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From Farmer to Trader. Cross-Border Functional Upgrading in Northwestern Mexico

De agricultor a distribuidor. *Upgrading* funcional transfronterizo en el noroeste de México

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ABSTRACT

This article aims to analyze the upgrading of producers in northwestern Mexico in the global value chain of horticultural products and understand the characteristics and dimensions of this process. Twenty-three semi-structured interviews were conducted with different growers and distributors in the region, and the information collected was validated with secondary sources. The results show that: *(i)* there has been a functional upgrading in these actors from producers to marketers, as well as an upgrading of products and processes; *(ii)* trust between the parties is key to increasing the maturity of the horticultural value chain; *(iii)* capacities have been developed to adapt to the demands of international markets; *(iv)* innovation and continuous improvement are imperative to keep up with the dynamics of cross-border trade. The knowledge generated is an empirical input for future research focused on the response capacity of regional agents to the demands of the world market.

Keywords: 1. international trade, 2. economic development, 3. fruit, 4. vegetables, 5. social adaptation.

RESUMEN

El objetivo del artículo es analizar el upgrading de productores del noroeste de México en la cadena global de valor de productos hortícolas y conocer las características y dimensiones de este proceso. Para ello, se aplicaron 23 entrevistas semiestructuradas a diversos agricultores y distribuidores de la región, cuya información se trianguló con fuentes secundarias. Los resultados evidencian que *i)* se produjo un upgrading funcional, pasando estos actores de ser productores a comercializadores, y, paralelamente, un upgrading de productos y procesos; *ii)* la confianza es clave para potenciar la maduración de la cadena de valor hortícola; *iii)* se desarrollaron capacidades de adaptación a los requerimientos de los mercados internacionales; *iv)* son imperativas la innovación y mejora continua para adecuarse a las dinámicas del comercio transfronterizo. El conocimiento generado es un insumo empírico para futuras investigaciones enfocadas en la capacidad de respuesta de los agentes regionales a las demandas del mercado mundial.

Palabras clave: 1. comercio internacional, 2. desarrollo económico, 3. fruta, 4. hortalizas, 5. adaptación social.

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INTRODUCTION

The coastal region of Hermosillo in Sonora, together with several agricultural districts in Sinaloa, underwent a process of productive and organizational transformation beginning in the 1990s, within the broader context of the implementation of the North American Free Trade Agreement (NAFTA) among Mexico, the United States, and Canada in 1994. The ensuing trade liberalization intensified the specialization of horticultural production, necessitating higher levels of technological sophistication and promoting the expansion and diversification of consumer markets. As Rubio (1994) observes, grain and cereal cultivation was supplanted by a new cropping pattern aligned with the global reorganization of agriculture, characterized by a pronounced increase in international trade between emerging and developed economies.

Wong and Salido (1992) characterize this phenomenon as the emergence of a model rooted in export-oriented agroindustry, particularly focused on the production of fruits and vegetables. The northwestern region of Mexico, in particular, leveraged its comparative advantages to capitalize on the opportunities generated by the country's aggressive trade liberalization during this period. This region adapted effectively to the new agricultural policy, notably through the reduction or elimination of subsidies, the removal of guaranteed prices, and the determination of crop prices based on quotations from the Chicago and New York exchanges, as well as through the promotion of technological innovation and private investment.

In this manner, the agroindustry consolidated an organizational framework consistent with the flexible production systems characteristic of post-Fordism. In the context of agriculture, some authors have identified this framework as *agromaquila* (Gómez Cruz & Caraveo López, 1990; Wong & Salido, 1992; Sandoval et al., 1996), drawing an analogy with the maquiladora model and its geographically divided production processes, labor-intensive activities being located in Mexico, while knowledge-, design-, or trade-intensive tasks were carried out in the United States. This organizational modality, previously typical of the manufacturing sector, was initially replicated within the domain of export-oriented agriculture.

The primary comparative advantage of the agromaquila lay in its access to low-wage labor. However, from a global value chain (GVC) perspective, farmers did not develop competitive advantages in technology or infrastructure, as they occupied the lowest tier of the chain (Macías, 2003). Similarly, Rubio (2001) and Marañón (1997) emphasize that most Mexican producers held a subordinate position relative to multinational corporations, a dynamic that translated into limited benefits for regional development.

Despite the foregoing, an interesting trend has emerged over time: some fruit and vegetable producers in northwestern Mexico have gradually repositioned themselves within the global value chain, assuming the role of marketers of their own production. This is particularly evident among horticulturists in the coastal region of Hermosillo and in select agricultural districts of Sinaloa, who constitute the focus of the present study.

Pavlakovich-Kochi and Thompson (2013) highlight this phenomenon, which has fostered the consolidation of a cross-border cluster linking vegetable producers in Sonora and Sinaloa with storage, distribution, and transportation firms in the border state of Arizona, United States. Upon crossing the border, the fruits and vegetables are received by produce companies, specialized firms engaged in the storage, importation, and marketing of these products. This process stimulates the integration of additional economic activities, such as customs services, transportation, and sales brokerage. To underscore the economic significance of these firms, it is notable that during the first half of the 2010s, "approximately 120 000 trucks carrying fresh Mexican produce crossed the border, with an estimated value of 2.5 billion dollars" (Pavlakovich-Kochi & Thompson, 2014, p. 1). Currently, around 70% of the slightly more than 100 produce companies in the study area are wholly or partially owned by Mexican farmers.

To analyze this phenomenon, the specialized literature was reviewed. Among the most influential contributions is the work of Gereffi and colleagues, who examined the structure of agricultural global value chains (GVCs) across various countries (Dolan et al., 1999; Lee et al., 2012; Duval et al., 2018; Scheitrum, 2022; Soliman et al., 2023).[4] This GVC approach was extensively applied in the studies by Dolan and Humphrey (2000), which explored how Kenyan vegetable exporters to the United Kingdom expanded their functions and capabilities within the chain. While British importers concentrated on global logistics and supply chain management, the exporters focused on production and product diversification, increasing their output from a limited number of vegetable varieties to as many as 80 distinct products.

Barrientos and Visser (2012), in turn, analyzed the functioning of horticultural value chains in South Africa, following a marked increase in exports of horticultural products to European markets. The authors found that South African producers significantly enhanced their production processes and product quality to comply with stringent European standards. In other words, Barrientos and Visser documented a process of functional and product upgrading among horticulturists in the region.

Regarding the study region, evidence on upgrading among agricultural producers in northwestern Mexico, particularly in the coastal region of Hermosillo, remains limited. Villa and Bracamonte (2013) examined how global production networks contributed to the modernization of agriculture in northwestern Mexico, focusing on the coastal region of Hermosillo and the southern part of Baja California Sur. In both regions, producers faced significant environmental challenges, such as aquifer depletion and contamination, while simultaneously striving to achieve highly competitive standards in the production of both conventional and organic fruits and vegetables, and to satisfy national and international demand, primarily from the United States and, to a lesser extent, from the European Union, Canada, and Japan.

