

# Impact of producer profiles on the sustainability of protected agriculture: analysis of the COMESA value network

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## ABSTRACT

**Objective:** to analyze how producer profiles influence the sustainability of production units under protected agriculture, using historical customer records and the dynamics of a Mexican agribusiness, COMESA's value network, as a case study.

**Design/Methodology/Approach:** producers were segmented into three main groups —subsidized producers (inductees), entrepreneurs, and intermediary service providers— based on their financial and operational characteristics. Transaction recurrence was analyzed as an indicator of financial sustainability. Some tools of social network analysis were also applied to map their integration into the value network.

**Results:** entrepreneurial producers showed greater operational continuity and a significant share for COMESA's revenues. This financial power is reflected in more sustainable production units. In contrast, subsidized producers showed low transaction recurrence and weak loyalty, which limits the long-term sustainability of those production units.

**Limitations/Implications of the study:** despite this analysis is based on the records of a single company, our findings offer a replicable framework that can guide support strategies in similar contexts.

**Findings/Conclusions:** strengthening connections with strategic stakeholders —such as financial institutions, marketing companies, and technical advisors— is essential to improve the sustainability of production units, especially among the most vulnerable producers. Considering producer profiles in development programs can improve long-term results.

**Keywords:** protected agriculture, value network, productive sustainability.

**Citation:** Alvarado-Chávez, L. G., Altamirano-Cárdenas, J. R., Alvarado-Raya, H. E., Muñoz-Rodríguez, M., & Patiño-Delgado, A.L. (2025). Impact of producer profiles on the sustainability of protected agriculture: analysis of the COMESA value network. *Agro Productividad*. <https://doi.org/10.32854/ej2cdm12>

**Academic Editor:** Jorge Cadena Iñiguez

**Associate Editor:** Dra. Lucero del Mar Ruiz Posadas

**Guest Editor:** Juan Francisco Aguirre Medina

**Received:** December 11, 2024.

**Accepted:** October 11, 2025.

**Published on-line:** December XX, 2025.

*Agro Productividad*, 18(11). November. 2025. pp: 31-39.

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## INTRODUCTION

Protected agriculture is established as an essential strategy to address challenges such as climate change, water scarcity, and food security. In Mexico, the area devoted to this type of crops has experienced significant growth in the last decade, reflecting producers'



ability to adapt to increasingly demanding environmental conditions and market demands. However, the success of these units is not based solely on technology, but also on network dynamics and the specific characteristics of farmers, who face challenges in terms of financing, technical training, and access to competitive markets. Worldwide, the adoption of protected agriculture systems has allowed for optimized yields and improved quality of agricultural products. Solid evidence demonstrates their potential to overcome environmental limitations and effectively respond to market demands.

In Mexico, official data show an upward trend in the total area cultivated under this model, underscoring its growing importance in the agrifood sector. For these reasons, this study focuses on analyzing the dynamics that influence the sustainability of production units under protected agriculture, considering the role played by the interaction between producers and other key actors in the value network. Our approach sought to contribute elements for the formulation of public policies and the design of business strategies that promote technological adoption, as well as the effective integration of producers into more resilient value networks. Through the case study of COMESA, a Mexican enterprise dedicated to the integral development for agribusiness, we examined how different client profiles relate to their ability to remain and consolidate within this productive system.

The objective was to analyze how producer profiles influence the sustainability of production units under protected agriculture, using historical customer records and the dynamics of a Mexican agribusiness, COMESA's value network, as a case study.

## **MATERIALS AND METHODS**

The study focused on COMESA, a Mexican family business specialized in greenhouse construction and the provision of technologies for protected agriculture. Since its founding in 2012, COMESA has operated in 20 states in Mexico, allowing it to analyze a variety of agroecological conditions and levels of technological development. This background offers now a representative perspective on the production dynamics in the protected agriculture sector.

