Bridging Demand and Supply of Specialty Crop Diversification:

Exploring Market Potential of Finger Limes

Andres Bejarano Loor
Master Student
Department of Food and Resource Economics
University of Florida
abejaranoloor@ufl.edu

Dr. Lijun Angelia Chen
Assistant Professor
Department of Food and Resource Economics
University of Florida
lijunchen@ufl.edu

Dr Suzanne Thornsbury
Professor
Department of Food and Resource Economics
University of Florida
thornsbs@ufl.edu

Dr. Manjul Dutt
Assistant Professor
Department of Horticultural Sciences
University of Florida
manjul@ufl.edu

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Abstract:

Increasing consumer demand for variety in food products and grower interest in high-value alternative crops are fueling the development of novel specialty crops that may have strong market potential. The University of Florida has focused on developing new opportunities for citrus, including finger limes (*Citrus australasica*), recently releasing two cultivars with tolerance to Huanglongbing (HLB or citrus greening disease). However, the potential markets and supply chain relationships for Florida finger limes remain unexplored.

This case study investigates how demand and supply factors must align to support the successful commercialization of a new product. An integrated theoretical framework is applied to analyze the economic system for finger limes, including stakeholder decision-making, motivation, and information exchange. Results highlight key drivers and constraints and illustrate an approach to assess emerging specialty crops with market uncertainty and limited data.

Designed for capstone undergraduate and master's students in agricultural economics and agribusiness, this case supports applied learning in market analysis, supply chain development, risk assessment, and stakeholder engagement. For more advanced students, a quantitative method appropriate for limited data is identified. The accompanying teaching notes equip students with practical skills to evaluate market opportunities for emerging products.

Keywords

diffusion of innovation, economic systems, finger limes, fuzzy TOPSIS, specialty crops, supply chain

JEL Codes: A22; D81; O33; Q13

1. Introduction

Designed for capstone undergraduate and master's students in agricultural economics and agribusiness, this case study supports applied learning in market analysis, supply chain development, innovation adoption, risk assessment, and stakeholder engagement. By working through a real-world example of Florida finger limes, students will gain experience in assessing market potential, with a focus on understanding stakeholder motivations and decision-making beyond traditional price and yield considerations. Students are encouraged to think about commercialization strategies, including the importance of communication channels, policy environments, and supply chain coordination. They are equipped with tools to evaluate market-building opportunities, identify adoption barriers, and consider risk and uncertainty as critical factors in agribusiness decision-making.

Emerging specialty crops provide an opportunity to diversify and reshape food systems for both consumers and producers. Consumers are interested in new foods and are more willing to try new products or pay for new flavors (Barcellos et al. 2009). Novel, visually striking food products are of particular interest in the specialty food and experiential dining segments. Individuals switch among products, categories, or brands to avoid decreasing utility caused by repeated purchases of the same item or product (Ratner et al. 1999; Zhang 2022). U.S. specialty food and beverage sales reached $194 billion in 2022 and were projected to climb to $207 billion by the end of 2023 (Specialty Food Association 2023). This expansion suggests a promising market environment for differentiated specialty crops that offer culinary novelty and premium appeal.

As growers seek to capitalize on emerging market trends and respond to shifting consumer preferences, this demand is increasingly reflected in the supply side. Growers are motivated by higher margins, less competition, and direct-to-market opportunities that are related to specialty crop production (Kim 2016). Alternative crops can provide solutions to the production challenges faced by conventional crops (Blare et al. 2022). Growers, especially those operating on a smaller scale, are increasingly

motivated to diversify into niche crops that provide stable returns, disease resilience, and access to emerging markets.

This case study investigates how demand and supply factors influence market opportunities for an emerging specialty crop being developed in Florida. Florida's citrus industry, once a global leader in orange juice and fresh citrus production, has been severely impacted by Huanglongbing (HLB), commonly known as citrus greening disease (Grafton-Cardwell 2022). The disease has led to declining yields, rising production costs, degraded fruit quality, and a shrinking number of commercially viable groves (Trejo-Pech, Spreen, and Zansler 2018). Between 2004 and 2024, Florida's citrus acreage declined from 748,555 to 274,705 acres (Hudson 2025), and orange production decreased 92 percent between 2003/04 and 2023/2024 (Simnitt 2023).

Growers have been looking into alternative crops as a response to recent challenges with citrus production. Non-citrus alternatives, such as blueberries, olives, and peaches, have been considered, some of them with very high initial investments (Trejo-Pech, Spreen, and Zansler 2018). One citrus alternative that has been gaining interest is the finger lime (*Citrus australasica*), a specialty citrus fruit native to Australia and recently introduced to Florida through two cultivars developed by the University of Florida: UF SunLime and UF RedLime (Dutt 2022a; 2022b). In addition to HLB tolerance, finger limes are characterized by their distinctive juice vesicles, which are small, pearl-like juice pulps known as "citrus caviar" that provide a unique culinary texture and visual appeal (Dutt, Evans, and Singh 2019; Faber 2021). They could potentially cater to premium markets where innovation, flavor diversity, and presentation matter. (Emerging Industries 2023).

At the same time, developing sustainable markets for novel foods has proven risky. Previous crops such as açai, chia, and quinoa show how initial enthusiasm can lead to market booms followed by price crashes, supply issues, and eventual decline when demand stabilizes or shifts (Blare, Corrales, and Zambrino 2020). To establish a sustainable finger lime industry, it is essential to proactively align supply

with demand, as well as long-term investment in supply chain development, institutional support, and targeted marketing.