[4] The existence of other approaches complementary to GVCs, such as global production networks and global commodity chains, is acknowledged. Their omission from the literature review is intended to avoid theoretical saturation, as the conceptual framework is further expanded in the following sections through the introduction of a new category: regional value chains.

Villa and Bracamonte (2013), following the perspective of López Placencia and Gomis (2004), argue that upgrading emerges as a necessity for agricultural producers to adapt to conditions primarily dictated by buyers within global value chains, a challenge addressed through learning processes and the adoption of new technologies. In their study, the authors employ three analytical categories to assess upgrading: product, process, and organizational. Their results indicate that both agricultural regions made progress in terms of product, process, and organizational competitiveness, exhibiting both shared trends and notable differences.

With respect to competitive product upgrading, the authors note that producers shifted away from traditional cropping patterns to concentrate on the intensive and highly technologized production of fruits and vegetables, primarily targeting international markets. In terms of process upgrading, while similarities were observed in certain activities, such as improvements in international certifications, substantial differences emerged in the adoption of new technologies. Finally, convergence was evident in the upgrading of organizational functions, including managerial competencies, logistics and marketing strategies, and the incorporation of new technologies (López Placencia & Gomis, 2004).

In a study conducted by González (2015), the value chain of the wine industry in Baja California was analyzed, revealing two types of challenges: internal, related to technological, economic, marketing, and distribution capacities; and external, including environmental issues such as aquifer overexploitation and salinization, the scarcity of local suppliers, and the absence of governmental support schemes for company financing. In other instances, the literature addresses global value chains only for specific products—such as tomatoes and cucumbers from Sinaloa exported to the United States—emphasizing the economic benefits of marketing these commodities but without examining issues such as upgrading (Duval et al., 2018; Scheitrum, 2022).

The review of the literature on upgrading in agricultural value chains highlights a research problem encompassing two main dimensions. First, upgrading is an increasingly relevant issue in emerging economies such as Mexico, as it theoretically allows key companies or economic agents, in this case, fruit and vegetable producers, to expand into other activities or segments of global value chains (GVCs) linked to developed countries. Second, upgrading involves a continuous process of learning, adaptation, and modernization within GVCs, facilitating integration into global production networks (Villa & Bracamonte, 2013). In this context, it is essential to examine the strategies implemented by Mexican-owned produce companies to adapt and progress across the various segments that constitute and integrate the global chain of fruit and vegetable production and marketing.

It is important to note, as previously mentioned, that the specialized literature has addressed this topic predominantly within the manufacturing sector. The possibility of an upgrading process entails recognizing that the historical inertia, where producers in peripheral regions remain confined to marginal stages of the value chain, particularly those that are labor-intensive and characterized by limited or no governance capacity within global chain structures, can indeed be overcome, as discussed by Gómez Cruz and Caraveo López (1990), Wong and Salido (1992),

Sandoval et al. (1996), Borbón (2001), and Sandoval Cabrera (2012). Nevertheless, a significant knowledge gap persists regarding how Mexican producers have succeeded in moving upward within global value chains. This gap underscores the need to examine the specific dynamics through which certain fruit and vegetable producers from Sonora and Sinaloa have transitioned from agromaquila operations to becoming marketers and distributors in the United States.

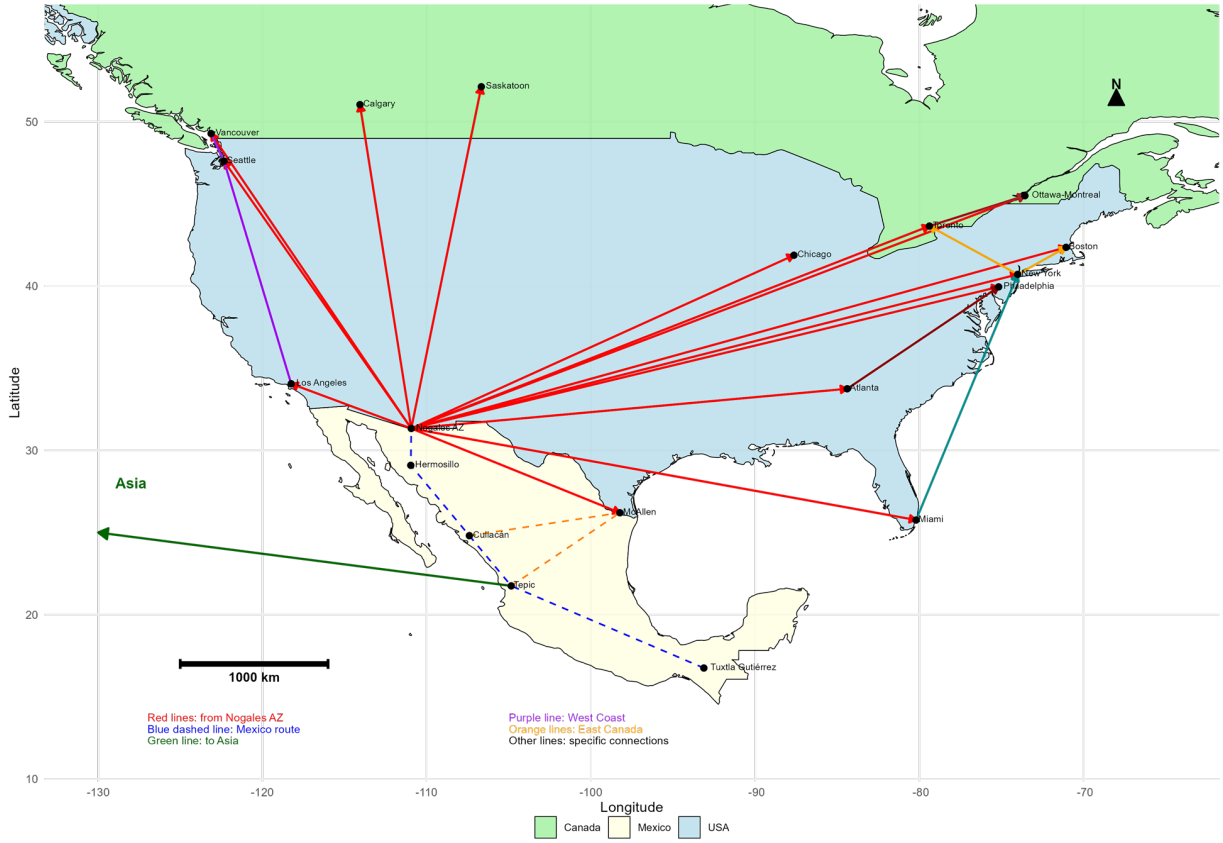
Building on this background, the objective of this study is to analyze the upgrading of producers in northwestern Mexico within the global value chain of horticultural products, with the aim of identifying the characteristics and dimensions of this process. The knowledge generated constitutes both a theoretical and empirical contribution toward understanding the factors that have enabled some farmers to transition from producers to marketers. The following sections present the theoretical framework relevant to the research problem, describe the methodological strategy employed, and analyze and discuss the principal findings in light of their implications for the study area. The paper concludes with a summary of the main conclusions.

