Method of Technological Change: Experimental methods in coffee post-harvest processing

Timothy H. Heinze

Department of Agricultural Leadership, Education, and Communications

ALEC 640: Methods of Technological Change

Dr. Robert Strong

April 25, 2021

Method of Technological Change: Experimental methods in coffee post-harvest processing

For the average coffee consumer, enjoying a daily cup is often void of a thorough understanding of the complex supply chain for this global commodity. Roughly 12.5 million smallholder farmers produce 80% of the world's coffee yielding on average 600 kilograms per hectare; moreover, there are nearly 100,000 coffee farms yielding, on average, around 17 metric tons each accounting for the remaining 20% of global production (Browning, 2015). Coffee production is predominately positioned in equatorial regions of the Global South grown in over 60 different countries (Mighty, 2017). Many of these countries find themselves among the poorest and least developed in the world (International Coffee Organization, 2018). Five countries – Brazil, Vietnam, Colombia, Indonesia, and Ethiopia – are responsible for producing and exporting roughly 73% of the world's global supply of coffee (Mighty, 2017). Coffee is most often exported in its green, or raw, form requiring further processing in consumption countries including roasting, grinding, and brewing. While this might favor the preservation of freshness and quality, it significantly disadvantages producers from realizing the full value of their crop (International Coffee Organization, 2019). In reality, producing countries are only able to realize roughly 10% of the total value of the industry, which as of 2017 was estimated at around $200 billion (Samper et al., 2017). It is this loss of value capture that has been at the center of discussions concerning what threatens the viability of coffee production into the future.

As a global commodity, coffee prices are subject to the principles of supply and demand, the fluctuations in weather, pests, and diseases, as well as the economic impacts of oscillating currencies and financial markets. In fact, it has been noted as to the higher volatility of coffee pricing as compared to cocoa, tea, sugar, and other tropical commodities (Gilbert & Morgan, 2010). According to the International Coffee Organization (2019), coffee farmers are faced with

the reality that “at current price levels a significant proportion…struggle to break even” (p.2). This reality presents coffee producers as standing at a crossroads deciding between pursuing other crops or seeking innovations that make coffee farming financially sustainable. Though it is beyond the context of this paper to expound on the complexities of pricing in the coffee market, it is essential and foundational to the understanding of innovations within coffee post-harvest processing.

Since Norwegian coffee professional Erna Knutsen first coined the term “specialty coffee” in 1974, the industry has witnessed the expansion of a differentiated and value-driven sector that focuses on geographic regions and unique flavor profiles (Guimarães et al, 2016, as cited in Guimarães et al., 2020). This is not unique to coffee as globally industries have emerged fueling consumer preferences for unique flavors, new processing methods, originality, and the like (Specialty Food Association, 2017, as cited in Guimarães et al., 2020). Evidenced in the development of industry sectors like craft brewing, artisanal chocolates, specialty teas, and more, the changes in consumption patterns have created a different type of consumer with demands that break outside of traditional norms (Guimarães et al., 2020). For coffee, it is now estimated that this differentiated market segment – specialty coffee – represents 50% of the global value of coffee while only making up roughly 20% of global production (Rafael, 2020). With the current growth in consumption markets for countries like India, Indonesia, Vietnam, China, and more, consumption is estimated to continue growing at 2% annually (International Coffee Organization, 2019). The specialty coffee market is also expected to continue growing and capturing market share as well (Rafael, 2020). Therefore, coffee producers across the world are waking up to the opportunities afforded them through the production of higher quality coffees and selling into this differentiated market. However, accessing these differentiated markets finds producers balancing

not only the normal challenges faced with agricultural production such as climate change, biennial crop cycles, diseases, pests, and more, but also seeking to overcome the knowledge gap associated with producing these types of coffees. Further complicating this issue is the reality that understanding these elevated quality demands of a consuming market are quite literally a "world away." This paper specifically addresses the adoption of new and innovative processing methods to coffee post-harvest processing and attempts to shed light on the potential for widespread adoption of these practices globally.