While several stakeholder groups have expressed interest in the emerging Florida finger lime industry, there is limited knowledge about the market potential and supply chain dynamics. Preliminary industry articles show that growers face uncertainties regarding market size, buyer access, production risks, and postharvest handling practices (Neff 2024). Challenges include unestablished marketing channels, regulatory barriers to interstate citrus shipping, and a lack of production and demand data. These issues are common in the early commercialization of alternative specialty crops, where limited information is a serious barrier (FDACS 2024; Fletcher 2002; Poling 1999).

This case study illustrates how economic frameworks can guide market entry analysis under conditions of uncertainty and limited data. Using Florida finger limes as a real-world example, we highlight how stakeholder motivations, information exchange, supply chain dynamics, and policy environments shape commercialization outcomes for niche crops. We introduce an integrated theoretical framework that draws on economic systems theory, diffusion of innovation, and supply chain mapping approaches to analyze commercialization pathways. Results inform strategic, actionable insights and an industry outlook for developing a sustainable finger lime sector. Instructors can adapt the case to stimulate discussions on emerging markets, innovation diffusion, risk assessment, and interdisciplinary approaches to agribusiness problem-solving.

2. Integrated Theoretical Framework

To support real-world decision-making in the development of a viable new agricultural industry or commodity, the analyst must consider the intersection of production and markets. Each framework highlights a different but complementary aspect of the challenges and opportunities facing this emerging specialty crop. Integration of the Economic Systems, Diffusion of Innovation, and Supply Chain mapping frameworks provides a comprehensive understanding of the opportunities and challenges facing finger lime commercialization in Florida.

Integrating the economic systems, diffusion of innovation, and supply chain mapping frameworks provides a holistic lens for analyzing the commercialization of finger limes. The economic systems perspective clarifies how stakeholder motivations, decision-making authority, and information flows shape both production and market development. Diffusion of innovation theory helps explain the pace and pattern of adoption and identify the roles of early adopters and the barriers to broader acceptance. Supply chain mapping connects these insights by visualizing how products and information flow—or fail to flow—between actors (stakeholders), revealing critical bottlenecks and gaps in the value chain. Together, these frameworks enable a comprehensive understanding of the institutional, behavioral, and logistical factors influencing finger lime market entry and growth.

2.1 Economic Systems

An economic system encompasses the institutions, norms, and mechanisms that structure the production, allocation, and consumption of goods and services within a society (Black, Hashimzade, and Miles 2009). Every economic system must resolve four fundamental tasks: what to produce, how to produce, who gets the product, and how to provide for the future (Gregory and Stuart 2013, p. 159). Neuberger and Duffy (1976) and Conn (1997) were the first to articulate three fundamental structures inherent in all economic systems: motivation, decision-making, and information. Enderle (2017, p. 70) discussed varying perspectives of economic systems and provided updated definitions and interpretations of the three structures. The motivation structure encompasses the objectives, incentives, and enforcement mechanisms that guide and sustain economic behavior within the system. The decision-making structure refers to how authority and responsibility for economic choices are distributed among actors, whether individuals, firms, or organizations. The information structure describes the processes and channels through which data and knowledge relevant to economic decisions are gathered, communicated, processed, and utilized.

Davis and Serrano (2016) applied the notion of economic system to examine food systems, emphasizing the diverse roles and interactions of stakeholders from producers to consumers. They highlighted that

each participant or stakeholder navigates distinct institutional rules, market environments, and policy landscapes, which, in turn, shape their actions and outcomes. In a recent study, Gurung et al. (2024) analyzed the three structures in an emerging food system characterized by legalized sales of meals prepared in private residences. Their analysis demonstrates how regulatory changes can redistribute decision-making authority, shifting who gets to participate and under what conditions; how changing consumer values and preferences reshape the motivation landscape; and how digital platforms (e.g., social media) transform the format and accessibility of information. These findings illustrate the adaptability of economic system structures in response to evolving social, economic, and policy contexts.

Applying the economic systems perspective to the finger lime industry provides an overarching framework for understanding market development and supply chain dynamics. As a novel specialty crop, finger limes contend with fragmented information, uncertainties in decision-making, and evolving incentives shaped by production, market, and regulatory forces altogether. Analyzing how information is shared, authority is distributed, and motivations are formed helps identify bottlenecks and opportunities for intervention, clarifying commercialization challenges and informing strategies for successful integration into broader food systems.

2.2 Diffusion of Innovation

Diffusion of Innovation (DOI) theory (Rogers 2003) describes the process by which new ideas or products spread within a social system over time. Diffusion occurs through communication channels among members of the system and is influenced by the innovation's key attributes, including relative advantages, compatibility, complexity, trialability, and observability. Individuals adopt innovations at different stages (Figure 1). People are typically classified into five adopter categories: innovators (the first 2.5 percent of a group to adopt a new idea or product), early adopters (13.5 percent), early majority (34 percent), late majority (34 percent), and laggards (16 percent). Innovators and early adopters are

particularly important in the early stages of diffusion, serving as opinion leaders who shape broader perceptions of the innovation (Rogers 2003).