UPGRADING IN GLOBAL VALUE CHAINS

The globalization of production constitutes the prelude to the development of GVCs, as they form part of the broader reorganization of the world economy that unfolded between the late twentieth and early twenty-first centuries. This transformation reshaped the competitive dynamics of nations, firms, and industries, thereby redefining international trade patterns. In this context, Gereffi (1999) observes that the exponential growth of imports in developed countries reflects a shift in the center of gravity of manufacturing and export activities toward emerging economies. Furthermore, Gereffi (1999) emphasizes that GVCs, now the principal mechanism of international trade and a complex network of interconnections among firms, countries, and regions, originate from the fragmentation of production into distinct stages distributed across different geographic locations according to their comparative advantages (Porter, 1985). Accordingly, GVCs encompass successive stages that add value to the final product, through technological innovation, design improvements, cost optimization, or quality enhancement, implying the specialization of each participating country or region in strategic segments of the production process (Gereffi, 1999; Flento & Ponte, 2017; Ponte & Sturgeon, 2017).

Horticultural GVCs comprise several interconnected segments that progressively add value to the product. The process begins with the selection and purchase of seeds, followed by planting and the application of agricultural practices tailored to the ecological conditions most favorable for specific crops. The harvested produce is then transported to facilities for sorting, cleaning, and packaging, where additional value is incorporated through quality standardization and product presentation. Subsequently, these goods are distributed domestically or internationally via transportation systems designed to preserve freshness and quality, ultimately reaching wholesale and retail markets, or in some cases, the final consumer directly (Gereffi & Fernandez-Stark, 2011). Map 1 illustrates the stages and geographic distribution of the GVC analyzed in this study.

Map 1. Distribution Lines in the North American Fruit and Vegetable GVC



Source: Own elaboration based on interview data.

As depicted in Map 1, a global value chain has emerged along the Mexican Pacific coast, linking horticultural production regions with marketing and distribution firms (produce companies) located in Río Rico, Arizona (Fresh Produce Association of the Americas, 2023). From this hub, goods are distributed to multiple collection centers across the United States and Canada. For the purposes of this study, the focus is on horticultural producers in Sinaloa and Sonora, northwestern Mexico,[5] with particular attention to the growers in the coastal region of Hermosillo, Sonora.

Over the last two decades of the twentieth century and continuing into the present, economic integration frameworks driven by globalization have experienced profound transformations, accelerated by the disruptions of supply chains resulting from the COVID-19 pandemic and the trade conflict between China and the United States. These developments have fostered the emergence of new growth hubs grounded in regional comparative advantages, a process that has influenced the evolution of global value chains across multiple economic sectors and productive activities, including agriculture (Richey & Ponte, 2021). This phenomenon is particularly evident in the fruit and vegetable production chain.

[5] Although Colima is also a city located on the Mexican Pacific coast, from which horticultural products are primarily exported to the Asian market, it is considered outside the scope of the present study.

In this context, a fundamental assumption of upgrading within GVCs is the central role of the lead firm as the dominant actor in the chain, determining the nature of relationships with other firms, access to international markets and technologies, and the development or enhancement of capabilities (Gereffi, 1999; Humphrey & Schmitz, 2000; Morrison & Pietrobelli, 2008; Pietrobelli & Rabelloti, 2011). In line with this, Gereffi (1999) underscores governance as a critical factor for understanding the organization and management of the actors involved in GVCs. Building on this idea, Gereffi et al. (2005, pp. 84–85) proposed a classification of five types of governance, based on three key dimensions: the complexity of transactions, the codification of information, and the capabilities of suppliers. The five governance types they identify are:

1. *Market-based governance.* In this type, the lead firm exerts minimal influence, as the primary mechanism of control is the market-determined price, which maintains relatively stable relationships among the various actors in the chain. A defining characteristic of this governance type is the presence of low entry barriers, which often leads to frequent changes in suppliers.
2. *Modular governance.* In this type, distributors play a central role in the manufacturing process, producing goods according to client specifications while assuming full responsibility for process quality and the technology employed. This arrangement requires access to sufficient capital to support the necessary investments.
3. *Relational governance.* This governance type is characterized by close relationships and mutual dependence between buyers and sellers. Reputation and trust among actors are central to the formation of alliances between geographically dispersed firms, complementing more traditional perspectives that associate this type of governance with factors such as family ties or physical proximity.
4. *Captive governance.* In this type of chain, small suppliers depend heavily on transactions with large buyers, creating a position of dependency that often results in higher production costs to meet client requirements. These networks are typically marked by intensive control and supervision by the dominant firms.
5. *Hierarchical governance.* This type is characterized by vertical integration, in which primary coordination is achieved through managerial control from supervisors to subordinates, or from the central office to subsidiaries and affiliated companies.

Table 1 summarizes the relationship between the five types of governance and the three determinants identified by Gereffi et al. (2005). These theoretical assumptions provide a framework for understanding how farmers in northwestern Mexico have enhanced their position within the chain, that is, how they have achieved upgrading. This process occurs when actors engaged in lower value-added activities seek to move into higher-value segments by enhancing technologies, skills, and quality, thereby increasing their competitiveness and participation within the chain (Porter, 1985; Giuliani et al., 2005; Gereffi & Fernandez-Stark, 2011).

