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Sustainability and Competitiveness of Mexican Rose Production for Export: A Policy Analysis Matrix Approach Assessing Economic and Social Dimensions

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Abstract

The agricultural economic policy in Mexico has inadequately addressed the integrated sustainability needs of the rural sector. This study adopts a sustainability perspective to examine economic policy distortions and market failures in the export-oriented rose cultivation sector, and evaluates their effects on the economic and social sustainability of producers in Tenancingo and Villa Guerrero, Mexico. A Policy Analysis Matrix (PAM) and CONEVAL poverty line metrics were used to evaluate private and social profitability as indicators of financial viability and resource use efficiency. Findings indicate that, despite being supported by distortionary policies, the rose export sector remains competitive and financially viable, constituting a key pillar of economic sustainability. Moreover, the social profitability of rose production exceeded its private profitability, suggesting a net positive socioeconomic benefit and a sustainable allocation of resources from a societal perspective. Furthermore, per capita income in the rose production unit (RPU) exceeded the poverty line established by CONEVAL, directly supporting social sustainability and strengthening livelihood resilience. The study concludes that current resource allocation mechanisms are inefficient for sustainability over the long term. It emphasizes the need for policy shifts toward greater innovation, more effective technology transfer, improved market access, and stronger human capital to strengthen the sustainability of the sector as a whole. Rose cultivation exhibited a significant positive multiplier effect on the regional economy, reinforcing its contribution to sustainable rural development.

Keywords: agricultural policy; social profitability; economic sustainability; social sustainability; resource use efficiency; sustainable rural development

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1. Introduction

Rural development policies in Mexico can be periodized into four stages: agrarian redistribution (1929–1940), import substitution (1940–1970), shared development (1970–1982), and structural adjustment with economic liberalization (1982–present). These stages can be grouped into two broad periods. The first prioritized land redistribution and public investment in agricultural credit, technology, and infrastructure to diversify output, increase productivity, expand the supply of raw materials, and earn foreign exchange through primary sector exports. The second emphasized industrial expansion while reducing support for agriculture and deepening integration into global markets; this orientation remains in effect [1,2].

Some international studies have examined how government policies, including fiscal incentives and trade regulations, shape production practices, market access, and sustainability initiatives in these industries [3]. In particular, Ref. [3] evaluates the effectiveness of different tax incentives in promoting investment and development in the Latin American flower industry, taking into account the diverse economic and regulatory contexts across countries. Other studies highlight how the perishable nature of horticultural goods requires a stable and skilled labor supply, shaping policy considerations related to labor availability and wage structures [4].

Public policies in Mexico have undervalued agricultural activity since the country's trade liberalization [5,6]. Recent production policies have lacked integration, primarily emphasizing social programs rather than advancing science and technology, innovation, training, financial support, research, and technology transfer [7]. This oversight has allowed for persistent trade barriers, highlighting the need to implement targeted strategies that capitalize on agricultural productivity and strengthen the sector's global competitiveness [8,9].

Mexico possesses favorable agroclimatic conditions that have supported the development of floriculture and its resulting export market. According to the Mexican Ministry of Agriculture, this industry provides roughly 250,000 direct jobs and about one million indirect jobs, with women accounting for around 60% of production. The sector benefits approximately 10,000 open field flower growers and 100 to 150 export-oriented producers operating in greenhouses, typically on plots of up to five hectares [10,11].

Floriculture in Mexico traces its origins to religious and ritual practices. Although exports began in the 1930s with shipments of wild-collected orchids and other ornamental species, the sector expanded markedly after 1977, when the Mexican state promoted domestic production through credit for ornamentals destined for export, treating the activity as a source of foreign exchange amid falling oil prices [1]. Floriculture, a branch of ornamental horticulture, encompasses the production and commercialization of cut flowers, foliage, and potted plants. Given its large-scale operations and labor-intensive processes, it is regarded as an industrial sector oriented toward aesthetic demand and luxury consumption [1,12].

Floriculture also serves as a source of foreign exchange for producing countries [13]. Roses (*Rosa* spp.) are marketed primarily as cut flowers and potted plants, and are also used in the fragrance, cosmetics, and pharmaceutical industries, sustaining strong demand in domestic and international markets [14].