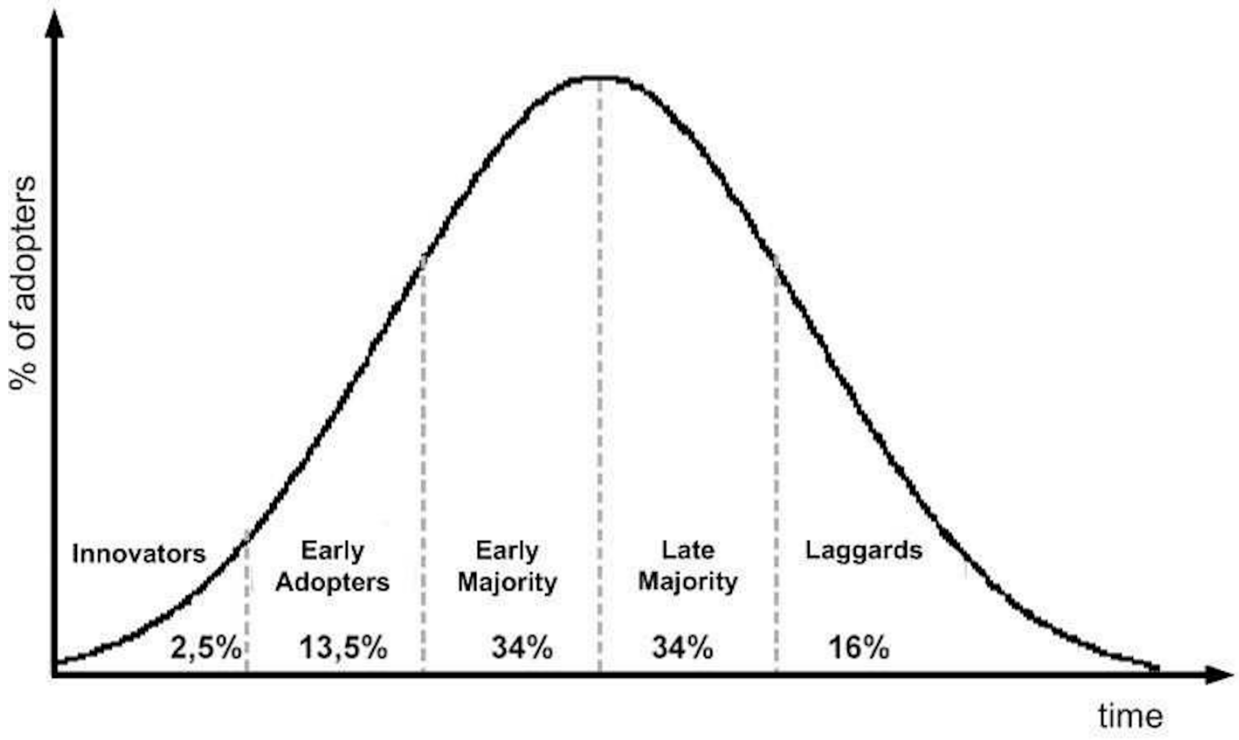

Figure 1. Adopter Categories in the Diffusion of Innovation Process

Source: Rogers (2003).

The DOI theory has been widely applied to understand both consumer and producer adoption of innovations in agricultural and food systems. For example, Gonera et al. (2021) leveraged the DOI framework to segment consumers in the adoption of plant-based diets, finding that motivations such as sustainability, novelty, and product diversity were key drivers for early adoption of alternative foods. Similarly, Yang et al. (2024) applied the DOI theory to assess changes in consumer behavior during the COVID-19 pandemic, demonstrating how early adopters played a key role in promoting local food purchasing and online platforms. Their findings highlight the importance of perceived relative advantage and communication channels in accelerating adoption. On the production side, the DOI framework has been employed to understand growers' adoption of new (e.g., hydroponics and hoop houses) and value-

added (e.g., fresh cut) technologies (Torres 2022), as well as cover cropping practices (Lavoie, Dentzman, and Wardropper 2021).

DOI is relevant in assessing the adoption of finger limes among citrus growers—a novel citrus product positioned as a premium food facing early-market challenges and uncertain production challenges. Compared to more familiar crops, emerging crops often experience slower adoption due to limited market data, uncertainty about demand, and low initial awareness. DOI theory helps pinpoint key factors influencing adoption, such as perceived advantages, production compatibility, and the visibility of successful adopters. This perspective enables targeted strategies to accelerate diffusion, like leveraging early adopters in the culinary and mixology sectors and improving communication to reduce perceived risks for growers.

2.3 Supply Chain Mapping

Supply chain mapping is the process of systematically identifying, visualizing, and analyzing all flows of materials or products from the upstream to the downstream ends of a supply chain (MacCarthy, Ahmed, and Demirel 2022). This practice serves as a critical foundation for effective supply chain management (MacCarthy, Ahmed, and Demirel 2022). The severe disruptions to supply chains during the COVID-19 pandemic accentuated the need for greater resilience in agricultural and food supply chains (Chenarides, Manfredo, and Richards 2021) and highlighted supply chain mapping as an essential tool for understanding the network of interconnected actors and for identifying system vulnerabilities (Cui et al. 2022; Norwood and Peel 2021).

The Food and Agriculture Organization (FAO) emphasizes that comprehensive mapping is vital for pinpointing inefficiencies and uncovering opportunities for value addition throughout agri-food supply chains (Kaplinsky and Morris, 2013). For example, Cui et al. (2022) mapped the U.S. fresh tomato supply chain, uncovering key relationships among growers, intermediaries, and retailers, and identifying challenges such as perishability, labor shortages, and transportation bottlenecks. Sultan, Routroy, and Thakur (2021) employed value stream mapping (VSM) to evaluate and enhance the sustainability of

downstream operations in the Indian surimi supply chain, demonstrating how mapping practices can optimize resource use and reduce environmental impacts.

