing annual sourcing reports and which describe on-farm production practices, highlight farmer profiles, and divulge prices paid to farmers for specialty cacao. This data was used to investigate the actual prices paid to farmers per kg of specialty cacao.

This research also showed for the first time that most of the reported specialty cacao purchases were from Ecuador, Venezuela, Peru, the Dominican Republic and other Latin American origins, rather than West Africa, Indonesia, or Brazil, where the overwhelming majority of global cacao is produced. Although craft chocolate makers and specialty cacao distributors primarily sourced from South and Central American countries, the relationships between improving farmer livelihoods and the production of specialty cacao in Ecuador described by previous research are still likely not applicable at a global scale. Local politics, culture, geography, climate, cost of production, and other factors certainly play a major role in shaping future industry developments. Research that specifically addresses the needs of local specialty cacao industries would support more effective industry development.

Additionally, global chocolate production is dominant in Europe and North America, although a growing domestic market in South and Central American origin countries has continued to develop in recent years. The strong focus on craftsmanship, social responsibility, and transparency by craft chocolate makers has highlighted the negative social and environmental impacts of global chocolate production and propelled the industry to more urgently address these challenges. Members of the bean to bar chocolate industry are also aware of approaches to sustainable agricultural development being applied in related industries. Innovative and outwardly focused, many craft chocolate makers are already looking to specialty coffee or viticulture to adopt techniques, better support farmers, and communicate quality expectations in their own production or supply chain.

However, specialty cacao producers are still often asked to shoulder the burden of production and maintaining consistent quality. Offering cacao producers more robust contracts that guarantee sales and allow for more flexibility in accommodating quality issues along the supply chain may mitigate the burden on farmers. Additionally, cacao farmers justifiably need access to reasonable access to independent, unbiased, and objective farmer-driven information on price transparency, market averages, and quality grading systems. with tools to better share their story and brand their products to enhance accessibility.

Investments to address technological innovation is often suggested to be a more urgent need for cacao production. However, like many other instances of advancements in the chocolate world, craft chocolate makers will need to improve production technologies in order to become more sustainable and better support farming communities. It is also well recognized that facilitating educational opportunities for women and young girls can significantly improve the resilience and access to markets for agricultural producers.

The significance of postharvest production also cannot be overlooked in terms of importance for the quality of specialty cacao, and strategies and quality expectations must be better communicated. Fine and specialty cacao industry working groups have also identified the need to better harmonize quality parameters, including specific conditions that occur during the cultivation and post-harvest stages of cacao production. The quality of the starting materials for use in the production of specialty cacao is paramount, and should be free of contaminants and disease, which cannot be removed during processing. Immature, overripe, damaged, and diseased pods are considered to be unfit for use in specialty cacao production, and previous research has not investigated these combined factors.

Pod storage is a common postharvest practice and describes the interval of aggregation time taking place after harvest but before breaking. Longer pod storage periods can encourage the proliferation of unwanted microorganisms from damaged and contaminated pods and contribute to the development of off-flavors and unwanted free fatty acids in cacao beans. Previous studies on the combined effects of pod storage and maturity have not been performed from the perspective of the specialty cacao industry, specifically considering the need for higher quality input materials. In light of specialty cacao industry developments and changing market demands, the principal studies regarding pod storage and maturity are quite dated and tangential, in addition to being fairly limited in respect to location, specifically to Malaysia and Ghana.

The delicate flavor notes desirable in fine, or specialty chocolate, are a major distinguishing characteristic from commodity cacao, and originate from the variations in postharvest processes. The growing specialty cacao industry prioritizes cacao that has been manufactured with diverse and fine flavor in mind. Higher standards for the processing methods and materials used in production is supported by a philosophy that all steps of chocolate production are performed with the intention of creating a premium product.

This research also revealed for the first time that the demographics of Japanese craft chocolate businesses are unique in that many small businesses make up the total market share, which is starkly different from the few industrial chocolate production companies commanding global market share since the late 1980s. Through specialized distribution channels that cater to a targeted consumer base, diverse business proprietorship, and distinct pricing strategies and quality requirements, this industry certainly employs organizational ambidexterity from an emerging market context.

In Japan, some craft chocolate makers also source cacao beans to contribute to better living conditions for farmers or address environmental impacts and challenges of social responsibility such as the lower share of revenue earned by farmers of the total marketed product. For example, one of the most prominent specialty cacao buyers and distributors in Japan, Tachibana Shoten, states that their commodity cacao purchases are above the market price at $10,000 per MT (suggestively $200 above the market price).

Despite the Mesoamerican roots of what we currently describe as chocolate, Japanese consumers often associate chocolate with western countries producing chocolate. The deterritorialization of cacao origins with portrayals of the processed product as of European origin have certainly contributed to consumer perceptions that fine chocolate products originated in Europe.

The bean to bar movement in part acknowledges the long production chain for cacao processing into finished chocolate, calling attention to the role of farmers in the production process, which has been poorly detailed throughout the industry, through souring reports and origin-based identification. Origin-based identification, however, may contribute to monetary benefit or detriment for producers when selling products based on origin demand. Often wielded as a branding tool, disproportionate advantages or disadvantages are allotted to particular origins, for example, in the case of West African cacao unfairly deemed of lesser quality simply based on regionality regardless of actual quality.

