Colegio de Postgraduados

Response of economic indicators of guava (*Psidium guajava* L.) production to public policies: Mexico

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ABSTRACT

Objective: To estimate the profitability, competitiveness, and efficiency of guava production in Mexico in order to determine whether agricultural public policies have strengthened or undermined its economic performance.

Design/methodology/approach: The Policy Analysis Matrix (PAM) was applied, complemented by the Relative Economic Competitiveness Index. Private prices and production costs were compiled from Mexico's guava-producing states. For each production system, data were collected on cultivated area, yield, output, production system type, input units, wages, and farm-gate and marketing prices.

Results: At private prices, 98.45% of guava production was profitable and 94.75% was competitive; under social prices, these proportions declined by 4.35 and 2.85 percentage points, respectively. Additionally, 92.88% of production exhibited comparative advantages, concentrated in 6.25% of the guava-producing states. In 93.75% of state-level production systems, agricultural policy was pivotal for sustaining guava production; conversely, in Michoacán and Aguascalientes, policy was not a determining factor. Production displayed favorable relative competitiveness for investors, but not from a social perspective.

Findings/conclusions: Guava production in Mexico showed high profitability and competitiveness under both private and social prices. Comparative advantages were identified only in the production systems of Aguascalientes and Michoacán. Overall, agricultural public policies enhanced profitability, competitiveness, and efficiency, particularly in states characterized by rainfed production systems.

Keywords: comparative advantage; competitiveness; profitability; market failure; subsidy

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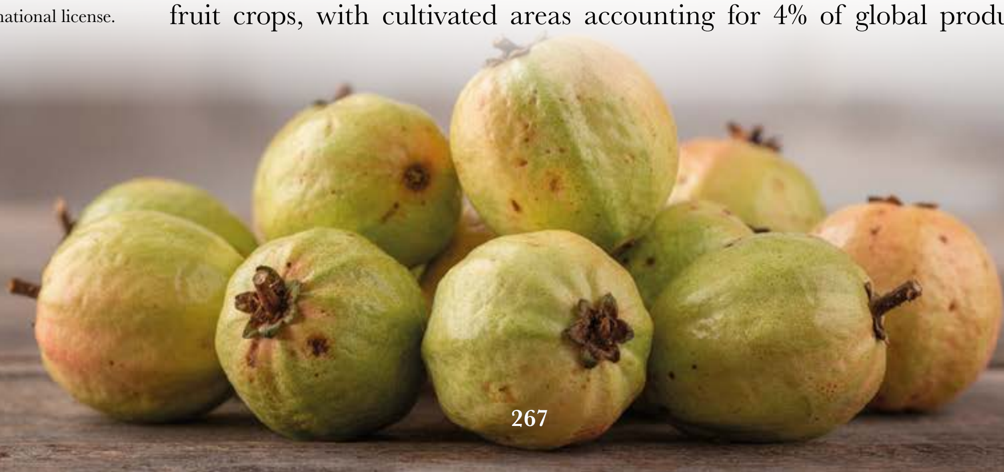
INTRODUCTION

Guava (*Psidium guajava* L.) is a prominent crop in Mexico, with strong global consumer acceptance largely attributable to its contribution of health-promoting nutrients, according to the Secretaría de Agricultura y Desarrollo Rural (SADER; formerly the Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación [SAGARPA]) (SADER, 2019). From an international trade perspective, guava is one of the country's relevant fruit crops, with cultivated areas accounting for 4% of global production (Servicio de