Applying supply chain mapping to the finger lime industry is especially important given its status as a novel specialty crop with an underdeveloped supply network. By systematically mapping the finger lime supply chain, we can identify key actors, clarify the sequence of activities from production to market, and detect potential bottlenecks that may impede product flow or compromise quality. Mapping reveals where information gaps or infrastructure weaknesses exist, enabling growers, marketers, and policymakers to design targeted interventions that strengthen the supply chain, enhance product reliability, and build market confidence in finger limes as a viable and premium specialty crop.

3. Data and Approach

With limited history, data limitations are inherent for emerging market sectors. This case study draws on a diverse set of data sources, including stakeholder interviews, structured surveys, and industry reports, to help fill critical knowledge gaps and inform the analysis of demand and supply factors under the three economic system structures. In this way, the stakeholder data serve as scientific evidence to ground the discussion without shifting the primary focus from applied learning and practical decision-making.

Primary data were collected between August 2024 and March 2025 from key stakeholder groups involved in the Florida finger lime value chain, including growers, food enthusiasts, mixologists, extension agents, and home gardeners. Surveys were administered at three major industry events: the 2024 Citrus Expo in Tampa, the Campari USBG Day of Service in Jacksonville, and the Finger Lime Field Day hosted by UF/IFAS in Citra. In total, 119 participants completed the survey, comprising 33 growers, 43 enthusiasts, 15 extension agents, 11 mixologists, and 17 home gardeners. The survey instruments focused on key themes relevant to market development, including stakeholder awareness and familiarity with finger limes, perceived market potential, willingness to recommend, and willingness to adopt the crop or fruit.

3.1 Advanced Analytical Approach: Fuzzy TOPSIS Methodology

For more advanced students, a multi-criteria decision-making (MCDM) technique that combines fuzzy set theory with the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method can be applied to build on the survey and interview data. More information and examples are provided in the teaching notes.

This approach offers three key advantages. First, it transforms subjective linguistic responses into structured numerical data (Cantillo, Martin, and Roman 2020; Cantillo, Martin and Roman 2020), addressing the uncertainty present when stakeholders express preferences as "somewhat likely" or "very interested." Through triangular fuzzy numbers (TFNs), the method captures the inherent ambiguity in these evaluations, acknowledging that different respondents interpret rating scales differently. Second, it enables robust analysis despite small sample sizes typical in emerging markets. By measuring each stakeholder group's distance from both fuzzy positive and negative ideal solutions (FPIS/FNIS), the method compensates for limited observations while still producing actionable rankings of stakeholder segments most likely to adopt finger limes. Third, it integrates multiple evaluation criteria simultaneously, weighing factors like awareness, willingness to adopt, and perceived barriers.

4. Decision-Making

Mapping the finger lime supply chain reveals a fragmented network where stakeholder motivations are shaped by both market opportunities and systematic constraints. As shown in Figure 2, the Florida finger lime supply chain encompasses several groups of actors or stakeholders across three phases: (1) the production phase, including nurseries, agricultural input suppliers, and growers; (2) the post-harvest phase, including processors and wholesalers/distributors; and (3) the consumption phase, featuring food retailers (grocery stores), food services (including restaurants and bars), and consumers. In addition, supporting actors, such as research and extension professionals and policymakers, play a continuous role throughout the entire supply chain, facilitating knowledge transfer, technical assistance, and regulatory compliance. Each participant fulfills a distinct yet interdependent role in moving finger limes from initial

production to final consumption. This underscores the importance of collaboration and coordination for ensuring consistent supply and desired product quality.