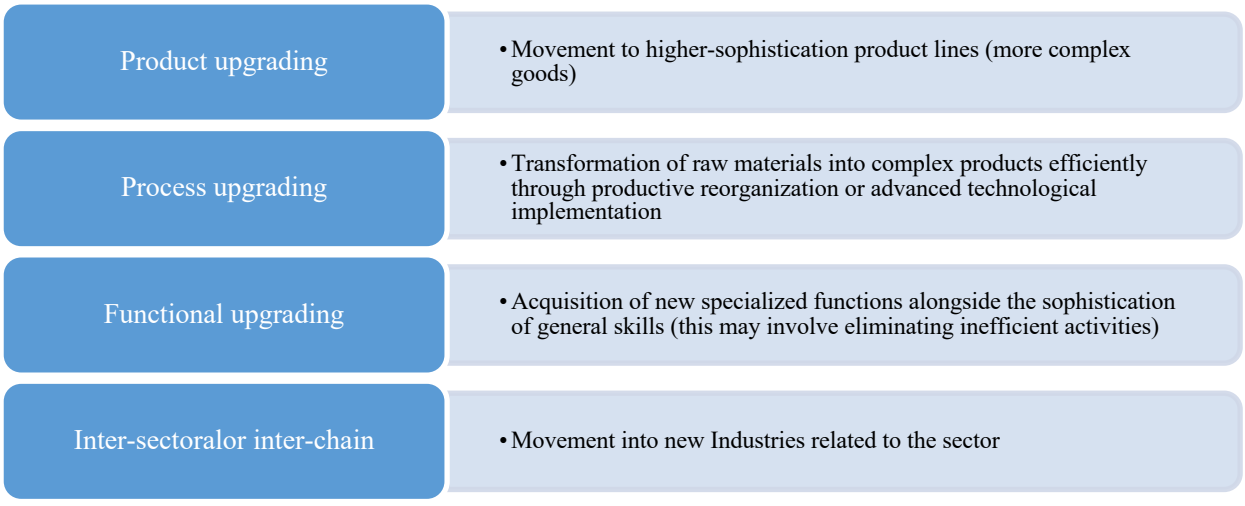
Table 1. Relationship Between Causal Factors and Types of Governance in GVCs

Type of governance	Complexity in transactions	Coding skills (transactions)	Supplier capacity	Level of coordination
Market	Low	High	High	Low
Modular	High	High	High	
Relational	High	Low	High	
Captive	High	High	Low	
Hierarchical	High	Low	Low	High

Source: Gereffi et al. (2005, p. 87).

Gereffi (1999) proposes a classification of four types of upgrading: *(i)* product upgrading, *(ii)* process upgrading, *(iii)* functional upgrading, and *(iv)* inter-sectoral or inter-chain upgrading (Figure 1). This study focuses primarily on functional upgrading, examining how a group of Mexican horticultural producers moved vertically within the chain by acquiring new and more complex functions related to the marketing and distribution of products, consolidated within the produce industry. Nevertheless, the study also considers the potential for product or process upgrading, acknowledging that these categories are not mutually exclusive and may occur concurrently or in combination within the dynamics of global value chains.

Figure 1. Upgrade Categories



Source: Own elaboration with information from Gereffi and Fernandez-Stark (2011).

In summary, the theoretical framework on upgrading in GVCs suggests that governance structures play a critical role in enabling upgrading among the various agents or firms involved. The different types of governance—hierarchical, market-based, modular, relational, and captive—

shape the distribution of resources and capabilities along the chain. For instance, under relational governance, where close, trust-based ties prevail, firms may have greater opportunities to innovate and enhance their processes and products due to the continuous flow of information and collaboration. In contrast, within a captive governance environment, small suppliers are often constrained by the demands of dominant buyers, which can limit their capacity to move into higher-value activities.

Additionally, governance structures can be understood as a form of coordination that does not originate from market exchanges between parties, in which chain leadership, typically exercised by a *large buyer* or *producer*, is effective in maintaining control over production in labor or technology intensive industries, but less so in sectors lacking an established lead firm (Gereffi et al., 2009). These strategic sectors have traditionally been managed through vertical governance when led by a large producer, or through buyer-driven governance when a purchaser dominated the chain (Kaplinsky & Morris, 2001). Consequently, the type of governance directly influences the upgrading potential of firms, shaping their growth trajectory and their capacity to achieve greater benefits within the chain.

METHODOLOGICAL STRATEGY

Study Area

The spatial framework of this research encompasses the horticultural regions of Culiacán, Sinaloa, and the coastal area of Hermosillo, Sonora, as well as the distribution centers (produce) located in Río Rico, Arizona. This study area was selected because, at the outset of the research, it was found that the vast majority of Mexican farmers who own produce companies in Arizona originate from these regions in northwestern Mexico.

Temporal Framework

The analysis focuses on the period from 1990 to 2020, during which significant transformations took place in Mexico's agricultural sector, driven by the implementation of NAFTA and, later, the USMCA. This timeframe encompasses the transition in which Mexican horticulturists evolved from primarily producing to assuming roles as marketers.

Method

Fieldwork was conducted through 23 semi-structured interviews with horticulturists from the study region and managers of produce companies located in Río Rico. The semi-structured interview is a qualitative method that combines the flexibility and depth of dialogue with a defined structure, allowing researchers to investigate complex topics while maintaining focus on specific objectives (Kvale & Brinkmann, 2009). This approach permits the adaptation of questions based on participants' responses and enables the exploration of significant aspects that arise during the conversation. The topics addressed in the interviews, and the corresponding questions (Table 2), were designed to capture participants' perspectives, experiences, and opinions regarding functional

upgrading, drawing on the theoretical framework established in the works of Gereffi (1999), Humphrey & Schmitz (2000), Morrison et al. (2008), Gereffi & Fernandez-Stark (2011), Ponte & Sturgeon (2017), and Flento & Ponte (2017).

Table 2. Semi-Structured Interview Questionnaire

Theoretical field	Problematization	Interview question
GVC	Proximity to large markets serves as a key incentive for the location of specific industries. The distance between Hermosillo and Nogales is approximately 300 kilometers, positioning Nogales as a strategic hub for the marketing of fruit and vegetable products.	1. What factors influence your decision, as marketers, to locate your operations near the Nogales border checkpoint?
	GVCs achieve specialization through the marketing of goods across distinct production stages; As a result, certain segments of the chain incentivize production and management activities that enhance productivity and promote business improvement or expansion. Producers from the coastal region of Hermosillo typically participate in this process when interacting upstream, forming business relationships with produce companies in the United States.	2. Have you implemented any improvements in industrial or functional processes, product quality, or market diversification as a result of collaboration with your horticultural partners? 3. How has the relationship between producers and marketers evolved in contexts where there is a specific division of labor across stages, involving international coordination of activities?
Produce	Due to the division of activities inherent in GVCs, firms in developing countries are expected to enhance their industrial and organizational capabilities, a process referred to as upgrading. The emergence of specialized facilities for handling vegetables -commonly known as produce companies- may be a direct outcome of the upgrading achieved within this GVC.	4. How has the productive reorganization of your industrial facilities influenced your position within the value chain, and what improvements have resulted from this reorganization?
	Produce companies facilitate the escalation of activities for their horticultural partners by transmitting information about market changes and demand. This process is particularly dynamic when the grower owns their own distribution company.	5. What is the primary factor that determines your decision to establish a relationship with a producer or marketer? As a result of your collaboration with the produce industry, have you experienced any transfer of technology or knowledge? What is the actual influence of your distribution partner on your operations? 6. Do produce companies enable you to handle higher-quality goods, and if so, does this enhance your negotiating power or alter your relationships with suppliers in related industries? 7. Have you implemented any improvements in industrial or functional processes, product quality, or market diversification as a result of collaboration with your horticultural partners?