Coffee Post-Harvest Processing

The term "coffee" can mean very different things depending on your position within the global coffee supply chain. For the consumer, it might represent the beverage providing one's daily caffeine intake and the needed jumpstart to one's morning. On the other hand, for the producer, coffee is the seed of a fruit grown on an evergreen tree producing harvests one to two times annually. Once harvested, the steps coffee takes from seed to cup can impact the final flavor. Upon harvesting, coffee fruit, in contrast to other grain products, has roughly a 65% moisture content that presents a challenge to producers who are concerned with defect development – like mold – that would lower the quality of the final product (Brando, 2004). Therefore, coffee post-harvest processing methods have traditionally been centered on the preparation of coffee for transport by lowering moisture content through drying to stable levels (Sanz-Uribe et al., 2017). The two main traditional methods to process the coffee fruit are: the natural (dry) method and the washed method.

The natural method is the oldest method and consists of harvesting coffee fruit and allowing it to dry to a 10-12% moisture content with the entire fruit intact (Brando, 2004). Depending on the temperature during drying, ripeness levels of coffee fruit, soil conditions,

health of the tree, weather conditions, and more the quality this method produces can vary widely (Borém et al., 2014). The washed processing method, sometimes referred to as fully washed or wet processing, became popular during the Industrial Revolution when all industries were experiencing innovations centered around efficiencies in manufacturing (Brando, 2004). In addition, the climate conditions of equatorial regions were such that drying coffee with fruit intact created higher risk of mold and fungus development (Borém et al., 2014). The washed processing method involves the actions of pulping the coffee fruit to expose the seed as well as the attached mesocarp, loosening of the mesocarp through fermentation, washing free all mesocarp, and then drying the coffee to a 10-12% moisture content (Borém et al., 2014). Similar to the natural method, the variations within this method and impacts to quality are vast.

While coffee post-harvest processing originally focused mainly on ensuring the coffee was stable for transport by drying thoroughly, recent decades have seen it evolve into a complex, chemistry-driven approach requiring skills and technical know-how to create various flavor profiles through these steps. Furthermore, producers who wish to access the higher price incentives of the specialty coffee market must be able to deliver differentiated, consistent, and high-quality coffee products that match this growing consumer demand (Specialty Coffee Association, 2019). In the last several years, a new trend has grown out of this push and drive for innovation. Referred to as “experimental processing methods,” this includes methods such as anaerobic processing, carbonic maceration, lactic fermentation, and yeast inoculation. These methods specifically focus on manipulating environments and conditions during fermentation to develop nuanced flavor profiles. Though admittedly there is not industry consensus on the definition or “recipe” for these methods, the consideration of their adoption and potential impact of the innovation are considered, nonetheless.

The Adoption of Experimental Processing Methods

The specialty coffee market presents an opportunity for producers to realize higher revenues by producing higher quality coffees. However, pursuing higher quality coffees as a means to financial sustainability is not as easy as it may seem. Producing higher quality coffees requires technical skills to control the post-harvest process as well as may incur higher costs of production. Over the last half century, this has found producers expanding on traditional processing methods to employing high levels of ingenuity to the post-harvest processing method pushing the boundaries of coffee quality potential. Further, it is evident that there is a growing demand for differentiated products by consumers, and through utilizing the innovation of experimental processing methods, producers can produce coffees to meet this demand. Framed within the principles described by Rogers (2003), this author endeavored to identify the innovators of this innovation, the characteristics of those who have adopted, and the future of this innovation.

In March of 2021, this author presented a Google Form survey to coffee industry professionals as an investigation into this innovation. 15 survey responses were received and 3 follow up interviews were performed after analyzing the results. The following represents a summary of these findings as well as this author's personal experience with this innovation.