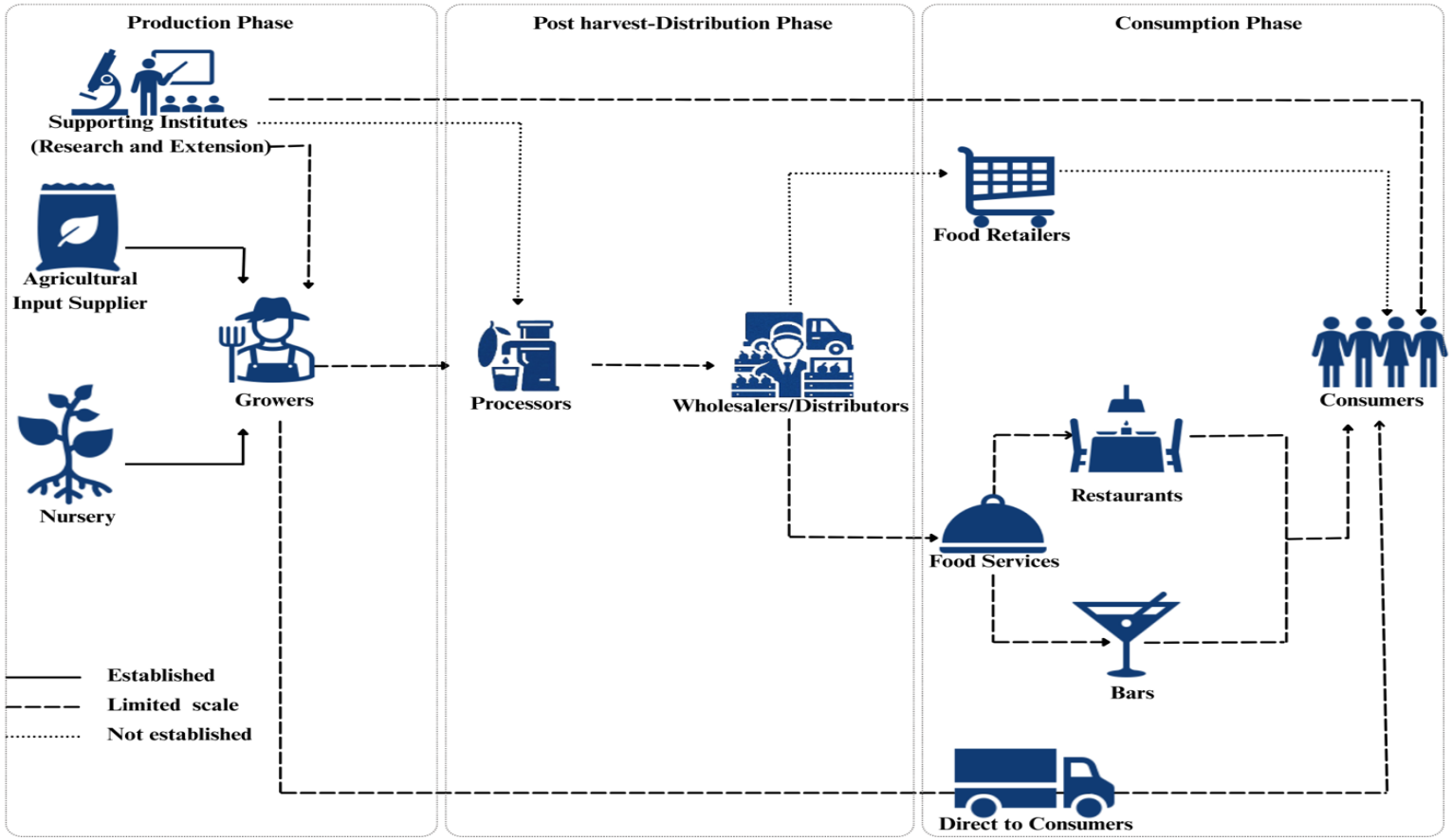

Figure 2. Finger limes supply chain map
Source: Authors conversation with stakeholders and industry representatives.

Notes: Solid lines indicate established supply chain relationships; dashed lines indicate established but limited-scale relationships; and dotted lines indicate relationships that are not yet established.

The supply chain starts with nurseries that propagate finger lime trees on select rootstocks, along with agricultural input suppliers who provide essential materials necessary to establish trees in the field. These resources are delivered to growers, the principal production actors, who are responsible for grove management, cultivation, harvest, and initial post-harvest handling to maintain fruit quality and safety.

Once harvested, finger limes enter the post-harvest phase, where processors, wholesalers, and distributors become key players. Processors (including packers) sort, clean, grade, and package the fruit to meet market specifications. Wholesalers and distributors manage the logistics of moving large volumes of product to various markets through cold chains and storage networks.

Next, the supply chain branches into two primary market channels: food retailers and food services. Food retailers include specialty grocery stores and upscale markets that sell finger limes directly to consumers. Food services, such as high-end restaurants and bars, represent an influential market segment, where chefs and mixologists leverage finger limes' unique sensory qualities (especially their "citrus caviar" texture) in gourmet dishes and cocktails (Neff 2022). These actors play a pivotal role in educating consumers, shaping demand, and increasing market visibility through creative applications and word-of-mouth influence (Sailly 2025).

In parallel, a direct market channel allows some growers to bypass intermediaries, selling finger limes directly to consumers through farmers markets, farm stands, and online platforms (examples include Miami Fruit and Shanley Farms). Although this segment operates on a small scale, it currently represents the primary and most accessible outlet for average consumers to order finger limes, given that formal post-harvest supply chains to mainstream food retailers have yet to be established. Sales to restaurants are similarly limited, largely confined to high-end establishments where chefs seek specialty ingredients. This direct-to-consumer approach not only provides growers with higher margins but also fosters closer relationships with niche markets, playing a pivotal role in sustaining early demand and awareness for the crop (FarmstandApp 2025).

Regulatory bodies and research and extension professionals are embedded throughout the supply chain. They provide essential oversight and support, such as helping nurseries maintain plant health standards (Allen 2019), advising growers on pest management (Toepfer et al. 2020) and enterprise budget (Lloyd and Thilmany 2008), guiding processors and packers in food safety compliance (Allen 2019), and promoting market development through outreach and education (USDA AMS 2022). For example, USDA programs assist specialty crop producers with food safety certification costs, ensuring compliance with regulatory requirements, while extension professionals bridge the gap between research and on-the-ground practices to enhance market access.

5. Motivation to Participate

Stakeholder motivation to engage with the finger lime value chain varies depending on their roles, goals, and perceived market potential. At the 2024 Finger Lime Field Day hosted by the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS 2024) approximately 50 participants attended, representing a diverse group of growers, homeowners, and industry professionals. Among these participants, 40 percent expressed interest in the commercialization of finger limes, and 46 percent described themselves as being involved in education and regulatory roles. In 2025, the field day participation increased to 80, reflecting a significant rise in stakeholder awareness and engagement of this novel citrus crop.

For Florida growers, finger limes offer an opportunity for crop diversification and serve as an alternative to traditional citrus varieties affected by Huanglongbing (HLB). Research highlights their natural HLB tolerance, with field trials showing low bacterial titers and minimal symptom progression (Dutt, Nielsen, and Grosser 2017). Additional motivations include accessing niche markets, where premium prices may be obtained due to the fruit's novelty and culinary appeal, and the prospect of capturing higher profit margins if production and market risks are effectively managed. Direct-to-consumer prices in April 2024 range from $121 to $485 per kilogram (Table 1), reflecting strong market potential for early adopters (Neff 2023). Our stakeholder survey results indicate that 86 percent of Florida

growers were aware of finger limes, but concerns about buyer access, cultivation practices, and upfront costs remain key barriers.