Información Agroalimentaria y Pesquera [SIAP], 2025). Accordingly, guava production in Mexico exhibits substantial potential for profitability and competitiveness, particularly in Michoacán, Aguascalientes, and Zacatecas, which lead national output (SIAP, 2024). To consolidate this potential, public policies play a strategic role by integrating economic and productive instruments; nonetheless, their design and implementation may generate both favorable and adverse effects. On the one hand, subsidies, tax incentives, and accessible credit can reduce production costs and enhance farmers' relative profitability (SAGARPA, 2007). Conversely, SAGARPA (2007) cautions that government transfers can render the sector's profitability unsustainable. Similarly, Wenqi *et al.* (2022) contend that such instruments constrain sectoral competitiveness. González and Orrantia (2006) argue that investment should prioritize support services to increase agricultural productivity rather than focusing on expanding subsidies. In addition, SADER (2023) notes that technological modernization, improvements in irrigation systems, and training in sustainable practices raise agricultural productivity. Despite the sector's commercial dynamism and the presence of fiscal incentives in Mexico's agricultural sector, the cultivated area devoted to guava has remained stagnant; from 2000 to 2024, the planted area stayed relatively constant (SIAP, 2025). According to the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP, 2018), Mexico has the potential to expand the planted area for this crop, primarily in tropical and subtropical zones. No national-level studies have been identified that analyze guava production in Mexico using the Policy Analysis Matrix (PAM). The crop's social profitability, its comparative advantages, and the effect of public policies and market distortions on competitiveness and efficiency across producing states remain insufficiently documented. Guava was selected due to its regional importance and its sensitivity to public policy, which enables the assessment of economic effects that are less apparent in fruit crops with greater export weight. Against this backdrop, the objective of this research was to estimate the profitability, competitiveness, and efficiency of guava production in Mexico within private and social production frameworks. Specifically, the study assessed whether agricultural public policies in force as of 2024 increase these economic indicators or, alternatively, diminish them. To examine public policies, it was necessary to distinguish private profitability from social profitability in order to identify market failures and the divergences associated with State intervention.

MATERIALS AND METHODS

Information used

Statistical tests (α=0.05) were conducted in SPSS v27 to analyze measures of central tendency for the private and social economic indicators of profitability, competitiveness, and efficiency across Mexico's guava-producing states in 2024, with the aim of drawing inferences regarding the observed differences among these indicators. The analysis did not incorporate environmental externalities. Private and social economic indicators of profitability, competitiveness, divergences, and efficiency were estimated using the Policy Analysis Matrix (PAM) proposed by Monke and Pearson (1989), based on state-level averages. This methodology is structured as a two-entry matrix in which rows correspond to revenue, tradable input costs, and domestic factor costs; the resulting balance reflects profitability (González & Alferes, 2010). The Programa de las Naciones Unidas para el Desarrollo (PNUD, 2018) notes that social competitiveness comprises the income, health, and education dimensions. In this context, and for the purposes of the present study, the social assessment of competitiveness was grounded in the Social Competitiveness Economic Coefficient (SCEC), adopted as a technical approach to estimate the effects of public policies and market distortions on productive competitiveness evaluated at social prices. In addition, the Relative Economic Competitiveness Index (RECI) was proposed as a methodological tool to assess the private benefit-cost ratio (BCR) and social competitiveness (SCEC).

$$RECI = \frac{BCR}{SCEC}$$

The RECI makes it possible to determine the extent to which competitiveness observed under private conditions differs from that assessed from a social perspective, thereby facilitating a comparative analysis of economic efficiency.

Private profitability and competitiveness

Annual average private production prices and costs were obtained for Mexico's guava-producing states (SIAP, 2025). For each production system, information was drawn from the Comisión Nacional de los Salarios Mínimos (CONASAMI, 2023), the (INIFAP, 2025), SIAP (2025), and the Instituto Nacional de Estadística y Geografía (INEGI, 2024). The dataset included planted, harvested, and loss-affected area (ha); total output (kg) and production value (thousands of pesos); production system type (irrigated and rainfed); Guava Production Units (GPUs) (the acronym will be used consistently throughout the document to refer to guava production units); yield (kg/ha); agricultural day-labor wages; and local, national, and export marketing prices.

Private profitability (D) was estimated as the difference between total revenues (A) and the sum of tradable input costs (B) and domestic factor costs (C), incorporating subsidies into both components (Monke & Pearson, 1989). Private competitiveness was assessed using the private benefit-cost ratio (BCR), which expresses the capacity of the production system under prevailing technology, prices, and policy interventions to cover domestic factors with the value added at market prices (Monke & Pearson, 1989; SAGARPA, 2019). Values of $D>0$ indicate profits, $D=0$ break-even, and $D<0$ losses. For the BCR, values <1 indicate competitiveness, $=1$ economic equilibrium, and >1 a lack of competitiveness. From a policy standpoint, $D>0$ and $BCR<1$ indicate financial viability; values near break-even suggest vulnerability to changes in prices or costs; whereas $D<0$ and $BCR>1$ imply a need for interventions aimed at improving productivity, technological efficiency, or access to inputs.