The Innovators and Their Characteristics

The innovators are defined as the first 2.5% within a social system to adopt an innovation, and they typically are venturesome, possess higher financial resources, and can shoulder the risk of innovations failing more so than others (Rogers, 2003). Within the context of experimental processing methods, effectively evaluating this percent proved difficult as there is limited information as to the total amount of producers focusing on producing specialty coffee let alone

those exclusively engaged in this specific innovation. However, from this researcher's survey, there were five producers identified by multiple respondents as those who were first to adopt this innovation: Aida Battle, La Palma y El Tucan, Granja La Esperanza, NinetyPlus, and Daterra Coffee Farm. In total, 14 different producers were identified as adopters of this innovation. From personal experience, this author is aware of significantly more producers that have adopted this innovation; therefore, it was not appropriate to consider the total number of adopters globally as what was presented in the survey, but they could be considered the innovators. However, reflecting on the results from the survey combined with personal experience, this author would identify the current stage of adoption for this innovation as nestled within the early adopter stage (Rogers, 2003). Certain individuals who have adopted this innovation are integrated, respected, and role models within their respective social systems; furthermore, several of them have a high degree of opinion leadership within those networks solidifying their identity as early adopters (Rogers, 2003).

Those identified through the survey as innovators clearly reflect Rogers' (2003) characteristic traits of this adopter category. These individuals have substantial financial capacity, are connected to international and diverse communication networks, are more apt to handle the risk of failure, and possess higher education levels (G. Hernandez, personal communication April 9, 2021). For example, Daterra Coffee Farm, an innovator identified in the survey, articulated that their first experimentation at their farm in Brazil with carbonic maceration began via an introduction from a coffee roaster in France (G. Moreira, personal communication, April 13, 2021). This specific roaster shared with them this technique prevalent in the wine industry as a potential experiment to be used with coffee. In addition, Daterra Coffee Farm produces roughly 4.8 million kilograms of coffee annually which allows them to shoulder the risk of failed

innovations. In this author's interview with Gabriel Moreira of Daterra, he adamantly acknowledged this being a significant advantage they have with experimentation as well as a crucial barrier for smallholders with these innovations. Likewise, Coffea Diversa founder Gonzalo Hernandez, who was identified as an innovator by a respondent to the survey, shared these sentiments as well (G. Hernandez, personal communication, April 9, 2021).

Gonzalo Hernandez comes from a coffee family in Costa Rice. He began as a coffee trader and now owns one of the largest private collections of coffee varieties in the world with over 800 different specimens. It is evident that his adoption of experimental processing methods was born from an innovative spirit as well as congruent with the profile of an innovator outlined by Rogers (2003). As a well-educated and well-traveled individual, Hernandez described innovation in processing methods as necessary to meet a market that is demanding differentiation but also articulated this as a risk for coffee producers. The flavor profiles of experimental processing fall outside of the typical quality specifications for the commodity coffee market. While this is in fact the allure from the consumer side, this alone presents risk that if a producer is unable to find a market for their coffee or if the results fall short of their target, they might very well be left with a coffee the commodity market would label as defective. Hernandez is able to shoulder this risk as he produces roughly 18,000 kilograms of coffee per year, has a thriving coffee tourism business, and has launched coffee plantations in Guatemala and Jamaica as well.

In agreement with Rogers (2003), the innovators and early adopters of the experimental processing method innovation have a unique set of characteristic traits as outlined above which facilitates adoption. However, coffee producers are facing low prices and the inability to break even through transacting in the commodity coffee market (International Coffee Organization, 2019). If in fact the specialty coffee market provides higher revenue opportunities and adopting

experimental processing methods is a means of access into this market, then why has adoption of this innovation not become widespread, and what are the barriers to its adoption?

The Path Forward

Rogers (2003) identified five different hurdles to the adoption of innovations: relative advantage, compatibility, complexity, trialability, and observability. If experimental processing methods are going to reach critical mass adoption, much work is still to be done to remove the hurdles of its adoption.