Craft chocolate makers often incorporate an educational component to engage with their customer base and find ways to reach new audiences. For example, Dandelion Chocolate in Japan has successfully reached craft chocolate consumers during the COVID-19 pandemic through virtual tasting events and wine pairings. Some of these outreach events have been facilitated by industry craft chocolate industry groups, enabling craft chocolate makers and specialty cacao producers to further their exposure. Such industry groups have been growing in recent years and may one day function as a vehicle to provide the resources necessary to address systemic inequalities on a meaningful scale. However, the industry must also urgently provide incentives for producers to come to the table and participate in the sustainable development of this industry.

Lastly, the fragility of the craft chocolate has been recognized by industry members for years and the effects of the global COVID-19 pandemic has further highlighted the need for investments in farmer relief, improved access to technology for business needs, and farmer empowerment for negotiations with buyers to mitigate risks. A significant number of craft chocolate businesses have been affected or expect to be affected at a level of “significant” or “existential threat” due to the global pandemic.

Changes that address bottlenecks contributing to these pressing industry issues must also be properly managed through system-wide policy that encourages accountability, both governmental and private. Additionally, programs that support online communication and sales opportunities for craft chocolate industry members have been successful in generating online outreach mechanisms for craft chocolate businesses. Online industry panel events featuring specialty cacao producers have also provided a platform for stakeholders to interact and share perspectives on the pandemic.

Craft chocolate makers impart a strong focus on craftsmanship, social responsibility, and transparency, facilitating a movement, supported by consumers who value sustainable development and high quality food production. In an era where government support, public technical assistance, and financial resources are spread so thin, it is imperative that businesses continue to implement policies that support sustainability goals. The craft chocolate and specialty cacao industry openly claims to allocate resources that address critical issues within the industry such as deforestation, illegal and child labor, land degradation, and ethical farmer welfare, and as such, merits special support; if this nascent specialty sector can survive the pandemic, it can continue to model possibilities for ethical chocolate.

Within the commodity cacao industry, cacao producer relief programs are often funded through grants and non-profits, and an industry-wide rhetoric of mysterious and untraceable supply chains has further placed the onus of addressing the environmental and ethical concerns related to cacao production on the farmers and cacao producers. This needs to change. The craft chocolate industry has the potential to launch initiatives that would better support the long-term success of specialty cacao producers, by taking on the burden of higher potential risks. Mutual empathy can help lead to a better collective understanding of the challenges that these industries face, and opportunities to support each other in the coming months and years.

Chapter 8. Conclusion

This research highlights craft chocolate and specialty cacao, a relatively unstudied industry, as a pioneering agricultural production system largely driven by consumer preferences for high quality food experiences and sustainable, ethical food sourcing. This research is the first to establish that fine flavor and specialty cacao beans are recognizable by the significant differentiators that allow specialty cacao and craft chocolate to support the sustainable development of cacao producing regions including quality, genetics, origin, certification and direct trade. Craft chocolate producers prioritize fine flavor notes, and product diversity, which can be quantified through these five pathways and promote business models that allow sourcing materials that contribute to better living conditions for farmers and addressing environmental impacts at the same time, as long as these initiatives remain a core value of the industry.

The majority of specialty cacao produced for craft chocolate is sourced from South and Central America (over 65%), in direct contrast to commodity cacao systems, which predominantly source from West Africa. The United States holds the most craft chocolate makers by country, and a significant portion of craft chocolate makers are based in the EU. The growing needs of consumers seeking more sustainable and socially responsible products have played an ancillary supporting role in supporting this industry. However, poor standardization, paired with the use of branding built through craft-chocolate quality and ethical principles liberally applied to non-craft chocolate products can weaken the identity of craft chocolate and the platform on which it stands. Through an industry wide survey, this research has identified for the first time the most important factors for chocolate makers when purchasing specialty cacao beans, including quality, ethical sourcing (focus on labor at origin), origin, and cultivation method (focus on the environment).

Additionally, craft chocolate makers agree that clearer standards and better industry organization is necessary to ensure that craft chocolate makers can continue developing a more exemplary and accountable supply chain. The higher expectations for cacao quality are also apparent and requires diligence throughout the entire production chain. Buyers may also value farmer and environmental welfare as well as developing transparent and direct trade networks is a big step towards more ethical sourcing for the chocolate industry as a whole.

The craft chocolate industry occupies a small and specialized niche within the global chocolate industry. In addition to catering to a specific subset of the consumer level fine chocolate base, these markets may provide cacao farmers with more sustainable resources than the traditional cacao marketplace. For example, the landed cost price for conventionally grown cacao offered by specialty cacao buyers from 2015-2018 were, on average, 140% higher than the world market price for commodity cacao, and 205% more than the ones of fair trade cacao, not inclusive of fair trade premiums. Additionally, the average farm gate price paid per kg of conventionally grown cacao by craft chocolate makers and specialty cacao buyers were, on average, 95% more than average producer price for West Africa, Brazil, and Ecuador markets between 2014 and 2019.