Profitability and competitiveness at social prices

Social profitability (H) was estimated as the economic return obtained by valuing goods and factors of production at their opportunity cost (Monke & Pearson, 1989). It was calculated as the difference between social revenues (E) and the sum of tradable input costs (F) and domestic factor costs (G), both evaluated at social prices. Values of H>0 indicate economic efficiency and social profitability; H=0 indicates recovery of the opportunity cost of resources; and H<0 indicates inefficient use of factors. Social prices were estimated following SAGARPA (2019), under the assumption that they reflect values undistorted by public policy or market failures (Monke & Pearson, 1989). Their calculation used the 2024 average exchange rate (18.33 MXN/USD) (Secretaría de Hacienda y Crédito Público [SHCP], 2025), together with information on tariffs, international prices of inputs and intermediate goods, and prevailing taxes and subsidies obtained from the Servicio Nacional de Información de Comercio Exterior (SNICE, 2025) and SHCP (2023), according to the following formula:

$$Ps = \Big[\big(Pm - \big(Pcsf\,\$(1+VM)\big) + S - I(1-C)\big) + \big(Pm - Pcsf\,\$(1+VM)\big) + S - I\left(C\left(\frac{PCm(1-IVA)}{PCm}\right)\right)\Big] + \Big[\big(Pcsf\,\$(1+V)\,T\$s\big)\Big]$$

Ps represents the social price of inputs and intermediate products, whereas *Pm* is the market price of the input in the Guava Production Units (GPUs). *Pcsf* \$ corresponds to cost, insurance, and freight (CIF) in U.S. dollars; *VM* and *VAT* refer to value-added tax rates; *V* denotes the import tariff; *S* and *I* correspond to subsidies and direct taxes; *C* is the percentage of transportation cost associated with fuel; *PCm* is the market price of fuel; and *T*\$*s* is the shadow exchange rate, based on the 2024 average exchange rate. The Social Competitiveness Economic Coefficient (SCEC) was calculated as the benefit-cost ratio at social prices $\big(SCEC = E/(F+G)\big)$, where *E* denotes revenues and $F+G$ represents factor and tradable input costs valued at opportunity cost (Monke & Pearson, 1989). Values greater than 1 indicate competitiveness, values below 1 indicate a lack of competitiveness, and a value of 1 implies that costs are only just covered.

Nominal and effective protection coefficients

Policy effects and market failures on the production system were assessed using protection coefficients. The Nominal Protection Coefficient (NPC) measures the divergence between private and social prices caused by taxes, subsidies, or other distortions (Monke & Pearson, 1989). For tradable outputs, it was estimated as $NPC_c = A/E$, where values >1 indicate price protection (an implicit subsidy) and values <1 indicate dis-protection or implicit taxation. For tradable inputs, it was calculated as $NPC_i = B/F$; values >1 indicate that producers pay for inputs above their social cost, whereas values <1 indicate subsidized inputs. Effective protection was evaluated through the Effective Protection Coefficient (EPC), which integrates the analytical framework of the Policy Analysis Matrix proposed by Monke and Pearson (1989) with methodological guidelines from the Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO, 2000), providing a robust theoretical basis for analyzing distortions in agroproductive systems. This indicator simultaneously incorporates divergences in outputs and inputs and their effect on value added, and was estimated as $EPC=(E-F)/(A-B)$. Values of EPC>1 indicate net protection for the productive activity, whereas values <1 indicate dis-protection. Nevertheless, the NPC and EPC do not fully capture the economic incentives faced by producers (Monke & Pearson, 1989).

Divergences and efficiency

Divergences (I) between evaluations at private and social prices reflect the effects of government intervention and market failures on the profitability of production systems, allowing identification of distortions that affect the efficient allocation of resources (Monke & Pearson, 1989). This indicator was estimated as the difference between revenue at private prices (A) and revenue at social prices (E). Values of I>0 indicate that the activity receives protection or benefits derived from policies or distortions that raise private profitability above social profitability; I=0 suggests the absence of relevant distortions and an efficient allocation of resources; whereas I<0 indicates dis-protection or implicit burdens that reduce private profitability despite economic efficiency. The magnitude and sign of I provide an objective criterion for assessing the need to adjust intervention instruments in order to improve efficiency and resource allocation in the agricultural sector. Regarding relative competitiveness, defined as the ratio between private competitiveness (BCR) and social competitiveness (SCEC), the Relative Economic Competitiveness Index (RECI) indicates that if RECI>1, the project is competitive for the investor but may generate losses or negative impacts for society; if RECI<1, the activity or project is socially competitive because social benefits exceed total social costs. Finally, RECI=0 indicates that no external benefits or costs exist in the activity, or that they offset each other, implying the absence of market failure and an efficient allocation of resources. Economic efficiency, or comparative advantage, was assessed using the Factor Cost Coefficient (FCC) coefficient, which expresses the share of social value added allocated to covering the costs of domestic factors of production, such as labor and capital (Monke & Pearson, 1989). Both costs and revenues were valued at social prices, and the coefficient was estimated as $FCC=G/(E-F)$. Values of FCC<1 indicate economic efficiency and the presence of comparative advantage, as value added is sufficient to remunerate domestic factors and generate surpluses; FCC=1 reflects an economic break-even situation, generating neither residuals nor losses for the producer; whereas FCC>1 indicates inefficiency, as the opportunity cost of resources is not fully covered. The sign and magnitude of the FCC enable identification of activities that use resources efficiently and those that may require improvements in productivity, technology, or factor reallocation.