Table 1. Direct-to-Consumer Finger Lime Prices in the U.S. Market (2024)

Company Name	Origin	Presentation	Color	Price	Size	Price per KG
Miami Fruit	Florida	Fresh	Red	$127	200 g	$635
Miami Fruit	Florida	Fresh	Red	$177	400 g	$443
Miami Fruit	Florida	Fresh	Red	$297	800 g	$371
Pearson Ranch	California	Fresh	Green	$60	16 oz	$132
Pearson Ranch	California	Fresh	Green	$20	4 oz	$176
Pearson Ranch	California	Fresh	Green	$35	8 oz	$154
Iheart Box	Florida	Fresh	Green	$150	2-3 lb	$150

Source: Compiled by authors from product listings on Miami Fruit, Pearson Ranch, and IHeart Box websites (accessed in April 2024).

Consumers, or food enthusiasts, are motivated by finger lime's distinctive sensory attributes, particularly the burst of citrus flavor contained in its vesicles and its visual appearance (Dutt, Evans, and Singh 2019). Phytochemical analyses confirm high levels of antioxidants and phenolic compounds, enhancing their perceived health benefits (De Vita et al. 2024; Wang et al. 2019). Our stakeholder survey targeting food enthusiasts revealed a willingness to pay up to $30 for a 10-fruit pack, with texture, visual appeal, and taste ranked as the most appealing product attributes. This aligns with broader trends in specialty foods, which account for 20 percent of U.S. food sales that attract novelty-seeking consumers (Neff 2022). The increasing consumer interest in novelty and functional foods aligns well with the appeal of finger limes, making them attractive to early adopters seeking new flavors.

Mixologists and chefs are motivated by recipe innovations and premium positioning. At the 2024 Campari Day of Service in Jacksonville, 58 percent of surveyed mixologists had prior awareness of finger limes, but 100 percent expressed high intent to incorporate them into menus. They also indicated that the

fruit's "citrus caviar" texture and vibrant colors (e.g., UF RedLime) are particularly valued for cocktail garnishes and gourmet dishes. One-on-one interviews with mixologists further revealed that challenges such as small-batch availability, limited information on shelf life, uncertain sourcing (i.e., not knowing where to order finger limes), and the need for deseeding complicate consistent sourcing and broader adoption. These findings align with trends in the specialty food and beverage sector, where products that offer strong sensory appeal, compelling narratives, and exclusivity can command premium prices and drive market differentiation (Sipper 2024).

Extension professionals are motivated by the opportunity to promote a climate-resilient, HLB-tolerant crop that aligns with Florida's agricultural diversification goals. Surveyed extension agents rated workshops, webinars, trials, and collaborative research as the most effective strategies to promote finger limes. They emphasized that profitability, HLB tolerance, and yield potential are the most critical factors influencing grower decision-making. Notably, about 60 percent of surveyed extension professionals rated finger limes as having high to very high potential for Florida agriculture. Their commitment to closing the current knowledge gap drives their engagement, positioning them to lead in disseminating early research findings, guiding production decisions, and establishing best practices for this emerging specialty crop.

Applying the Diffusion of Innovation framework clarifies how stakeholders are positioned along the adoption curve in the finger lime market. Mixologists and chefs act as innovators and opinion leaders, driving early demand and visibility by featuring finger limes in premium dishes and drinks. Early adopters, such as food enthusiasts and direct-to-consumer growers, demonstrate the fruit's appeal and set trends for broader acceptance. Extension professionals serve as change agents, bridging knowledge gaps and supporting grower adoption. As finger limes gain exposure, more pragmatic stakeholders in the early majority may engage, especially as supply chain reliability and market information improve. This understanding helps align marketing, outreach, and supply strategies with each group's influence on adoption.

5.1 Economic Considerations

Economic considerations significantly influence stakeholder decisions regarding engagement with the finger lime value chain, reflecting broader trends in specialty crop adoption where market access, risk perception, and value-added potential drive behavior.

For growers, a primary concern is market access uncertainty. While finger limes offer diversification potential and HLB tolerance, growers express concerns about fragmented buyer networks and limited data on consistent sales channels. Surveyed Florida growers highlighted that unknown buyers is a top risk, deterring investment despite the crop's premium pricing potential ($121–$485/kg).

Consumers face price sensitivity and value ambiguity. Finger limes, being a premium, novel item, are likely going to be priced above standard citrus fruits. Direct-to-consumer pricing from retailers such as Miami Fruit in Florida and Pearson Ranch in California affirms this trend, with prices ranging from $121 to $485 per kg depending on the variety, color, and size. These high price points limit accessibility limit accessibility to niche segments like food enthusiasts. Successful marketing in similar markets relies on education and in-store sampling to bridge the value perception gap, such as Sumo Mandarins (Sumo Citrus 2021).

Mixologists prioritize supply consistency and small-batch fulfillment. High-end bars and restaurants require reliable access to fresh, visually striking finger limes for cocktail garnishes and food pairings, but face challenges with high price points, perishability, inconvenience of deseeding, and order scalability. These concerns echo broader specialty crop dynamics, where labor-intensive handling and cold chain gaps inflate costs and limit adoption. Managing costs and order predictability are key factors in maintaining profitability and operational consistency in bar programs (Hines 2023). Therefore, competitive pricing structures are critical.

Extension agents base resource allocation on return-on-investment (ROI) analysis and grower demand. UF/IFAS (2024) prioritizes finger limes due to their HLB tolerance and alignment with Florida's agricultural diversification goals but faces constraints from limited validated data on yields and pest

management. This reflects a national pattern where extension programs favor crops with proven profitability and existing infrastructure, such as blueberries or organic strawberries.