As the craft chocolate and specialty cacao industries expand in market share, benefits from improved standardization of terminology and more comprehensive parameters are expected. Advocating for craft chocolate makers and chocolate industry members to publish transparency or sourcing reports may encourage others to follow their lead and help to set a standard for more predictable pricing. The current practices for industry members include participating in direct trade acquisition strategies and offering significant price premiums. For example, in stark contrast to commodity cacao acquisition strategies, 38% of craft chocolate makers find and contract individual farmers for cacao acquisition. In addition, a majority of chocolate makers (60%) believe routinely used quality assessment techniques do not meet the needs of bean to bar chocolate makers or could use improvement. Industry members also agree on the need to establish a more inclusive quality assessment technique and prioritize farmer welfare. Unlike commodity cacao products, specialty cacao systems present substantial opportunity to refine identifiable differentiators that justify the premium pricing and educate buyers on value throughout the supply chain.

This research not only clarified the significant differentiators of the craft chocolate and specialty cacao industry, but also identified current practices for industry members that allow this industry to function as an excellent example of future food security approaches and international development. Farmers can achieve significant changes in quality through easily adopted postharvest practices and improved quality assessment protocols. For example, with storage and ripeness postharvest treatments. Previous research has been primarily dedicated to commodity cacao production systems, using different standards for quality that cannot be applied to specialty cacao production. This research found that postharvest treatments of pod storage and pod maturity significantly impacted pulp quality in early stages of cacao processing, with overripe and ripe pods more likely to show signs of disease than underripe pods overall. Pods displayed significantly more damage due to disease after four and five days of storage, whereas fresh pods and pods stored for one to two days showed the least.

Research limitations include gathering findings for a relatively under-researched industry, with access to a narrow scope of resources that primarily require in-depth participation with industry events and membership as well as being privy to the goings on of the constantly evolving industry. Due to the limited availability of industry transparency reports, the results may not be representative of industry members who choose not to publish transparency reports or participate in otherwise accessible business reporting practices. Additionally, farmer benefits due to direct trade agreements are not often certified through a third party and we rely on communications from specialty cacao buyers. Similarly, results reported in this research on Japanese craft industry and the global craft chocolate industry were limited to businesses with an online presence or accessibility to the greater craft chocolate marketplace.

In summary, the specialty cacao and craft chocolate industry demonstrates the potential to address ongoing industry concerns within sustainability science through the increased popularity of premium pricing and direct trade, to encourage sustainable production practices as long as the industry continues to prioritize sustainable development, including investments in social and environmental welfare, and particularly in regard to demanding gender, racial, and social equality across the board. This emerging industry has the potential to support the future of the chocolate industry as well as the sustainable development for cacao-producing regions through environmental, social, economic, and sensory excellence.

Ultimately, cacao farmers are agricultural entrepreneurs managing complex businesses that require reasonable access to independent, unbiased, and objective farmer-driven information on price transparency, market averages, and quality grading systems.

The results of this research can be used as a format to describe and align the industry for the international market to grow and flourish responsibly and superbly.

Appendix

Figure 1. Cacao growing in an agroforestry production system.

Figure 2. Cacao pods on the tree

Figure 3. Cacao fruit

Figure 4. Cacao seeds

Figure 5. Inspecting cacao in Ecuador.

Figure 6. Fermenting cacao in wooden boxes.

Figure 7. Assessing cacao quality in Vietnam.

Figure 8. Cacao farmers and producers.

Figure 9. Cacao farmer and producer.

Tasting Protocols

Today you will be tasting three origins of cacao, plus one calibration sample.
Please do not look at the description for the origins until after you have finished tasting.

There are many samples, so make sure you limit the sampling time to have maximum 10 min per treatment (per tab), otherwise it will take a very long time (three origins per treatment = 3 minutes per sample maximum).

Treatments:
Unroasted cacao nibs
Roasted cacao nibs
Unroasted and ground cacao nibs
Roasted and ground cacao nibs
Finished chocolate
(optional)Unroasted cacao nibs
(optional) Roasted cacao nibs
(optional) Unroasted and ground cacao nibs
(optional) Roasted and ground cacao nibs

If you decide you want to do the optional sampling, please do not throw away the treatments until the end, the optional sampling will be explained at that point.

For all samples, drink water before and after. Smell first, then taste.

You will need:
Oven, Grinder, and Scale
Vessels for samples (36 labeled bags provided)
Tins for roasting (7 labeled tins provided)
At least 4 glasses (wine glass is best, but anything between 200mL and 400mL is ok)
Cover for glasses (paper, foil, plastic is ok). Please do not forget to add the label.
Filtered water for drinking and rinsing.
Tasting Excel sheet (sent via email). Please save your excel sheet with your name in the file name as provided.
Cacao samples (36 labeled bags provided)
Chocolate samples (3 provided)

Step 1: Roast Samples
Roast Set 1 packs at 120 ºC for 15 min:

Step 2: Grind Samples
Grind each pack labeled with a '_G'. There will be unroasted (UR), and roasted (R) packs to grind. There should be 7 roasted samples, 6 unroasted samples, 7 ground roasted samples, and 6 ground unroasted samples, for a total of 36 labeled bags.