The analysis covered the period 2012 to 2023, integrating both the early years of consolidation of the company and recent changes in public policies, especially the reduction in subsidies since 2020 (Hernández Suárez, 2021). This timeframe facilitated the assessment of the impact of those transformations on sustainability and on the dynamics of producers within the value network. Quantitative information was obtained from the internal records of COMESA, which included detailed data on commercial transactions operated during the study period. Key client information was collected, such as the type of project, payments in the contract, frequency of purchases, and characteristics of the business relationship. All of which allowed us to integrate a robust database on business dynamics.

Additionally, semi-structured interviews were conducted with key actors in the value network to validate and enhance, with complementary information, the trends observed in historical records. According to Kvale (2007) recommendations, a flexible thematic guide was used to delve deeper into emerging issues during qualitative data collection. Ten interviews were conducted; six with entrepreneurial producers; three with technical service

providers, two of them specialized in high-tech production and one with representation in the Secretariat of Agricultural Development; finally, one with a supplier who also acts as a competitor.

To visually analyzing and mapping the strategic interactions of COMESA with its environment, social network analysis tools were used; specifically, UCINET (Borgatti *et al.*, 2002) and Gephi (Bastian *et al.*, 2009). UCINET allowed the analysis of structural properties of the network, such as modularity; while Gephi facilitated the graphical representation of complex interactions, helping to identify patterns and areas for improvement.

The methodology was structured in three main stages. First, a segmentation of COMESA's customers was featured (Alvarado Chávez *et al.*, 2024) based on market segmentation principles (Kotler & Keller, 2016), as well as on the typology of entrepreneurial families (Islas Moreno *et al.*, 2023). This classification facilitated the grouping of customers according to common operational, financial and relational characteristics, thus allowing the analysis of their behavior within the value network. Second, recurrence of transactions was analyzed using statistical techniques that provided indicators on the impact of each segment on the financial stability of the company (Fernández, 2017). Finally, the interactions between the main actors related to COMESA were evaluated, considering how those relationships contribute to the creation of value, and to the sustainability of agricultural operations (Muñoz Rodríguez & Santoyo Cortes, 2020).

Our methodological approach was based on the conceptual definition of systemic innovation manager (Klerkx *et al.*, 2009). This approach emphasizes the role of intermediary individuals or organizations that facilitate interaction and capacity building in complex systems; promoting collaboration and the co-creation of innovative solutions. From this perspective, COMESA was analyzed as a systemic innovation manager within the value network of protected agriculture. The combination of quantitative and qualitative methods provided a comprehensive view of the commercial and relational dynamics of the company. This approach allowed us to identify critical factors influencing the sustainability of production units, and to offer a replicable methodological framework for other companies in the protected agriculture sector.

## RESULTS AND DISCUSSION

Analyses showed that the profiles of producers directly influence the sustainability of their production units and their behavior within the value network. Based on COMESA's historical records, three customer segments were identified, subsidized producers (inductees), entrepreneurial producers, and intermediary service providers (Alvarado Chávez *et al.*, 2024). Each group presents distinct operational characteristics and interaction patterns, which affect their ability to remain in the protected agriculture market.

Subsidized producers, mostly small rural farmers, accessed technologies through government subsidies. Their participation focused on small-scale projects geared toward self-consumption, with limited technical integration and weak market connections. Although they represented 76% of the total clients served by COMESA, their economic

contribution was 15% during the 2012-2023 period due to their low recurrence and limited investment capacity. This situation reflects a strong dependence on external resources and weak institutional coordination (Scott, 2014).