5.2 Non-Market Factors

Complementing the economic considerations outlined earlier, non-market factors play a critical role in shaping stakeholder decisions about finger lime adoption and supply chain participation.

For growers, limited agronomic information specific to production and harvest represents a major barrier. Despite the crop's potential for diversification and HLB tolerance trait, uncertainties persist around optimal cultivation practices, pest management strategies, and postharvest handling protocols. For example, field trials in different parts of Florida (e.g., Citra, Homestead, and Lake Alfred) reveal that production challenges vary depending on the production location. Additionally, gaps in labor requirements and harvesting techniques, such as the need for manual harvest due to the thorny shrubs, heighten perceived risks and deter investment.

For mixologists, sensory and aesthetic qualities are pivotal non-market drivers. Finger limes' distinctive visual and textural attributes, such as small vesicles that resemble caviar, significantly enhance the perceived value of cocktails and gourmet dishes (Dutt, Evans, and Singh 2019). This novelty plays an important role in creating memorable consumption experiences and distinguishing menu offerings in competitive hospitality settings. However, storage and preparation challenges present a major non-market limitation. Finger limes are susceptible to chilling injury at standard refrigeration temperatures, requiring specialized storage conditions to maintain quality, a constraint that complicates routine use in bar environments (Neff 2024).

For extension agents, the limited research data critically impacts support and outreach strategies. Extension programs rely on robust evidence from field trials, cost-benefit analyses, and market assessments to advocate for new crops. In the case of finger limes, sparse agronomic data (e.g., optimal fertilization rates and irrigation needs) and unverified yield projections hinder the development of credible outreach materials. Without concrete evidence of profitability or scalability, extension

professionals may deprioritize finger limes in favor of crops with established best practices in Florida, such as blueberries.

5.3 Policy and Institutional Factors

Policy and institutional factors present some institutional limitations on developing finger lime markets, particularly for growers, processors, and distributors. A stringent regulatory network for Florida citrus was designed to combat the spread of disease in established citrus, but also has impacts on markets for emerging specialty crops like finger limes. These policy and institutional constraints underscore that, beyond stakeholder motivation and economic viability, successful market development for finger limes also requires strategic efforts to align regulatory frameworks and institutional resources with the needs of an emerging specialty crop sector.

For growers, propagation restrictions under the Citrus Nursery Stock Certification Program (Rule 5B-62, Florida Administrative Code) (Florida Administrative Code 2015) mandate disease-free nursery stock production, including rootstock certification and nematode testing for all commercial operations. Small-scale growers face compliance costs of $15–$20 per tree, while dooryard nurseries are exempt from nematode testing but still require registration. Additionally, quarantine regulations for citrus canker and citrus black spot (CBS) restrict interstate movement. For example, fruit from CBS-quarantined counties (e.g., Collier, Hendry) must be transported to packinghouses in tarped trailers, imposing additional logistics costs.

For processors and wholesalers, interstate shipping mandates pose operational hurdles. Under USDA-APHIS compliance agreements (QC-222), distributors must pre-inspect fruit, provide phytosanitary certificates, and adhere to cold chain protocols for shipments to states like California (Ross 2024). Small-batch specialty processors, critical for niche markets, often lack the resources to meet these requirements. Postharvest handling rules further complicate efforts: APHIS-approved fungicidal wax treatments are mandatory even for minimally processed citrus, including finger limes, which can conflict with marketing claims of “natural” premium quality (USDA APHIS 2024).

For extension agents, the ability to promote finger limes is closely tied to institutional support for research and outreach. Because finger lime research in Florida is still in its early stages, extension professionals lack validated production guidelines, postharvest recommendations, and reliable economic data to share with growers (Sailly 2025). Increased investment in crop research, demonstration blocks, and market studies – similar to efforts for blueberries and HLB-resistant citrus – will be necessary to overcome these barriers and expand support for finger limes within the extension and grower communities.

6. Outlook and Strategic Recommendations

To support real-world decision making in the development of a viable new agricultural industry or commodity, the analyst must consider the intersection of production and markets. Integration of the Economic Systems, Diffusion of Innovation, and Supply Chain Mapping frameworks provides a comprehensive understanding of the opportunities and challenges facing finger lime commercialization in Florida. Collectively, these frameworks reveal a clear disconnection across the finger lime value chain. Production, marketing, and consumer adoption efforts are not yet fully aligned, creating risks of supply-demand mismatches and market stagnation. Addressing these disconnections through improved communication networks, targeted marketing for early adopters, and supply chain coordination strategies will be critical to realizing the crop's market potential.

Insights from the diffusion of innovation theory suggest that finger limes are currently in the early adopter stage, driven primarily by culinary innovators such as mixologists and chefs. Successful adoption depends on using these early adopters to build broader consumer awareness and acceptance over time while also managing price sensitivity among later adopter segments. The economic systems perspective shows us how stakeholder behavior is influenced not only by market incentives but also by institutional structures, information availability, and decision-making authority. Growers face regulatory uncertainties because of concerns in interstate shipping and the unknown market, while extension agents require formal

research support before actively promoting the crop. Understanding these factors is crucial for addressing the non-market barriers that could slow finger lime adoption, even if market demand begins to increase.

From a supply chain perspective, finger lime market development is challenged by a fragmented and underdeveloped value chain. Critical gaps exist between growers, intermediaries, and food service buyers, especially in terms of cold chain infrastructure, small-batch fulfillment, and postharvest handling practices. These disconnects limit the consistent flow of product and information, making it difficult to scale production while maintaining quality and reliability. Also, the lack of strong connections between early-stage growers and food service buyers constrains the flow of information about market needs, pricing expectations, and postharvest handling requirements.