(continues)

(continuation)

Theoretical field	Problematization	Interview question
Upgrading and downgrading	With the fragmentation of industry at a global scale and the transfer of activities, local firms in developing countries can achieve enhancements in their production processes, a phenomenon referred to as upgrading. However, such improvements emerge under specific conditions, giving rise to the following research questions.	8. In your horticultural activities, have you implemented a reorganization of production, procedural changes, or the introduction of technology that enhances your products' sophistication and quality, as well as compliance with buyer-imposed requirements for worker safety and sanitary standards?
	Just as upgrading denotes advancement or improvement, downgrading reflects the stagnation of a productive activity, exhibiting no measurable progress, whether economic, organizational, or social, such as improvements in labor conditions.	9. Are the products you market primarily targeted at markets where they command higher value, even if this requires establishing new distribution channels? To achieve higher value in these markets, are there specific improvements that must be implemented before entering the new distribution channels?
Functional Upgrading	This category of upgrading warrants particular attention, as it closely mirrors the situation of produce companies in Arizona, which reorganize into new and higher-level functions, thereby enhancing the overall efficiency of the chain. These companies concentrate on processes such as commercial design, value-added functions, and the elimination of low-efficiency activities, allowing them to focus on tasks of greater strategic significance.	10. As a result of this productive reorganization with your produce partners, what new functions and skills have you developed? 11. How are these new functions carried out? Do they require special investment or specific knowledge? 12. Now that you have reached this level of business development, what future challenges, threats, and opportunities do you anticipate confronting in the coming years? 13. What actions have you recently taken to address these challenges?

Source: Own elaboration.

RESULTS

The following section presents the main findings, highlighting the functional upgrading process achieved by Mexican producers in northwestern Mexico within the GVC of fruit and vegetable products.

Communication and Trust Networks

The first theme identified pertains to communication and trust-based relationships among the various agents and firms within the global value chain (GVC) of fruit and vegetable products, which facilitate the transmission of critical information. The analysis revealed that chain integration requires the lead companies, primarily wholesale firms, including supermarket chains and large restaurants, to communicate product specifications to produce companies, which then relay this information to the producers. The complexity inherent in transmitting and interpreting this information reinforces client control over the process. As one interviewee explained:

> I speak with them every day, with the field director in Mexico. His name is Juan José. Practically every day we share information, whether it's market information, details about the fruit, how the fruit is coming in regarding temperatures; everything is discussed daily. (Informant S, personal communication, February 14, 2022)

> In the produce companies, the relationship with the farmer is one hundred percent [priority], always. Both the salespeople and the supervisors, the managers, we are always in communication with the farmers, so everything we do involves feedback. (Informant S, personal communication, February 12, 2022)

The above is crucial, as produce companies enable producers to be informed about and alerted to market trends:

> Look, one of our responsibilities is to know how to respond, because there are things we cannot predict. For example, unforeseen events like weather impacts, and what we have to do is find the best way to react. If we see that the market is becoming saturated, we need to communicate this to the producer, so they limit their packaging to only the products that will actually sell in a saturated market, where sales are more difficult. It's all about communication. (Informant V, personal communication, February 7, 2022)

Informant V comments: "No one really packages a product if they don't plan to sell it, and if they are going to sell it they have to satisfy a consumer. I mean, it doesn't make sense to pack something the consumer won't like." The role of the produce company, then, is that of an intermediary: "we don't handle the fruit, we don't touch the product, we only handle the boxes" (Informant V, personal communication, February 7, 2022).

In this particular chain, trust-based relationships and interdependence between suppliers and clients are especially important. Communication and trust are central to the interactions between produce companies and producers, to the extent that horticulturists sometimes deliver their products to produce companies without knowing the selling price, confident that the latter, who earn a commission based on a percentage of the sale, will secure the best price for the benefit of both parties. Additional testimonies underscore this dynamic:

> In reality, not much product is purchased within Mexico because the model has always been that the producer sends it here without a fixed price, and the distributor has to place it according to market conditions. In this case, we act as commission agents. As a produce company, we receive a commission based on the sale, which motivates us to always sell at high prices, that is, to seek the best price. (Informant V, personal communication, February 7, 2022)

> Look, normally when one exports fruit to the distributor, how does the distributor earn? How do they earn? They handle a ten percent commission on the gross sale. (Informant VI, personal communication, February 8, 2022)

Adaptation and Diversification

The second theme identified concerns changes in production and marketing trends in response to the demands of international markets, primarily in North America. A diverse range of goods exported from Mexico was observed, indicating that producers and exporters remain attentive to market requirements, adjusting their production to satisfy both local demand and export opportunities. As noted by the interviewees:

> Dark pumpkins are primarily directed to the colder regions of the United States. Zucchinis are targeted more toward the general public. It's a mix of vegetables, like the Italian gray zucchini. Since zucchini is highly perishable, we cannot ship very far, and the best option we have is the United States. There are other options, but they won't give you a better price. (Informant F, personal communication, June 9, 2023)

> Above all, I think more than 50 percent of our volume is in colored bell peppers: red, yellow, orange... In zucchinis, yellow squash, eggplants, but we also handle regular and mini watermelons, organic oranges, Italian squash, normal squash. (Informant RC, personal communication, June 7, 2023)

In this regard, producers have been attentive to changes in market demand:

> We have a new range of competing products, such as berries, cherries, strawberries, and other items like different types of peaches. The number of categories in supermarkets 25 years ago was around 200 products; now it's 600 to 700. A very clear example is bell peppers, which used to be only green; now there are red and yellow bell peppers, and all of that is attractive. (Informant JM, personal communication, May 8, 2022)

It is worth highlighting how producers also diversify their clients abroad, primarily targeting the Asian market, while adapting their products to align with consumer preferences. These adjustments are coordinated by produce companies and are evident in aspects such as bag and box sizes or the number of items per package. Moreover, producers engage in a continuous process of adaptation and specialization through the adoption of advanced technologies and adherence to quality and social responsibility standards (Porter, 1990; Gereffi & Mayer, 2004; Nadvi, 2008). Regarding consumer demands:

> It depends on the market. Some markets pay very well, such as Japan or the United Kingdom. At certain times, we send products by plane, while other markets are less expensive and require on-time delivery, so we ship by boat, as is the case with the Philippines, Taiwan, and Central America. (Informant JM, personal communication, May 8, 2022)

Regarding the presentation of their products:

> The way the product is offered, inside small bags or boxes. Grapes, for example, used to be sold loose; now they are sold entirely in bags. Many types of tomatoes, like cherry tomatoes, are sold in small cartons, but there are also tomatoes that are still sold in clusters, in groups

> of three or five. It's the presentation, above all, the way the product is presented. (Informant S, personal communication, February 7, 2022)

This has been made possible through continuous improvement: "There are high-tech greenhouses, which is why they produce tomatoes exactly as demanded by the market. They achieve this because they control all the conditions within the greenhouses" (Informant JM, personal communication, March 8, 2022).