Step 3: Calibration
You will need
- The printed paper "Tasting Calibration" (provided)
- The tasting excel sheet
- 5 grams of the calibration pack labeled **R_CALI_G**

Put the sample into a glass cup for group to share, but do not discuss yet. Please make sure the cup stays covered and labeled. Smell, then taste. Rinse mouth with water before and after.

Part 1) Using the "Tasting Calibration" sheet
Everyone individually will score calibration sample (R_CALI_G) with values between 1-5
A score of 1 means there is nothing, 5 means overwhelming intensity.

Look at the Tasting Calibration document. Is there anything you would change? Any terms you would never use, or you don't see there that you use a lot?

Part 2) Using the Tasting Excel Sheet:
-Using the **"Taster" tab**, add your name, other information, notes if you feel like it
-Using the **"Calibration" tab**, input your individual score to the 'My Score' table (purple).

Part 3) After everyone is finished, calculate the average scores and discuss. Add average scores to 'Group Scores' table (green).

You can use the group calibration scores as a reference, for tasting the samples. This reference is available on each page as you move throughout the excel document tabs.

Step 4: Tasting
Each tasting sample should be 5 grams in the glass. I suggest keeping the samples in the labeled bags until they are ready for sampling, because otherwise it will require a lot of cups.

For each sample, input your individual scores to the tasting excel sheet within the appropriate column. Use the calibration as a reference for flavors, if helpful. Don't forget to rinse your mouth with water before and after each sample.

Part 1) **Unroasted Nibs Tasting 1 (UR)**
You will need:

- The tasting excel sheet tab **Tasting 1 (UR)**
- Calibration for use as a reference
- 5 grams from each pack labeled
    - CR_UR_
    - P_UR_
    - V_UR_

Part 2) **Roasted Nibs Tasting 2 (R)**
You will need

- The tasting excel sheet tab **Tasting 2 (R)**
- Calibration for use as a reference
- 5 grams from each pack labeled
    - CR_R_
    - P_R_
    - V_R_

Part 3) **Unroasted Ground Tasting 3 (GU)**
You will need

- The tasting excel sheet tab **Tasting 3 (GU)**
- Calibration for use as a reference
- 5 grams from each pack labeled
    - CR_UR_G
    - P_UR_G
    - V_UR_G

Part 4) **Roasted Ground Tasting 4 (GR)**
You will need

- The tasting excel sheet tab **Tasting 4 (GR)**
- Calibration for use as a reference
- 5 grams from each pack labeled
    - CR_R_G
    - P_R_G
    - V_R_G

Part 5) **Optional Wet Tasting** Skip to Chocolate tasting if no wet samples will be tasted.
You will need

- The tasting excel sheet tab **Wet Tasting**
- Calibration for use as a reference
- Hot water (90-96° C)
- 5 grams from each pack labeled in the WT Set

Add 10 mL of hot (90-95 ºC) water to each sample. Swirl in cup. Wait 3 min while keeping the cup covered.

Feel free to only sample 3 at a time to minimize the number of cups used.
Smell and add your scores. You can taste if you want, but it is not necessary if you don't want to.

You can add flavor descriptions that are not listed in "その他"

Part 6) Chocolate Tasting: **FINAL**
For each chocolate sample, input your individual scores to the tasting excel sheet within the appropriate column. Smell, then taste. Rinse mouth with water before and after each sample.

Complete tab 'FINAL' by tasting chocolate samples.

Thank you very much for your participation! Please email the completed excel sheet with your name saved in the title, as well as a photo of the ground cacao.
Now you can look at the descriptions of the origins that attached as "origin descriptors"

Additional Notes
Weight measurements are highly preferred for this protocol. Volumetric measurements are not repeatable, and may provide inconsistent results. If a scale is not available, please make note of sample particle size in the sample description sheet.

A burr grinder may be used to produce ground cacao sample. However, due to variability in potential particle size, a ceramic hand cranked sample grinder with capabilities to produce a grind size of at least 400-800 microns would be the most appropriate.

While a cacao guillotine is the preferred tool for cutting, a carefully used, sharp knife may be used instead. Pruning shears are not recommended for this protocol, due to damage to the structure of the dried bean:

Pruning shears may damage the side of the bean in contact with the blunt cutting edge, disrupting the integrity of the cut bean.

Expect a smooth, clean cut from a cacao guillotine, equally exposing both sides of the bean, while keeping the integrity intact.