RESULTS AND DISCUSSION

Private profitability and competitiveness

In Mexico, differences in domestic factors of production revealed substantial heterogeneity in guava production across states. At the national level, most guava output was profitable at private prices (D>0), concentrated in a large share of the planted area and production units. This outcome exceeded that reported by González and Alferes (2010) for maize (86.9% private profitability), reinforcing the notion that guava has strong productive potential, given that profitability is a critical driver of investment incentives (Porter, 2016). The profitability observed for guava in this study surpassed that reported for maize; however, these crops differ markedly in their productive characteristics. Whereas maize is an annual staple grain crop, guava is a perennial fruit crop, with higher initial investment requirements and a more specialized production system. The states with the highest profitability were Michoacán, Aguascalientes, and Zacatecas, which accounted for the largest share of national output and constitute the most profitable guava-producing regions. In these three states, production was also concentrated in a relatively small proportion of production units; nevertheless, they encompass an extensive cultivated area devoted to the crop. Although 91% of guava production in Yucatán was rainfed, the state exhibited high profitability; however, the area allocated to this crop is minimal (0.04%), representing a clear opportunity to expand production, particularly given its average yield of 13.5 t/ha. As proposed by INIFAP (2018), Mexico has the potential to increase the planted area for this crop, especially in tropical and subtropical zones. The lowest profitability was recorded in Guanajuato, Jalisco, the State of Mexico, Guerrero, and Nayarit, which together allocated only 7.28% of the guava-cultivated area, equivalent to 1,366 Guava Production Units (GPUs) (5.34%). Low profitability may be attributable to poor yields, limited cultivated area, or high production costs. These factors may have constrained profitability and help explain why their contribution represented only 5.42% of total national output. Across states, both total revenue and total investment in guava production varied. Although the highest total costs (B+C) were observed, the states exhibiting greater competitiveness (BCR>1) were those with the highest revenues (A). These differences may be influenced by the production system type, as the states showing competitiveness relied primarily on irrigated systems (Table 1). This result is consistent with De Luis-Peralta *et al.* (2025), who found that irrigated crops exhibited higher profitability than rainfed crops. This convergence supports the robustness of the findings and confirms that access to irrigation is a pivotal factor in enhancing agricultural profitability.

Table 1.

Federal entity	Total area (ha)	Total production (t)	Production system	Area with competitiveness (ha)	Production with competitiveness (t)
Aguascalientes	4,415.00	66,559.50	TR (99%) - P	4,386.63	66,131.84
Baja California*	1.55	2.74	TR - P	1.05	1.85
Baja California Sur	18.50	91.07	TR - P	n.c.	n.c.
Campeche	76.36	92.80	TR - P	n.c.	n.c.
Coahuila	n.i.	n.i.	n.i.	n.i.	n.i.
Colima	49.60	376.78	TR - P	n.c.	n.c.
Chiapas	62.00	329.84	TR - P	n.c.	n.c.
Chihuahua	22.72	94.90	TR - P	n.c.	n.c.
Mexico City (CDMX)	1.91	1.19	TR - P	n.c.	n.c.
Durango	255.57	330.22	TR - P	n.c.	n.c.

Table 1. Continues...