In summary, the sector under study demonstrates strong dynamism, stemming from its adaptive capacity to consumer habits and the demands of various international markets. This underscores the importance of the relationships that producers and marketers maintain with their end customers.

Geography

The geographic location of Nogales, Sonora, plays a critical role in economic development, particularly by facilitating the international trade of fruit and vegetable products. This emerged as the third key theme from the collected data. For instance, the Canamex Corridor, which connects Canada, the United States, and Mexico, passes directly through the border area encompassing Río Rico and Nogales, Arizona, on the U.S. side, and Nogales, Sonora, on the Mexican side, positioning it as a strategic hub for the international trade of Mexican agricultural products. As one interviewee noted:

> The location of the produce companies is more related to the history of imports here in Nogales, because previously everything came by train, and later by road, mainly from Sinaloa, where they can harvest and export in winter, a period with low production. That is, there was almost no work in December, January, February, and March, but when the first winter shipment was sold, the produce industry took off here in Arizona. (Informant S, personal communication, February 7, 2022)

Northern Mexico plays a pivotal role in transporting perishable products to the United States, with the Nogales border serving as a critical point in this commercial flow (Gómez Vásquez, 2022). The data indicate that the geographic importance of Nogales in the horticultural global value chain, as well as the upgrading achieved by Mexican farmers, is not the result of a deliberate public policy but rather stems from the timing of Sinaloa's winter harvest, which coincides with a period of low agricultural trade activity in the region. As one interviewee observed: "Road conditions improved, and more and more fields were producing, so it was necessary to go to different locations to load the trailers in the fields or at the shipment points" (Informant S, personal communication, February 7, 2022). Similarly,

> What we began to see were wholesalers locating on the outskirts of the city, all with the idea of capturing a certain market share, a niche. Therefore, it was necessary to rely entirely on using trailers to move the product. The produce companies located here because U.S. transportation laws allow a Mexican driver to enter any part of the country, but they must return with an empty trailer. This makes it almost impossible for produce companies to be

> located far from the Mexican border. (Informant S, personal communication, February 7, 2022)

However, once products from Sinaloa, and later from Sonora, began to be exported, an economic boom occurred, leading to substantial growth in the number of produce companies located in this region. As one interviewee points out:

> The industry has grown somewhat; it grows every year, at a rate of two to three percent of the total volume. Nogales continues to grow, southern Texas, and parts of the Rio Grande region as well, in the cities—they grow, continue to grow, and sometimes have grown at a faster rate than Nogales. (Informant S, personal communication, February 7, 2022)

Another factor influencing the geographic significance of the study area is U.S. transportation regulations. Initially established under the North American Free Trade Agreement (NAFTA) and later under the United States-Mexico-Canada Agreement (USMCA), these regulations permit Mexican freight trucks to enter the United States and deliver goods, while generally prohibiting cabotage for foreign carriers. Although these measures protect the interests of the U.S. freight transport industry, they make it economically unfeasible for Mexican carriers to deliver goods far from the border. Consequently, the border area has been reinforced as a strategic node in the horticultural global value chain. As one producer explained: "Because of freight costs, the border is cheaper, and moreover, the companies that market for us with their warehouses are located in Nogales; they have clients in different states and handle distribution." (Informant JM, personal communication, March 8, 2022)

This region has historically functioned as the primary entry point for fruits and vegetables into the U.S. market, owing to its infrastructure and strategic location (Bickel et al., 2018). However, some interviewees expressed concern regarding the construction of new transportation routes in Mexico, as a shorter distance from producers in the interior of the country to markets in Texas and Florida could reduce transportation costs and, in turn, diminish Nogales' competitiveness. A notable example is the Mazatlán-Durango highway, which has facilitated the distribution of products from central and southern Mexico through the border into the United States via Nuevo Laredo or El Paso, Texas. In this context, one interviewee noted:

> Since better transportation routes and direct connections from Sinaloa to Texas were implemented, the sales window in McAllen, Texas, has indeed opened wider. Texas created a market for products consumed directly by the customer, so tomatoes, bell peppers, and other vegetables produced in Sinaloa or Sonora, which are consumed quickly and intended for supermarkets, are now transported directly to the eastern U.S. market through Texas rather than Nogales. (Informant LS, personal communication, March 5, 2022)

Product and Process Upgrading

The fourth key theme identified is the functional upgrading process, which has also driven product and process upgrading. The increased complexity of activities undertaken by produce companies stems from the challenges associated with establishing value chain governance (Gereffi et al., 2005)

and the execution of new strategic functions that add value to primary production. This process is illustrated by one interviewee:

> When crossing the border, your products must be inspected and numerous procedures completed, so you invest in quality because you don't want to risk your harvest. In Mexico, we have developed a first-class packaging system. Post-harvest technology, such as the pre-cooling process, involves automated sorting machines. Many products are sorted by color or selected by size; thus, all products are uniform in size, color, or ripeness. Technology has significantly improved many aspects of packaging. (Informant O, personal communication, June 9, 2023)

When wholesale clients impose higher specifications for merchandise, new demands arise for the supply chain, including just-in-time deliveries and elevated product quality, as discussed previously in the section on adaptation and diversification. This scenario necessitates the implementation of practices designed to streamline these operations, such as the establishment of technical and procedural standards (Gereffi et al., 2005). One interviewee affirmed this, noting:

> They're very sophisticated over there because they already have infrared lights. As the squash arrives, they sort it to determine if it's first-grade or super-quality. That's how they handle it in Japan. Mine meets the highest standard, since to guarantee exports you have to ensure the reliability of product traceability. Doing business with Japan is very different from the United States—you only need one distributor to sell in the U.S., but in Japan, you don't. (Informant MC, personal communication, May 17, 2023)

The collected data indicate that produce companies and horticulturists have enhanced their operational and production processes, including automating product sorting and packaging, implementing food safety protocols, using software for inventory and accounting management, cultivating in greenhouses, and adopting practices related to social responsibility and environmental stewardship. One interviewee remarked on this:

> The learning curve in the agricultural sector never really ends, and the key is to stay consistent so you can average your good years with your bad years. So, a field today is totally different from a field 20 years ago. We have moved into agroindustry; we are no longer just farmers. I didn't have a food safety manager before, now we have one for each field, and we have a social responsibility manager. The information systems are up to date—inventory and everything else. Agricultural companies use management software systems just like manufacturing plants. Agriculture businesses are no longer about planting and seeing what happens; now the farmer plants what will be sold, has production costs very well calculated, manages administration and organization efficiently, uses software, and keeps track of estimated production dates by week and day. (informant F, personal communication, June 9, 2023)

In summary, the functional upgrading observed in the agricultural GVC of northwestern Mexico has been instrumental in driving both product and process upgrading, thereby enhancing the competitiveness and efficiency of horticultural producers in international markets. This

upgrading entails that Mexican producers and produce companies have adopted advanced technologies and innovative practices, significantly improving product quality and diversification. As a result, the production system has become more attractive to international markets and capable of competing at a higher level—an essential factor for effective integration into GVCs and access to more lucrative market segments. The interviewees underscored this point, noting:

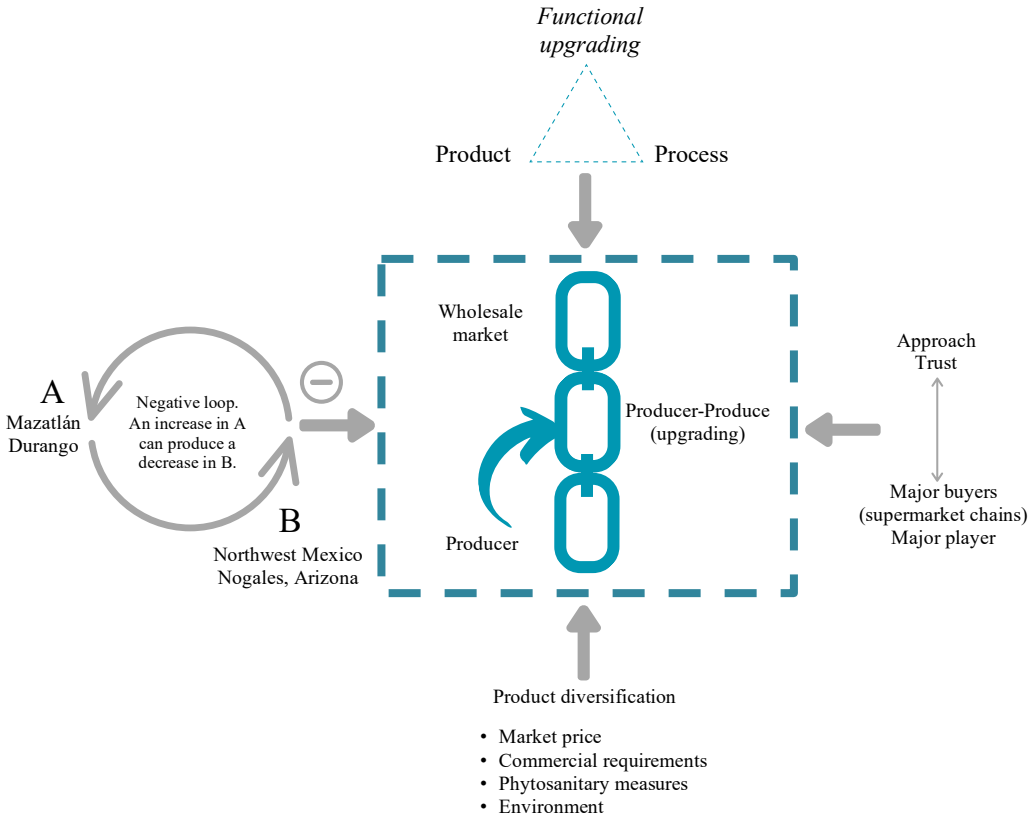
> The concept of the greenhouse was originally developed in cold regions to control temperatures, but the adoption of shade netting in greenhouses, such as in northern Sinaloa, was not primarily for temperature control—it was aimed at pest management. In fact, this practice has even reduced the need for pesticides through the use of shade nets and different greenhouse designs. (Informant S, personal communication, February 7, 2022)

> Regarding environmental issues, water management is extremely important. Each year, there are more restrictions on the use of herbicides and insecticides. These limitations are not only local or national but also global, imposing stricter regulations on producers. For example, as part of inspections, residue monitoring is essential—it is a very important matter. (Informant S, personal communication, February 7, 2022)

DISCUSSION

The four sections of the Results chapter illustrate the overall development of the Sonora-Arizona horticultural GVC across its various stages of growth and expansion, evolving from the export of cereals and grains to a diverse array of fruits and vegetables with highly specified qualities, distributed through production networks and supply routes. Throughout this process, producers have played a central role, providing critical information on shifts in consumer preferences in North America, as well as guidance on the technological adjustments necessary to enhance the productivity of horticultural activities in northwestern Mexico. In this context, Figure 2 schematically summarizes the four themes identified as particularly relevant for discussion based on these findings.

Figure 2. The Produces-Producers Relationships Within the Upgrading Process of the Northwestern México Horticultural Global Value Chain



Source: Own elaboration based on the results obtained.

First, the concept of upgrading is fundamental for understanding how farmers in Sonora and Sinaloa have increased their value-added within the global value chain (GVC), moving beyond the role of mere producers to directly engaging in the marketing of their products in the U.S. market, and, to a lesser extent, in the Asian market, while managing relationships with end customers (Gereffi, 1999). The results also highlight how these farmers have achieved both product and process upgrading, which are crucial for differentiating themselves in a highly competitive market and for meeting the stringent quality and food safety standards required in destinations such as the United States (Humphrey & Schmitz, 2002).

Second, the results reveal a territorial reorganization within the horticultural GVC of producers from the Costa de Hermosillo and, more broadly, northwestern Mexico. Of particular interest is the closer relationship that develops between producers and distributors through a work scheme centered on trust, diverging from conventional critiques of commercial exchange, in which marketing firms typically subordinate suppliers. This trust is grounded in shared identity, reinforced by long-standing business relationships and, in some cases, family ties, which align the interests of both parties in profit-sharing. It is important to note that produce companies earn income from the services they provide to producers, incentivizing them to act in the producers'

best interest. Nonetheless, this does not diminish the significant influence of large buyers, such as supermarket chains, who remain dominant actors in the value chain, dictating quantities, quality standards, and specific packaging requirements, compliance with which is essential to access the point of sale.

Notably, the grower-produce relationship facilitates the incorporation of changes requested by major buyers, promoting early adaptation to evolving food consumption patterns in the North American market. Trust is a critical factor in the development of "regional value chains," as it enables the exchange of information, knowledge, and skills, contributing to a horticultural sector that not only complies with U.S. regulatory standards but also meets, and in some cases exceeds, the expectations of end consumers.