テイスティング

はじめに:
今回は、3つの原産の違ったカカオ豆に加えて、もう一つカリブレーションのサンプルをテイスティングしていただきます。

カカオの原産の説明は、テイスティングが終わるまで見ないでください。

たくさんのサンプルをテイスティングしてもらいますので、それぞれのサンプルパッケージには最高でも10分ぐらいの時間制限をつけてください。（一つのパッケージは3つの原産がありますので、各テイスティングは最大3分ぐらいです）さもなければ、なかなか終わることができません。

サンプルのトリートメント（処理の違いによる区分け）は以下のようになっています。

生(ローストなし)のカカオニブ
ローストしたカカオニブ
生(ローストなし)で挽いたカカオニブ
ローストして挽いたカカオニブ
チョコレートにしたもの
【オプション】生のカカオニブ
【オプション】ローストしたカカオニブ
【オプション】生で挽いたカカオニブ
【オプション】ローストして挽いたカカオニブ

もし、オプションもテイスティングしたいと思われる場合は、すでに終わったものも最後までとっておいてください。後程、オプションのテイスティングも説明します。

テイスティングをするときは、必ず、その前と後に水を飲むか、水で口を注いでください。最初に香りを嗅ぎ、その後、味をみてください。

最初に準備・確認していただきたいもの：
オーブン、コーヒーミル（粉末にする器具）、計量器、サンプルを入れるグラスなどの容器（サンプル名を書いた26の袋はお送りします)
ローストにつかうアルミ容器（サンプル名を書いた7つのアルミ容器はお送りします)
最低4脚のグラスもしくはコップ（ワイングラスが理想的ですが、200ミリから400ミリはいる容器なら大丈夫です。また紙コップは匂いがつく可能性があるので、使わないで下さい)

グラス（またはコップなどの容器）を覆うカバー（紙、アルミフォイル、プラスチックでもOK）。サンプル名を付けることを忘れないように

飲料水
テイスティング用のエクセルシート（メールでお送りします）
エクセルシートは、あなたの名前をファイルネームに入れて、保存してください。
カカオのサンプル（サンプル名を書いた26のラベルをお送りします）
チョコレートのサンプル（3つお送りします）

ステップ1:ローストしたサンプル
次の各パッケージを120 ℃で15分、ローストしてください。

CR_R
P_R
V_R
R_CALI_G
CR_R_G
P_R_G
V_R_G

ステップ2：挽いた（粉状の）サンプル
"G“の付いたパッケージは粉状に挽いてください。生（ローストなし）URとローストRがあります。

CR_UR_G
P_UR_G
V_UR_G
R_CALI_G
CR_R_G
P_R_G
V_R_G

この時、挽いたカカオの写真を撮っておいてください。それによって挽いた目の細かさを確認することができます。

合計26の袋（パッケージ）となりますが、7つがローストするサンプル、6つが生のサンプル、7つが挽いたサンプル、そして6つが挽いた生のサンプルとなります。

ステップ3:カリブレーション
これに必要なものは以下の通りです。揃っているか確認してください。
カカオ豆のアロマを表にした“Tasting Calibration” (プリントをお送りします)
テイスティングのエクセルシート
R_CALI_Gと書かれているカリブレーション用パッケージ　–　各5ｇ

サンプルをグラス（またかコップなどの容器）に入れてください。この時、グループでまだ話し合わないで下さい。容器は必ずカバーで覆い、サンプル名が書かれていることを確認して下さい。まず、カリブレーションを最初に行います。ここから香りを嗅ぎ始め、テイスティングも始めてください。その前後は必ず口を濯いでください。

パート 1) “Tasting Calibration”の用紙を使って下さい。
各人でカリブレーションのサンプル
(R_CALI_G)を評価してください。その時、評価が 1 から 5 までありますが、1は何も感じない場合、5は最も強く感じる場合です。

Tasting
Calibrationの中で、あなたが加えたい表現(言葉)があれば書き込み、使わない表現(言葉)があれば、線をひいてクロスしてください。

パート 2) エクセルシートを使います。
-“Taster”のタブを開き、あなたの名前、その他の情報を入れてください。

-“Calibration”のタブを開き、各人のスコアを ‘My Score’
(紫色の欄)に入れてください。

パート 3)
グループ全員が終わったら、スコアの平均を出し、結果を話し合ってください。その後、平均スコアを ‘Group Scores’ (緑色の欄)に入れてください。

カリブレーションの中で、表現(表記)の追加、変更、削除などありましたら、その全てを“Notes”の欄(表の下にあります)に書き込んでください。日本語でも結構です。

サンプルのテイスティングでは、皆さんのグループのカリブレーション結果を参考に使ってもらっても結構です。

ステップ4: テイスティング

グラス(容器)に入っている各サンプルは必ず5gにしてください。サンプルのテイスティングが始まる直前まで、サンプル名のついた袋に入れておくことをお勧めします。さもなければ、たくさんの容器が必要になるからです。

エクセルシートを使って、各人の評価スコアをそれぞれのサンプルの欄に入れてください。その際、右側にあるカリブレーションを参考にしてください。各サンプルをテイスティングをするたびに、水で口を濯ぐことを忘れないでください。

パート 1)　生(ローストなし)のカカオニブUnroasted Nibs Tasting 1 (UR)
準備するもの
エクセルシートの Tasting 1 (UR)タブを開く
参考にするカリブレーションを使う
以下のラベルのついた各袋5 g づつ
CR_UR_
P_UR_
V_UR_

パート 2)　ローストしたカカオニブ Roasted Nibs Tasting 2 (R)
準備するもの
エクセルシートの Tasting 2 (R)タブを開く
参考にするカリブレーションを使う
以下のラベルのついた各袋5 g づつ
CR_R_
P_R_
V_R_