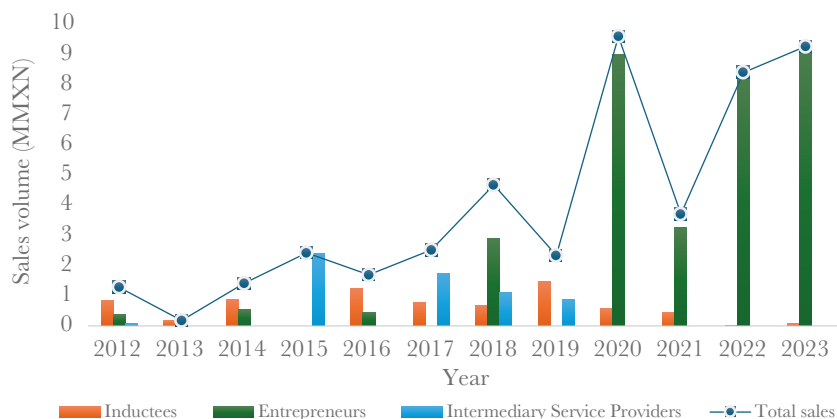
Muñoz Rodríguez *et al.* (2020) argued that, although subsidy-based programs seek to incentivize production and improve living conditions in rural areas, they do not address the structural causes that limit sustainable development, such as lack of access to markets and adequate technology. On the other hand, Aguilar Gallegos *et al.* (2013) emphasized that improving the sustainability of the subsidized group would require developing technical capacities, a better selection of beneficiaries, and to promote their integration into competitive markets. Furthermore, providing ongoing technical support, especially for larger, collaborative projects, would be essential to ensure operational and financial success.

In contrast, entrepreneurial producers consolidated their position as the most economically relevant segment. Representing only 18% of total clients, they generated 72% of COMESA's revenue. This group is composed of continuing professionals with advanced technology, new entrants with an entrepreneurial vision, and returnees with capital accumulated in other sectors, according to the typology of Islas Moreno *et al.* (2023). The ability of these participants to combine their own resources, private financing, and partial subsidies has allowed them to operate larger-scale greenhouses and maintain a sustained market presence.

A third segment, identified as intermediary service providers, played a prominent role in COMESA's early years of operation. This group consisted of professionals and companies that acted as project managers, channeling resources to end-producers through the technical support provided by COMESA. Between 2012 and 2018, those participants facilitated the execution of numerous projects financed by public subsidies. However, starting in 2020, their participation decreased significantly, and they ceased to appear as recurring clients. The reasons for this departure are linked to changes in subsidy policies, more rigorous evaluation criteria, and technical feasibility issues in the managed projects. The disappearance of this segment reflects a transition from the intermediation model to direct relationships between producers and specialized suppliers.

In the evolution of these segments and their economic participation, we observed how the reduction in subsidies starting in 2020 modified COMESA's revenue structure (Figure 1). The change in public policies primarily affected subsidized producers, who reduced their presence and transactions. In contrast, entrepreneurial producers maintained or even increased their investment; these participants demonstrated greater resilience facing institutional changes.

These findings are consistent with those reported by Muñoz Rodríguez y Santoyo Cortes (2020), who highlight that institutional coordination and engagement with strategic stakeholders largely determine access to key resources and continued production. Similarly, similar studies in Latin America have documented that farmers with a greater capacity to build strong relationships with suppliers, institutions, and markets tend to maintain more stable operations (Klerkx *et al.*, 2009).



**Figure 1.** COMESA revenue records, by market segment during the period 2012-2023.

**Transaction recurrence, recommendations and post-2020 adaptation**

The recurrence of transactions reinforces the differences among the segmented profiles of producers. Entrepreneurial producers do subsequent transactions with greater frequency and economic volume, which indicates a more stable and long-term business relationship. This recurrence not only implies operational continuity, but also confidence and reinvestment capacity. These are key indicators of sustainability in the context of protected agriculture (Table 1).

Beyond purchasing power, transaction recurrence exhibits interaction dynamics based on mutual trust and reputation between producer and supplier. Producers who return to COMESA do so not only out of a need for expansion, but also because they perceive value in support, technical advice, and the quality of service received. This long-term relationship generates a multiplier effect within the network, as it allows for constant feedback, technological updates, and shared access to successful experiences.

COMESA data indicated that only 9% of its customers made recurring purchases during the 2012-2023 period; however, this group generated 56% of the company’s total revenue. Sales recurrence is therefore emerging as a critical indicator of financial and operational sustainability. Recurring customers not only returned for new services but also strengthened their business relationship with the company, which expresses continuity in the operation of its production units.