Third, beyond commercial success and the development of upgrading processes across various dimensions, there is a notable level of interaction between producers and distributors aimed at ensuring that horticulturists adjust and diversify their products. This dynamic reflects the sector's capacity to adapt to commercial requirements, including phytosanitary measures, environmental challenges such as aquifer overexploitation, ethical labor practices, and, importantly, product pricing. These interactions foster innovation in agricultural operations through the adoption of technologies that enhance productive capacity, while simultaneously enabling producers to diversify both the variety and quality of the crops they bring to market.

Several clear examples illustrate product diversification, as reported by CONAGUA (2024b), based on the factors described above. One case is zucchini: at the beginning of the 2000s, the Costa de Hermosillo recorded an annual pumpkin harvest of approximately 32 000 tons, with an average yield of about 16 tons per hectare (ton/ha). In the following decade, pumpkin cultivation was largely replaced by zucchini (or *calabacita*), with annual production reaching nearly 80 000 tons and an average yield of 32 ton/ha. Another example is cucumber: production began at roughly 2 000 tons in the early 2000s, growing to 20 333 tons by 2016 and 40 018 tons by 2020. A similar trend is observed for watermelon, whose production ranged between 40 000 and 80 000 tons until 2013 and subsequently increased to a total of 367 000 tons by the end of that decade.

It is important to note that, although environmental factors were identified as determinants of adaptive capacity within the produce-producer relationship, a limitation of the present study is that these factors were not addressed as a theoretical reference to be contrasted with the empirical findings. Nonetheless, it is anticipated that environmental issues—particularly the recurring water stress in northwestern Mexico—will play an increasingly significant role in shaping changes to products and processes in the agricultural sector and, consequently, in the governance of the global value chain (GVC). According to Hernández Vásquez (2021) and CONAGUA (2024a), droughts intensified in 1997, 1999, 2000, 2011, 2013, 2017, 2018, 2020, 2021, 2022, and 2023, a trend expected to continue in light of the ongoing impacts of climate change.

In this context, the functional, product, and process upgrading of farmers in northwestern Mexico will increasingly depend on the design and implementation of climate change adaptation and mitigation strategies. Measures such as crop diversification, improvements in irrigation

systems, and investment in climate-resilient technologies can not only reduce vulnerability to extreme events but also enhance competitiveness in international markets, where sustainability considerations are becoming increasingly important (Ponte, 2019).

Fourth, although geography has historically favored the study area, due to the characteristic growing seasons of northwestern Mexico and U.S. cargo transport regulations, this advantage is not permanent. The construction of the Mazatlán-Durango highway in 2012, part of Federal Highway 40 extending from Mazatlán to Matamoros at the U.S. border, has enabled producers from Mexico's southern Pacific horticultural region to use this route, thereby reducing the distance to markets in Texas and Florida. As several interviewees noted, this development has weakened Nogales' role as a key node in the commercialization of these products.

In this context, and to maintain its strategic relevance, Nogales must innovate and enhance its logistics services, adapting to the evolving dynamics of cross-border trade. Investments in technology, improvements in customs processes, and binational collaboration are essential to reinforcing its position as a key hub for the transportation of perishable products in northern Mexico. The consolidation of these commercial links is strongly influenced by the geographic distribution of borders, territories, and the distances between production nodes and final product destinations. This reflects a reorganization of production chains in this subsector, a process further intensified by the current environment of trade conflicts and nearshoring. Consequently, agricultural GVCs appear to be increasingly concentrating on a regional rather than a global dimension, an issue that future research will need to examine from an ontological perspective.

Finally, the four points discussed above suggest that the analyzed GVC exhibits a *market-type governance* structure. As outlined in the theoretical framework, this governance type is characterized by a relatively low level of influence from the lead firm, in this case, wholesale companies such as supermarkets and restaurant chains. The primary control mechanism is the market-determined price, and the relationships among the various agents or actors within the chain remain comparatively stable. It is noteworthy that this governance type features low entry barriers, resulting in frequent changes of suppliers.

Regarding the determinants of this type of governance (see Table 1), the following observations can be made: *(i)* the complexity of communication between agents for transmitting information and knowledge about demanded products is low, as fruits and vegetables are largely standardized and do not require extensive specifications; *(ii)* considerable skills are needed to interpret and act on information provided by final customers, as the results indicate that both produce companies and producers have diversified their products and processes in response to evolving consumption patterns; and *(iii)* a high capacity on the part of suppliers (producers) is essential to meet customer requirements regarding the color, shape, and size of fruits and vegetables.

When these three factors are considered together, which collectively determine market-type governance in the GVC, two relevant consequences emerge, as noted by Ponte (2019). First, the low specificity of the products allows the lead firm to shift costs onto the companies lower in the chain, a topic that warrants further investigation due to its significant implications for the economic

and social development of agricultural areas in Sonora and Sinaloa. Second, this same low product specificity generates increased competition among producers. Consequently, and this is the key insight, the improvement of a producer is achieved by moving up within the GVC through changes in function or economic activity, such as transitioning from a producer to a distributor, which is precisely the phenomenon observed among the Mexican farmers analyzed in this study.

CONCLUSIONS

This study analyzed the horticultural global value chain (GVC) in northwestern Mexico, with a particular focus on Sonora and Arizona, highlighting how producers in this region have achieved functional upgrading. Functional upgrading is understood as the continuous learning process by which horticulturists align their agricultural practices with those of developed economies, while also incorporating specific functions such as negotiating with large buyers, opening new distribution channels, analyzing market demand, and capturing competitive advantages in the food market. This process effectively enables producers to transition into distributors in international markets, particularly in the United States. This transformation was examined within the theoretical framework of GVCs.

The study identified a process of adaptation and diversification in response to the demands of the North American market, including the expansion of exported product varieties with specific qualities, such as taste, color, size, and shape, tailored to consumer preferences, while also enhancing nutritional value. Furthermore, the geographic location of Nogales emerged as a key node for the international trade of horticultural products, serving as a direct route to the North American market and facilitating the development of the produce industry. The findings also highlight the increasing complexity of activities within the GVC, which introduces new governance challenges, shifting from a vertical, hierarchical model dominated by a major buyer toward a more horizontal approach characterized by relational and modular governance and inter-local cooperation.

The study demonstrates that interaction and trust between producers and distributors have been central to effective adaptation to changing market conditions, emphasizing the importance of innovative practices and efficient supply chain management for global competitiveness. These findings are crucial for understanding the dynamics of GVCs and their capacity to respond to contemporary environmental and economic challenges, calling for a reconsideration of traditional approaches to the international division of industries, with greater attention to specific geographies and the emergence of regional value chains.

Translation: Erika Morales.

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