パート 3)　生(ローストなし)で粉状にしたカカオUnroasted Ground Tasting 3 (GU)
準備するもの
エクセルシートのTasting 3 (GU)タブを開く
参考にするカリブレーションを使う
以下のラベルのついた各袋5 g づつ
CR_UR_G
P_UR_G
V_UR_G

パート4)　ローストし粉状にしたカカオRoasted Ground Tasting 4 (GR)
準備するもの
エクセルシートのTasting 4 (GR)タブを開く
参考にするカリブレーションを使う
以下のラベルのついた各袋5 g づつ
CR_R_G
P_R_G
V_R_G

パート 5)　オプションのウエット・テイスティングOptional Wet Tasting
もし、行わない場合は、チョコレートのテイスティングに移ってください。

準備するもの
エクセルのWet Tastingタブを開く
参考にするカリブレーションを使う
(90-96° C) の熱いお湯

以下のラベルのついた各袋5ｇづつ
CR_UR_
P_UR_
V_UR_
CR_R_
P_R_
V_R_
CR_UR_G
P_UR_G
V_UR_G
CR_R_G
P_R_G
V_R_G
各サンプルに10 mL の熱湯を加えてください。
容器を揺らしてお湯が行きわたると、カバーをかけて3分間待ってください。

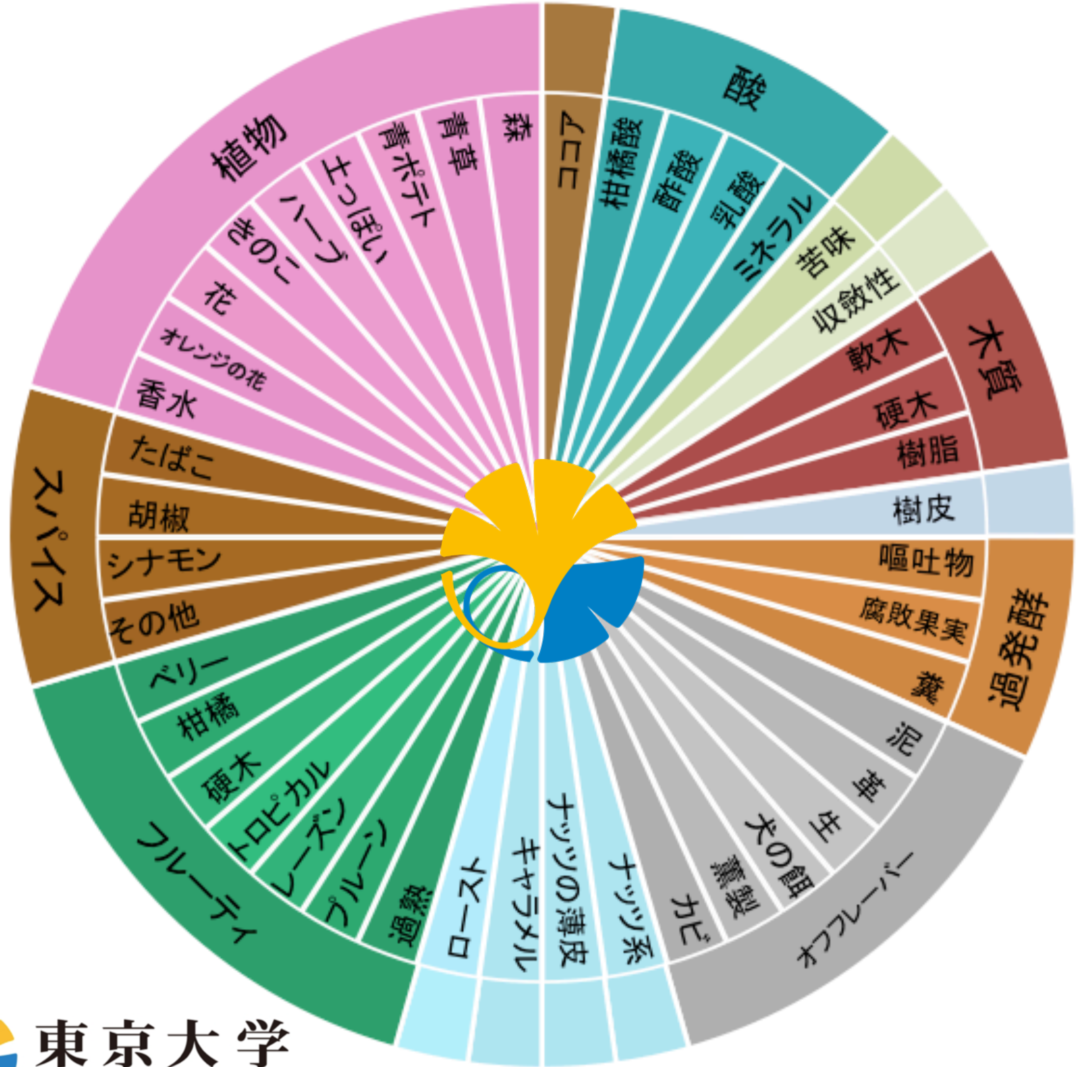
種類が多いので、サンプルを３つ一度に評価してもらっても結構です。

香りを嗅ぎ、スコアを付けて下さい。味わってもらっても結構ですが、その必要はありません。もし、記載にない表現（表記）がある場合は、エクセルシートの下にある “Note”の欄に書き込んでください。