**Table 1.** Distribution of recurring sales by segment in COMESA (2012-2023).

	Initial sale		Subsequent sales	
	Transactions	Sales (MMXN)	Transactions	Sales (MMXN)
Inductees	9	0.87	18	1.16
Entrepreneurs	7	12.82	11	10.02
Intermediary SP	6	0.49	9	1.18
Totales	22	14.18	38	12.36

Inductees, Entrepreneurs, Intermediary Service Providers.  
 Inductees (subsidized producers); SP: Service Providers; MMXN: Millions of Mexican pesos (2012-2023).

An analysis of transaction patterns showed that, starting in 2020, the proportion of customers making recurrent purchases increased significantly. This trend coincides with the market reconfiguration following the reduction of government subsidies. Such a decrease forced many producers to rely on their own resources and to seek more stable business relationships. In this context, entrepreneurial producers demonstrated greater adaptability, strengthening their ties with COMESA and other key participants in the value network.

In addition to recurring sales, the referral channel was also crucial; 97% of COMESA's sales during the period analyzed came from referrals from satisfied customers (Table 2). This dynamic underscores the importance of a positive customer experience as a driver of business growth. Recurrent producers not only generate direct income but also act as active promoters within the sphere of protected agriculture.

The combination of recurring and referrals represents a dual indicator of sustainability. On the one hand, it ensures constant economic flows; on the other, it expands the value network by attracting new customers with similar profiles. This dynamic reinforces the position of entrepreneurial producers as strategic players in the sector and confirms the relevance of their profile to the continuity of the production model.

From a public policy perspective, the results suggest that simply providing subsidies to small-scale producers is not enough. It is essential to support them with strategies that promote their progressive integration into value networks with higher density. Strengthening technical, financial, and organizational capacities should be an integral part of support programs, with differentiated schemes based on the profile of producers. Furthermore, supplier companies such as COMESA can play an active role in building relationships and transferring knowledge.

### Value Network and the integration role of COMESA

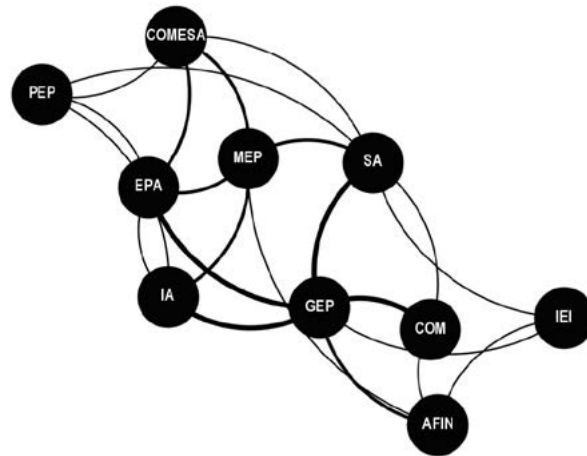
The structural analysis of the value network allowed us to map the interactions between the main actors linked to protected agriculture in Mexico. Using UCINET (Borgatti *et al.*, 2002) and Gephi (Bastian *et al.*, 2009), different levels of collaboration and connectivity were identified among producers, marketers, suppliers, financial institutions, public entities and research institutions.

The general network of participants linked to greenhouse systems shows COMESA, with particular emphasis on its role as an articulation node (Figure 2). Its central location in the network reflects its ability to connect producers with other key participants, including

**Table 2.** Sales distribution and transaction recurrence in COMESA, as made by client-client referrals (2012-2023).

	Referral sales		Non-referral sales		Total sales	
	(MMXN)	(%)	(MMXN)	(%)	(MMXN)	(%)
Recurring customers	26.50	99.9	0.04	0.1	26.54	56
Non-recurring customers	19.51	93.2	1.43	6.8	20.94	44
Total	46.01	96.9	1.47	3.1	47.48	100

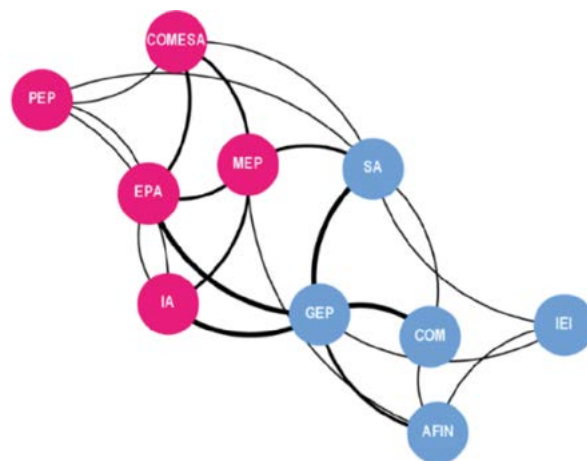
MMXN: millions of Mexican pesos.