Federal entity	Total area (ha)	Total production (t)	Production system	Area with competitiveness (ha)	Production with competitiveness (t)
Guanajuato*	119.00	961.85	TR - P	n.c.	n.c.
Guerrero*	221.58	2,406.07	TR - P	106.55	1,156.95
Hidalgo	64.00	433.80	TR - P	n.c.	n.c.
Jalisco	333.47	3,607.38	TR - P	136.39	1,475.39
State of Mexico*	845.50	9,217.38	TR - P	593.67	6,471.97
Michoacán	12,729.00	192,612.82	TR (98%) - P	12,490.28	189,000.53
Morelos	15.00	118.60	TR - P	n.c.	n.c.
Nayarit	36.00	311.85	TR - P	12.23	105.98
Nuevo León	1.05	0.11	TR - P	n.c.	n.c.
Oaxaca	236.61	1,415.39	TR - P	n.c.	n.c.
Puebla	47.30	444.00	TR - P	n.c.	n.c.
Querétaro	73.00	267.28	TR - P	n.c.	n.c.
Quintana Roo	20.72	55.96	TR - P	n.c.	n.c.
San Luis Potosí	110.30	193.34	TR - P	n.c.	n.c.
Sinaloa	3.00	15.99	TR - P	n.c.	n.c.
Sonora	n.i.	n.i.	n.i.	n.i.	n.i.
Tabasco*	18.00	218.88	TR - P	0.61	7.46
Tamaulipas	55.46	460.84	TR - P	n.c.	n.c.
Tlaxcala	4.15	0.12	TR - P	n.c.	n.c.
Veracruz*	13.50	96.26	TR - P	0.54	3.86
Yucatán*	10.00	135.00	T (91%) R - P	9.10	122.85
Zacatecas	1,505.00	23,824.02	TR (100%) - P	1,499.73	23,740.61

Source: Authors' elaboration.
*No social competitiveness. T=rainfed; R=irrigated; n.i.=no information; P=perennial; n.c.=no private competitiveness.

Mexico exhibited high private competitiveness in guava production, achieved across 19,292.48 ha, corresponding to 8,746 Guava Production Units (GPUs). However, this level of competitiveness was lower than the profitability indicator. In this regard, González and Alferes (2010) note that being profitable does not necessarily imply being competitive, which explains this discrepancy. In other words, competitiveness requires additional conditions such as efficiency, sustainability, and market persistence (Müller, 1995).

Profitability and competitiveness at efficiency prices

Public policy effects and market distortions altered realized profitability; therefore, assessing performance at efficiency prices made it possible to identify the system's underlying (true) profitability and competitiveness. National production was largely socially profitable (H); however, a substantial share of production units did not achieve social profitability due to low economic-efficiency metrics, resulting in structural differences across production systems. The loss of social profitability is mainly attributable to the small scale of many production units, which limits their capacity to expand output and, consequently, leads to higher production costs. By contrast, large-scale production systems sustain high profitability due to superior infrastructure and integration into more dynamic markets, including international markets.

These results indicate that the lack of profitability primarily affects small guava producers, who face greater constraints in generating sufficient income and maintaining the economic viability of their production units. Consequently, incentivizing small agricultural producers is pivotal for sectoral development, as they supply food to more than 40% of Mexico's population (SADER, 2024). When competitiveness was evaluated at economic prices, national production showed a very high level of social competitiveness (280,454.73 t), harvested on 86.71% of the hectares devoted to this crop and generated by 27.35% of national GPUs. The gap between profitability and competitiveness estimated at economic prices underscores that a producer or system may be profitable in the short term, yet not necessarily competitive. The federal entities with the highest social competitiveness were Michoacán, Aguascalientes, and Zacatecas, followed though to a lesser extentb y Jalisco and Nayarit. This difference may be explained by the greater participation of medium- and large-scale producers in the first three entities, which facilitates economies of scale, reduces unit costs, and expands access to financing.

Nominal and effective protection coefficients

The average (NPC) for outputs was 1.03 (Table 2), indicating that, as a result of agricultural policy, producers received prices 3% above the social value. This outcome reflects an implicit subsidy embedded in guava prices, providing producers with additional protection relative to the social benchmark. The NPC for tradable inputs indicates that market prices were below social prices, evidencing the presence of subsidies or an overvalued exchange rate that reduced their cost.

Table 2. Summary coefficients.