パート6)　チョコテート・テイスティング FINAL
まず香りを嗅ぎ、その後味わってください。エクセルの‘FINAL’のタブを開き、各サンプルの欄にスコアを記入してください。テイスティングの前後には必ず、口を濯いでください。

どうも、ご協力ありがとうございました。終わりましたら、エクセルのファイルにあなたの名前で保存し、ジーナまでメールでお送りください。その際、粉状にしたカカオの写真も忘れないでください。
ここで最後に、お送りした原産の説明Sample Descriptionsのファイルを見ていただいても結構です。

サンプル テイスティング



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SAMPLE ID:

日付: 名前:

1は何も感じない場合、**5**は最も強く感じる

ココア	1	2	3	4	5
酸	1	2	3	4	5
苦味	1	2	3	4	5
収斂性	1	2	3	4	5
果実(新鮮)	1	2	3	4	5
果実(古い)	1	2	3	4	5
花	1	2	3	4	5
木質	1	2	3	4	5
スパイス	1	2	3	4	5
ナッツ	1	2	3	4	5
甘さ	1	2	3	4	5
ロースト	1	2	3	4	5
オフフレーバー	1	2	3	4	5
その他:___________	1	2	3	4	5
その他:___________	1	2	3	4	5
その他:___________	1	2	3	4	5
口当たり	1	2	3	4	5
後味	1	2	3	4	5

NOTES:

CACAO ASSESSMENT

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ORIGIN:	SAMPLE ID:		Detailed Sample Name
VARIETY:	PROCESED BY:		Total Weight:

PROCESSING	DATE	PROCESSED BY	EQUIPMENT USED		
ROAST				Temp:	Minutes:
STORAGE	-		BAGS/VESSEL/SHELTER	Notes:	Days:
DRY	-		EXPOSURE/MATERIAL/SHELTER	Turns:	Hrs:
FERMENT	-		MATERIAL/DIMENSIONS	Kg: Turns:	Hrs:
PRECONDITION	-		EXPOSURE/MATERIAL/SHELTER	Notes:	Hrs:
HARVEST	-			Notes:	Days:

SAMPLE DETAILS

MOISTURE: BEAN COUNT:

SAMPLE WEIGHT: AVG BEAN WT:

ROASTED COLOR: PARTICLE SIZE:

FI COUNT

FULLY BROWN:

PARTIALLY BROWN: OVER FERMENTED:

VIOLET: UNDER FERMENTED:

SLATY:

DEFECTS COUNT

MOLD:

INSECTS:

BROKEN:

FLAT:

NOTES:

SAMPLE DESCRIPTIONS

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Origin: Costa Rica	Sample ID:	CR-X	Farm Information: The Terciopelo farm is located near the border of Panama in the Coto Brus region of Southern Costa Rica. As one of the first Heirloom Cacao Preservation farms, pods are farmed on the steep slopes of a dense jungle landscape. You may find this origin among Manoa Chocolate bars in Hawaii or Goodnow Farms Chocolate in the United States.
Variety: PMCT51, CATIE R4, R6, Seedling mix, misc			
Origin: Philippines	Sample ID:	P-X	Farm Information: The Biao Farm is located in the Davao region of Mindanao Island, in the Philippines. This fully-grafted agroforestry system produces pods for the local cooperative BARBCO.
Variety: BR-25, UF-18			
Origin: Vietnam	Sample ID:	V-X	Farm Information: The Tien Giang fermentary is located in the Mekong Delta, in low ling areas, of Southern Vietnam. Pods are sourced from throughout the region, grown by small scale farmers among hand-dug canals. You may find this origin among Marou Chocolate bars, distributed around the world.
Variety: TD-4, 6, 11			

CALIBRATION SAMPLE:

Origin: Ecuador	Sample ID:	CALIBRATION	Farm Information: The Costas Esmeraldas farm is located in the Esmeraldas region of Ecuador. Great care is taken to harvest ripe, disease free pods throughout two long seasons. You may find this origin in among Dandelion Chocolate bars in Japan and the United States.
Variety: Ecuadorian Nacional hybrids: EET-95, EET-96, EET-103			