The international market for Mexican roses is highly concentrated in the United States, which accounts for 99 percent of export volume. These shipments totaled 10.3 million dollars, representing 24 percent of Mexico's agri-food exports to that destination [15]. In 2023, national cut-rose production reached 9.95 billion dozen, distributed over nine states and covering an area of 1662 hectares. The State of Mexico represented the largest share (58%), followed by Puebla (19%), Morelos (18%), and other states (5%) [16]. Specifically, the Rural Development District of Coatepec Harinas in the State of Mexico emerged as the most productive region, encompassing 972 hectares. The municipalities of Villa Guerrero, Coatepec Harinas, and Tenancingo were leading contributors, accounting for 461, 220, and 206 hectares, respectively [16].

Literature consistently characterizes floriculture as highly profitable [17,18]. Beyond generating foreign exchange through exports [13], the sector stimulates regional development by creating direct employment—particularly for women—and indirect employment in complementary activities [12,19].

Under a market economic approach, the primary objective of the Policy Analysis Matrix (PAM) is to assess how government policies influence the private profitability of agricultural production systems and the efficient allocation of resources [20].

While both phenomena result in inefficient resource allocation, market failures reflect inherent imperfections in the economic system, whereas policy distortions arise from government interventions that alter market signals [21]. Specifically, market failures occur when the free-market mechanism does not allocate resources efficiently, often due to externalities, public goods, information asymmetries, or imperfect competition [21]. In contrast, policy distortions arise directly from government measures, including taxes, subsidies, tariffs, and quotas, which modify the incentives faced by producers and consumers and lead to departures from socially optimal outcomes [22]. The PAM framework is particularly useful for distinguishing between these effects, providing a structured approach to quantifying the welfare impacts attributable to each [23]. Understanding this distinction is crucial for designing appropriate interventions, since market failures typically require corrective policies that internalize external costs or benefits, whereas policy distortions call for the reform or removal of the distorting policies themselves [24].

In Mexico, the PAM has been widely used to assess the impact of free-market conditions on economic policy, market distortions, competitiveness, and profitability within fruit, vegetable, and rose production systems [25–31]. Nevertheless, few studies have addressed the effectiveness of economic policy under free-market conditions and its implications for the welfare of export-focused rose producers in Tenancingo and Villa Guerrero, Mexico. This gap in current literature represents the primary objective of this research.

The hypothesis of this research was that export-oriented rose cultivation in Tenancingo and Villa Guerrero, Mexico, remains competitive and socially profitable under the current agricultural policy framework, thereby contributing to economic and social sustainability. At the same time, it was assumed that existing distortions in resource allocation limit sustainability over the long run, implying that policy adjustments to promote innovation, improve technology transfer, and strengthen market integration are essential to enhance the overall resilience of the sector.

2. Materials and Methods

This study was conducted in the municipalities of Tenancingo and Villa Guerrero, located between 18°46′00″–19°06′00″ N latitude and 99°25′00″–99°39′00″ W longitude [32,33]. Data collection took place from March to May 2019, involving flower growers from Tenancingo and members of the Floriculturists Association of Villa Guerrero (ASFLORVI A.C.). Participants were selected using snowball sampling until saturation was reached, with a minimum requirement of 30 years of experience in flower production and commercialization. The study used the implementation of the North American Free Trade Agreement (NAFTA) in 1994 as the selection criterion, including only producers who have continuously produced and exported roses since that year.

The rose production unit (RPU) was determined in two phases. First, production data were utilized to create a technical coefficient matrix and define market prices (producer-paid prices) and private budget. Second, this information was presented to and validated by a panel of rose producers. A production unit (PU) is a representative hypothetical business employed to simulate real-world production and marketing activities [34].

Economic policy distortions were analyzed using the PAM, a double-entry accounting framework consisting of three rows (Table 1; [20]). The first row indicates the private profitability of an agricultural production system based on market prices, representing producer returns from resource management and related risks. The second row indicates economic profitability, where production inputs are valued at their true opportunity costs, free from policy distortions and market failures. The third row, derived from the difference between the previous two, identifies the effects of government intervention and market imperfections, explicitly highlighting policy-induced distortions and market failures [20,35]. Market failure occurs when markets fail to allocate resources efficiently, thus missing potential Pareto improvements [36]. Such inefficiencies require government intervention, frequently leading to policy distortions.