Crop	Nominal Protection Coefficient (NPC)	Effective Protection Coefficient (EPC)		Factor Cost Coefficient (FCC)
Guava	Output	Input		0.73
	1.03	0.94	1.05	

In 93.75% of state-level production systems, the (EPC) exceeded the Nominal Protection Coefficient (NPC), indicating that, in most states, agricultural policy is essential to sustaining guava production (45,504 t). This finding is consistent with Chica *et al.* (2016), who underscore the role of subsidies in enabling producers to remain in the market. Nevertheless, the results of the present study suggest that excessive reliance on such support may constrain long-term competitiveness, because factors such as productive efficiency and resource management are likewise decisive for sustaining profitability. By contrast, in Michoacán and Aguascalientes, agricultural policy was not determinative, as the NPC and EPC exhibited similar values. This pattern may be explained by the more consolidated infrastructure for collection, transport, and export channels in both states, together with a stronger orientation toward international markets

(Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria [SENASICA], 2025), which is consistent with their high productivity (85% of national production). In this regard, Jaffee (1993) showed that such consolidation was the outcome of public policies targeting the agricultural sector, including government negotiations to access new markets and support to promote the product internationally. The results further indicate that maintaining a scheme of generalized subsidies may foster dependency on these transfers, directly affecting social prices.

Divergences and efficiency

The comparison between private and social profitability in guava production showed that profitability calculated at market prices exceeded that estimated at social prices. This result can be attributed to State transfers and market distortions, which increased private gains by 2.87% above the underlying economic profitability, indicating that public policy or market imperfections generated excess private benefits for producers. This, in turn, suggests the presence of subsidies or support mechanisms that incentivized the productive activity. Guava production exhibited a relative competitiveness of 1.03; however, this value was 0.17 below the private-social profitability comparison, suggesting that while the activity is attractive for investors, it may entail social losses or adverse societal effects. This discrepancy arises because competitive capacity is not homogeneous across states. Guanajuato, Guerrero, the State of Mexico, Tabasco, Veracruz, and Yucatán lack competitiveness under economic-efficiency conditions (Table 1), which may reflect structural constraints (high costs, low yields, small-scale production, among others).

However, only a limited number of states (Aguascalientes, Michoacán, and Zacatecas) displayed comparative advantages, as reflected in a domestic factor cost coefficient below one. This outcome is explained by the fact that most production (92.88%) is concentrated in states with consolidated productive conditions, irrigated systems, favorable soils, and higher levels of technification (SIAP, 2019), translating into better yields and greater productive efficiency. In this context, Von Hesse (1994) argued that public policies can stimulate competitiveness, particularly those designed to promote export dynamism. Structural differences between production schemes are also evident. Although public policy contributes to sustaining productive activity and the incomes of a large number of small producers, results at social prices indicate that not all producers achieved favorable performance, suggesting that these policies do not correct structural limitations in every state. These findings imply that some small-scale producers maintained benefits due to public policies or market conditions rather than genuine competitiveness. In this regard, Von Hesse (1994) proposes incorporating smallholders into international markets as a strategy to strengthen real competitiveness over the long term. Thus, even when small producers obtain profits, society as a whole may face inefficient resource use, distortions in capital allocation, and, in some cases, additional environmental or fiscal costs. Porter (2007) notes that governments often prioritize policies with immediate benefits such as subsidies and protections which can constrain innovation and sectoral competitiveness. Overall, the results indicate that guava production in Mexico is profitable and competitive at private prices; however, at social prices, these indicators decline, revealing distortions associated with agricultural policy. Protection coefficients show that private profitability exceeds social profitability, reflecting dependence on prevailing protection mechanisms.

CONCLUSIONS

Guava production in Mexico exhibited high levels of private and social profitability and competitiveness. However, relative competitiveness was slightly lower than the private-social profitability comparison. National production showed comparative advantages concentrated in two states, revealing substantial regional differences in efficiency and competitive potential. In lower-performing regions, it is necessary to emphasize the implementation of regional strategies that strengthen efficiency and competitiveness. Agricultural public policies increased the profitability and competitiveness of guava production in Mexico. Nonetheless, it is essential to adopt strategies that consolidate sustained competitiveness in the medium and long term, rather than focusing exclusively on immediate outcomes. The Effective Protection Coefficient was the most sensitive indicator of public policy intervention, as it comprehensively captured distortions in input and output markets. The principal contribution of the Policy Analysis Matrix in this study lies in identifying areas of opportunity where the State can intervene through agricultural policy instruments, such as regional targeting and the design of differentiated strategies aligned with the needs of each state. In addition, applying this methodology to other crops is recommended, including fruit crops, horticultural crops, livestock systems, and staple grains.

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