To begin, the complexity of these processing methods goes well beyond the standard, traditional processing methods. More often than not, the techniques utilized in a region are based on historical traditions or knowledge that is passed down. Though early adopters can serve as opinion leaders of an innovation (Rogers, 2003), there is a level of technical skill and know-how that is required to execute and deploy experimental processing method techniques. Unless a producer is able to spend time experimenting, they would be hesitant to utilize these methods without a guarantee end buyer or promise of certain results. It should be noted here that observability of an innovation is positively correlated to its adoption (Rogers, 2003). However, isolation of producers as well as the hesitancy to share "trade secrets" makes this barrier to adoption difficult to overcome. This creates a space and need for change agents who can provide education to producers to overcome the complexity gap. Furthermore, those producers who are in need of support the most, often find themselves isolated, disconnected from mass media communication channels, and skeptical of new innovations (Rogers, 2003). This author would recommend the strategy to target early adopters and early majority with educational opportunities by charging a change agency with creating these extension modules. Sucafina, a global coffee trading company based in Geneva, Switzerland, has done just this with the

commissioning of “TheCenter.” This is an online learning community focused on providing relevant, accessible, and high-quality educational content, such as experimental processing methods, to the global coffee industry. This author is the manager of this program charged with its creation and expansion. TheCenter is seeking to bridge the complexity gap through knowledge and information.

Furthermore, complexity is not the only barrier. The relative advantage of an innovation is understood as “the degree to which an innovation is perceived as better than the idea it supersedes” (Rogers, 2003, p. 15). For coffee producers, the reality facing them is that their livelihood and that of their family’s is tied to their ability to market and sell what they produce. A coffee producer that currently sells their products to a lower priced or lower value market though shackled by low prices still ultimately rests in knowing they have a buyer for their product. If they are going to adopt a new method to processing, the risk of failure and guarantee of an end buyer has to be understood with a high degree of certainty establishing a relative advantage over previous methods. Without this, one cannot possibly expect widespread adoption of this innovation. One solution this author has experienced involves coffee roasting companies bridging this gap by financing the risk producers incur. For example, Proud Mary, a coffee roasting company with operations in Australia and the United States, approached a producer in Papua New Guinea with the idea of producing several lots of experimentally processed coffee. They provided the protocol for an anaerobic fermentation coffee and guaranteed to buy the product at an agreed upon rate before the coffee was even harvested from the tree. They provided a limitation on the volume, which allowed them to contextualize this risk within the scope of their total annual volume; however, it served as an increase to the relative advantage perceived by the producer and subsequent motivation to adopt.

With the adoption of any innovation, consequences exist (Rogers, 2003). Analyzing and anticipating these consequences are essential. In considering the adoption of the experimental processing method innovation, this author is convinced that the negative, indirect consequences require one to exercise extreme caution. While there is evidence of the direct consequences coffee producers realize through higher revenues, this also must be understood within the context of the capacity of the specialty coffee industry. Christopher Feran, one of the founding owners of Phoenix Coffee Roasters in Ohio, articulated his concern that these experimental processing methods are a fad, and if widespread adoption occurred, the initial windfall profits achieved by innovators would not be realized across the board (C. Feran, personal communication, April 27, 2021). Ultimately, a market that represents 20% of the global coffee industry would be unable to support widespread adoption and might not allow for producers to obtain higher prices for these types of coffees.

Conclusion

Though coming from a consuming country, this author often finds himself championing for the plight of the coffee farmer striving for a sustainable coffee supply chain. Since the establishment of the specialty coffee industry, professionals across the globe often articulate the opportunity that producers have to produce higher quality coffees and access this market. The innovation of experimental processing methods evolved as an extension of this direction. However, it is not that simple. The increased costs associated with these methods, lack of technical know-how, inability to finance the risk, and disconnect from markets demanding these types of products leave many coffee producers with the inability to adopt this innovation. Through conversations with coffee producers across the world and the survey performed for this paper, it is evident that the widespread adoption of the experimental processing method

innovation not only faces significant barriers but also might possibly be a poor decision for many coffee farmers across the world. Education regarding the technical skills required, providing connection to roasters who are willing to finance the risk, and linking producers to market opportunities are some of the solutions to obtaining wider spread adoption. On the other hand, producers should fully contemplate the volume limitation of the specialty coffee industry before adopting the experiment processing method innovation.