6.1 Information Exchange as a Path Forward

Improved information exchange can reduce uncertainty associated with new and emerging crops and markets. Formal communication channels are pivotal in disseminating validated, research-driven information about finger limes to stakeholders across the value chain. Extension services, including those provided by UF/IFAS and the nationwide network of USDA county extension agents, serve as the primary vehicles for delivering technical guidance, workshops, and educational materials to reduce uncertainty around novel crop adoption. For example, the UF/IFAS Monroe County workshop (2023) and the UF/IFAS Finger Lime Field Day (2021, 2024, and 2025) both featured hands-on training, allowing growers to ask questions and gain insights into finger lime cultivation under Florida's unique conditions (KONK Life 2023).

Research institutions and academic conferences further facilitate formal knowledge exchange, allowing researchers to share timely, updated research regarding finger limes, such as trial results and post-harvest practices. For example, research on finger lime chilling temperature and effective fruit coating were presented to growers at the 2024 Finger Lime conference. Demonstration blocks and product tasting bridge the gap between academic research and practical application. These events, often

hosted at the UF/IFAS Finger Lime Field Day (Sailly 2025), serve to reduce the gap between academic research and real-world practice, helping to build trust, stimulate interest, and accelerate the diffusion of innovations like finger limes. By leveraging formal communication channels, stakeholders gain access to scientifically validated information that supports informed decision-making and reduces the perceived risks associated with adopting a novel specialty crop.

Informal communication channels are equally critical in driving awareness and adoption, particularly during the early stages of market development. Social media platforms like Instagram and TikTok have become powerful tools for promoting food trends, especially among younger consumers (Losa Reinoso 2025). For example, a TikTok trend for cottage cheese-based foods led to a 15.9 percent rise in sales of the product in the United States in 2023 (Little 2023). Influencers and chefs have been increasingly leveraging social media to showcase finger limes' "citrus caviar" vesicles in visually striking dishes and cocktails.

Peer-to-peer (P2P) networks and word-of-mouth (WOM) communication together play a powerful role in shaping awareness, interest, and adoption of finger limes, especially during the early stages of market development. Innovators and early adopters act as opinion leaders, sharing their success stories, whether in person, through social media, or via online forums, helping reduce perceived risks and encourage trial among more cautious stakeholders. In the food service sector, endorsements from respected chefs or mixologists can trigger broader demand, as their recommendations often influence peers and set trends. Similarly, growers are more likely to consider planting finger limes after hearing firsthand accounts of profitability and cultivation success from fellow producers. Research confirms that peer recommendations and word-of-mouth referrals can have a far greater impact on adoption decisions than traditional marketing, as trust in personal networks and authentic experiences outweighs institutional messaging (Trusov, Bucklin, and Pauwels 2009).

6.2 Strategic Lessons and Recommendations for Specialty Crop Diversification

The case of finger limes highlights several strategic lessons for successfully commercializing new specialty crops under conditions of uncertainty and fragmented market structures.

First, it is essential to integrate formal and informal communication strategies to accelerate innovation diffusion. While formal channels provide credibility and technical knowledge, informal channels play a critical role in building consumer awareness and trust. Coordinated efforts across both communication spheres can help reduce the information gap between innovators, early adopters, and the rest of the market.

Finger limes exemplify a high-potential but low-structure innovation. Despite their culinary novelty, premium positioning, and adaptability, supporting market infrastructure, such as consistent supply chains and targeted marketing channels, remains underdeveloped. Specialty crop initiatives must recognize that innovation success is not determined only by product characteristics but also by the supporting infrastructure that enables consistent supply, quality assurance, and scalability.

A final strategic lesson is the importance of early investment in supply chain development, communication networks, and institutional support. Investing in demonstration plots, postharvest research, grower education, and market development initiatives at the earliest stages can significantly reduce adoption barriers in the future. Extension services and research programs should prioritize building production guidelines, economic viability studies, and buyer engagement strategies for emerging crops like finger limes. Similarly, private sector actors, nurseries, distributors, and specialty food companies have a role to play in fostering supply chain resilience and promoting product visibility. Without coordinated investment in these foundational areas, high-potential innovations risk stalling before reaching critical market mass.

7. Teaching Value and Learning Outcomes

Overall, the finger lime case offers an interdisciplinary learning experience that strengthens student skills in systems thinking, stakeholder analysis, and applied decision modeling These are key competencies for

future leaders in agricultural economics, agribusiness, and food systems innovation. Application of an integrated theoretical framework, combining Economic Systems, Diffusion of Innovation, and Supply Chain Mapping is demonstration with a real-world example. By engaging with the finger lime case, students learn how to systematically separate complex market development scenarios where uncertainty, fragmented information, and institutional barriers interact. The case provides a structured method for understanding not just consumer adoption dynamics but also the broader systemic factors that shape success or failure in emerging specialty crop markets.

The case promotes critical thinking about stakeholder alignment and decision-making processes. Students are encouraged to analyze how different participants- growers, consumers, mixologists, and extension agents perceive risks and opportunities differently and how these perceptions influence market outcomes. By examining the motivations, economic considerations, non-market influences, and policy constraints faced by each group, students gain a deeper appreciation for the coordination challenges characteristic of agricultural innovation and supply chain management. Suggested pre-class preparation materials, class structure, and discussion questions are all included in the teaching notes that accompany this case.

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