**Figure 2.** General linkage network in COMESA's value network. EPA: agricultural production specialists; COM: marketing companies; IA: agricultural inputs; SA: Secretariats of Agriculture; PEP: small production enterprises; MEP: medium production enterprises; GEP: large production enterprises; IEL: education and research institutions; COMESA: greenhouse builders; and AFIN: financing agencies.

financing agencies, educational institutions, and marketing companies. This position facilitates transfer of knowledge, technology adoption, and access to complementary services. All of which are critical elements for the sustainability of production units in protected agriculture.

The modularity analysis showed the existence of two large communities within the network (Figure 3). The first one, comprised of smaller-scale producers, shows limited connectivity, primarily with Government agencies. The second, comprised of medium- and large-scale producers, marketing companies, financial institutions, and research centers, presents a more cohesive and articulated structure. This segmentation suggests a structural barrier that prevents the integration of small producers into networks with greater technical and commercial capacities.



**Figure 3.** Modularity in COMESA's linkage network. EPA: agricultural production specialists; COM: marketing companies; IA: agricultural inputs; SA: Secretariats of Agriculture; PEP: small production enterprises; MEP: medium production enterprises; GEP: large production enterprises; IEL: education and research institutions; COMESA: greenhouse builders; and AFIN: financing agencies.

Within this articulated community, large production companies (GEP) are noticeable, operating on a significantly larger scale, with greenhouse surfaces exceeding 50 hectares. According to Pratt & Ortega (2019), these companies present a higher level of vertical integration, controlling everything from production to marketing and export of their products. They also use cutting-edge technologies, such as hydroponic crops and automated systems, and comply with strict international quality and safety standards to access export markets, especially in the United States.

The presence of GEPs establishes high standards of efficiency and competitiveness that, while raising the technological level of the sector, also generate significant gaps. Their disconnection from small and medium-sized producers restricts opportunities for knowledge transfer, adoption of advanced technology, and access to higher-value marketing channels. This structural fragmentation contributes to perpetuating inequalities within the network and reinforces the need for mechanisms that promote inter-segment linkages.

Entrepreneurial producers, located at the core of the densest network, maintain frequent ties with technical advisors, financial institutions, and strategic buyers. These connections strengthen their capacity to innovate, adapt, and remain competitive. In contrast, subsidized producers operate on the periphery of the network, with predominantly assistance-based ties, which limits their access to technology, training, and higher-value markets.

COMESA's role in this context transcends its commercial function. It acts as a systemic innovation manager, promoting connections between participants and facilitating capacity building among producers. This role is particularly valuable for strengthening the integration of marginalized segments within the protected agriculture system and promoting more balanced and sustainable collaboration schemes.

## CONCLUSIONS

This study confirmed that the producer profile significantly influences the sustainability of production units under protected agriculture. Data showed that entrepreneurial producers have higher levels of permanence and transaction recurrence, which means investment capacity, growth vision, and articulation with strategic stakeholders in the sector. Sales recurrence identified patterns of operational continuity that demonstrate favorable conditions for the consolidation of entrepreneurial producers; for example, their relationships within the value network. In contrast, subsidized producers exhibit more irregular participation, associated with financial limitations and weaker institutional ties.

The value network analysis highlighted COMESA as an integrating agent, due to facilitating links among producers, financing agencies, marketing companies, and research institutions. Articulation is key to strengthening technical and organizational capacities, especially in contexts where technical support is limited. Results offer valuable elements for the design of differentiated support, financing, and technological innovation strategies aimed at strengthening the permanence of producers in protected agriculture systems. Understanding the producer profile and their relational dynamics is a strategic component for public policies formulation and business decision-making in this sector.

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