The price struggles facing global coffee farmers are real. Coupled with changing climates, shifting demands, and the push for differentiated products producers are in need of innovations to support them in maintaining their livelihoods. While this author thoroughly enjoys drinking unique and nuanced coffees, the lack of widespread adoption of the experimental processing method innovation alone should serve as one piece of evidence as to its inability to be a global solution. There is no one solution to this global issue, and it is going to require voices from across the supply chain – from farm to cup – to provide solutions that find a world where coffee producers thrive and livelihoods improve.

References

Borém, F. M., Isquierdo, E. P., & Taveira, J. H. D. S. (2014). Coffee processing. In F. M. Borém (Ed.), *Handbook of coffee post-harvest technology: A comprehensive guide to the processing, drying, and storage of coffee* (1st ed., pp. 51-67). Gin Press.

Brando, C. H. J. (2004). Harvesting and green coffee processing. In J. Wintgens (Ed.), *Coffee: Growing, processing, sustainable production* (1st ed., pp. 604-730). WILEY-VCH.

Browning, D. (2018, September 19). *How many coffee farms are there in the world? Take 2* [Conference session]. 2018 Association for Science and Information on Coffee, Portland, Oregon, United States.

Gilbert, C. L., & Morgan, C. W. (2010). Food price volatility. *Philosophical Transactions of the Royal Society B: Biological Sciences, 365*(1554), 3023-3034. https://doi.org/10.1098/rstb.2010.0139

Guimarães, E. R., Leme, P. H. M. V., De Rezende, D. C., Pereira, S. P., & Dos Santos, A. C. (2019). The brand new Brazilian specialty coffee market. *Journal of Food Products Marketing, 25*(1), 49-71. https://doi.org/10.1080/10454446.2018.1478757

Guimarães, E. R., Dos Santos, A. C., Leme, P. H. M. V., & Azevedo, A. D. S. (2020). Direct trade in the specialty coffee market: Contributions, limitations and new lines of research. *Internext, 15*(3), 34-62. http://dx.doi.org/10.18568/internext.v15i3.588

International Coffee Organization. (2018). *Development of coffee trade flows* (ICC 121-4). http://www.ico.org/documents/cy2017-18/icc-121-4e-trade-flows.pdf

International Coffee Organization. (2019). *Achieving the Sustainable Development Goals in the coffee sector: Solutions to improve farmers' livelihoods and foster a sustainable coffee*

value chain (ED 2303/19). http://www.ico.org/documents/cy2018-19/ed-2303e-background-paper-ico-ecf-symposium.pdf

Mighty, M. A. (2017). "We Likkle, but We Tallawah": Maintaining competitive advantage in the crowded specialty coffee market. *Journal of International Food & Agribusiness Marketing, 29*(1), 70-91. https://doi.org/10.1080/08974438.2016.1266566

Rafael, V. E. (2020). *A business case to increase specialty coffee consumption in producing countries.* Specialty Coffee Association. https://static1.squarespace.com/static/584f6bbef5e23149e5522201/t/5f22985fd634f84394b826ea/1596102763860/A+Business+Case+to+Increase+Consumption+-+English+-+July+2020.pdf

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). The Free Press.

Samper, L. F., Giovannucci, D., & Vieira, L. M. (2017). *The powerful role of intangibles in the coffee value chain* (Economic Research Working Paper No. 39). World Intellectual Property Organization. http://www.wipo.int/edocs/pubdocs/en/wipo_pub_econstat_wp_39.pdf

Sanz-Uribe, J. R., Yusianto, Menon, S. N., Peñuela, A., Oliveros, C., Husson, J., Brando, C., & Rodriguez, A. (2017). Postharvest processing: Revealing the green bean. In B. Folmer (Ed.) *The craft and science of coffee* (1st ed., pp. 51-80). Academic Press.

Specialty Coffee Association (2019). *Price crisis response initiative: Summary of work*. https://static1.squarespace.com/static/584f6bbef5e23149e5522201/t/5ebd4d5f1e9467498632e0b8/1589464434242/AW_SCA_PCR_Report2020+-+December+2019+-+Update+May+2020.pdf