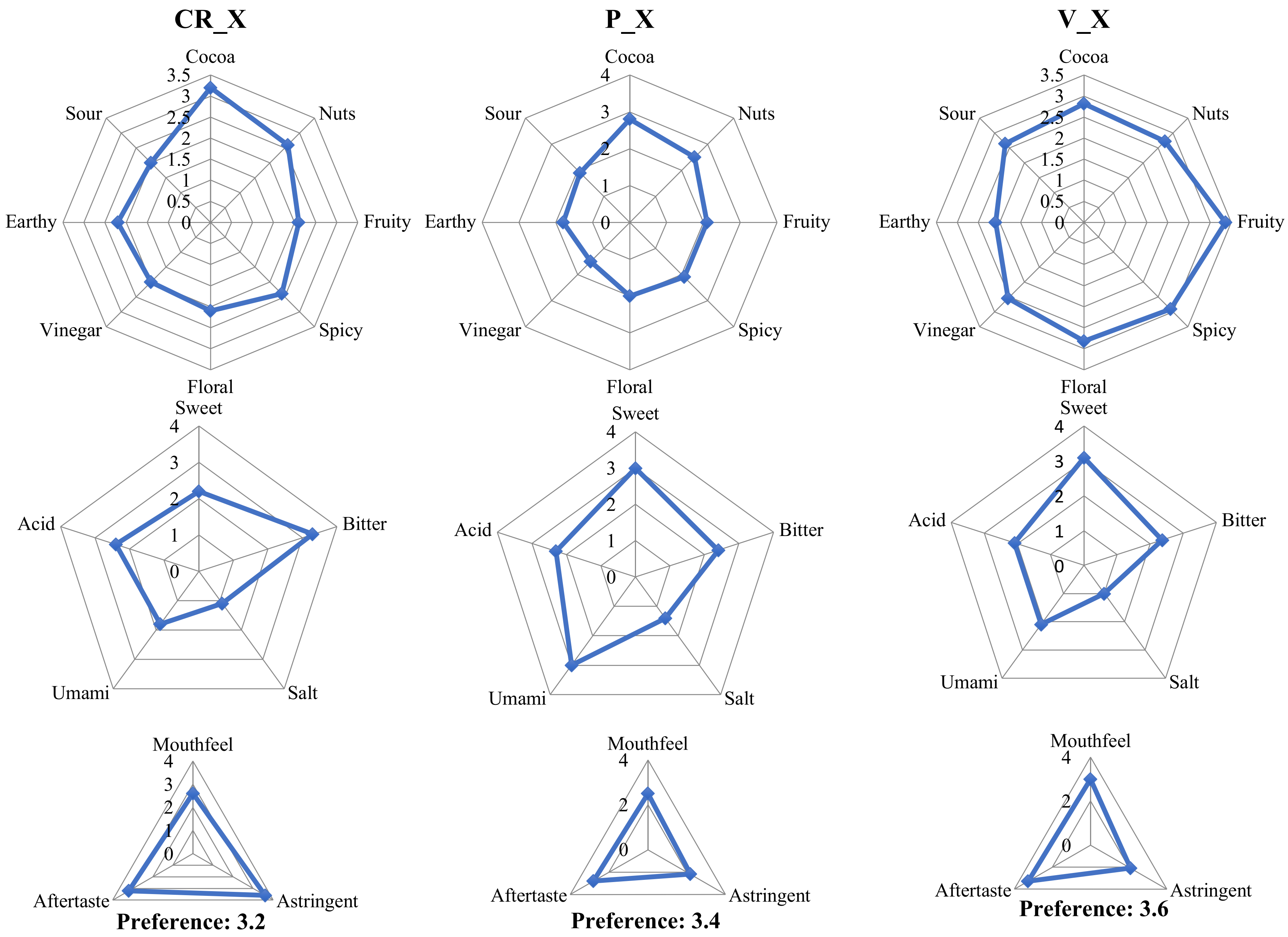
サンプルの説明

原産: コスタリカ Variety: PMCT51, CATIE R4, R6, Seedling mix, misc	サンプル ID: CR-X	農場について: テルチオペロ農場 Terciopelo farm はコスタリカ南部のコトブルス地域にあり、パナマの国境近くに位置しています。種を継承するエアルームのカカオ保存の最初の農場として知られ、カカオの木は深いジャングルの急な傾斜に植えられています。この原産のカカオは、ハワイのマノア・チョコレート・バーManoa Chocolate bars やアメリカ本国のグッドナウ・ファームズ Goodnow Farms が使っています。
原産: フィリピン Variety: BR-25, UF-18	サンプル ID: P-X	農場について: ビアオ農場 Biao Farm はフィリピン、ミンダナオ島のダバオ地域に位置しています。台木を使ったこの森林農業法により、地元のバルバコ BARBCO 農業組合にカカオ豆を提供しています。
原産: ベトナム Variety: TD-4, 6, 11	サンプル ID: V-X	農場について: テンジャン Tien Giang 発酵所はベトナム南部の低湿地、メコンデルタに位置しています。カカオ豆はこの地域の小規模農園から集められます。この原産のカカオは、世界中に流通しているマルー・チョコレート・バーMarou Chocolate bars でも使われています。

カリブレーション・サンプル:

原産: エクアドル Variety: Ecuadorian Nacional hybrids: EET-95, EET-96, EET-103	サンプル ID: CALIBRATION	農場について: コスタス・エスメラルダ農場 Costas Esmeraldas farm は、エクアドルのエスメラルダ地域に位置しています。2 回の長い生育期にわたって、 入念な手入れによって、完熟した病害フリーのカカオ豆が栽培されています。この原産のカカオ豆は、日本やアメリカで流通しているダンデリオン・チョコレート・バーDandelion Chocolate bars に使われています。

Finished Chocolate Tasting Results



(0-5)