Table 1. Policy Analysis Matrix structure.

Concept	Income	Production Costs		Profit
		Commercial Inputs	Internal Factors	
Private prices	A	B	C	D
Social prices	E	F	G	H
Policy effect	I	J	K	L

Source: [9].

The PAM was constructed using three matrices. The first matrix incorporated technical coefficients, directly tradable inputs (fertilizers, agrochemicals, packaging, fuels), indirectly tradable intangible factors (land, labor, capital, services), and internal production factors (depreciation and amortization). The second matrix contained production volumes and corresponding market prices. Combining these matrices yielded the private budget. The social budget was calculated with the methodology by [20], as adapted specifically to the Mexican economic context by [37].

Data for the RPU were estimated at 2019 market prices. The applied interest rate was 11.38%, reflecting development bank rates for that year, equivalent to a 28-day Interbank Equilibrium Interest Rate (Spanish acronym: TIIE) of 7.80%, along with a historical inflation rate of 3.60% [38]. Shadow prices were calculated using a reference rate of 2.5%, derived from U.S. production credit rates [39]. Production costs incorporated a 9% pesticide toxicity tax. The Special Tax on Production and Services (Spanish acronym: IEPS) applied to both production and marketing activities, including rates of 5.3% for gasoline, 6.1% for diesel, and 16.0% for value-added tax (VAT). Electricity tax costs were calculated using the agricultural tariff of MXN $7.25 per kWh for the study period, while land taxation was based on the cadastral value of MXN $1700.00 per hectare in the study region.

Shadow prices were calculated based on international market values before any tariffs or taxes were applied [40,41]. Export parity prices were determined using domestic product prices, adjusted to include all export-related costs such as international market prices, transportation, duties, fuel, and exchange rates [35,37]. Similarly, import-parity prices for production inputs were calculated from border or cost-insurance-and-freight (CIF) prices, with domestic transportation costs added to obtain an equivalent social price [37]. Because of its strategic location and capacity to handle import–export operations, the port of Veracruz, Mexico, was selected as the point of entry. The production sites examined are in Tenancingo and Villa Guerrero, two municipalities in the agricultural region of Toluca, Mexico.

The export parity price of the product was calculated using the FOB (Free on Board) border price, comparable to the CIF cost, with McAllen, TX, USA, designated as the export point. Internal or primary production factors were valued according to their domestic opportunity costs [37]. The economic value of equipment and machinery was estimated based on a 10% salvage value rate. For mechanized labor, the social price was assumed to be equivalent to the private price in the study region. Direct subsidies incorporated into the shadow price matrix were estimated from the 16% VAT refunds associated with the purchase of production inputs such as packaging, fuel, and lubricants.

2.1. Characterization of the Rose Production Unit

This section provides an overview of the rose production units (RPUs), including technical specifications, levels of mechanization, production data, and economic performance indicators.

2.2. Measures of Government Policy Impact on Rose Cultivation in Key Production Centers

2.2.1. Divergence Affecting Input Costs

A subsidy on tradable inputs implies that the RPU pays only a portion (B) of the total input cost (F), while the remaining amount ($J = B - F$) is covered by the government. Since B is less than F, J takes a negative value, indicating a subsidy. Conversely, a positive value for J would reflect a tax burden on inputs.

2.2.2. Factor Transfers

The divergences in factor markets lead to discrepancies between private factor costs (C) and social costs (G), generating a factor transfer defined as $K = C - G$. As with divergences in tradable input costs, a positive K reflects an implicit tax or a resource outflow from the system, while a negative K indicates an implicit subsidy or a resource inflow that benefits the agricultural system.

2.2.3. Net Transfers

Positive output transfers (I) represent subsidies to the agricultural system, as they increase revenues. Likewise, negative transfers in tradable inputs (J) and factors (K) indicate subsidies by reducing production costs.

2.3. Measures of Government Policy Impact on Rose Cultivation in Key Production Centers

Distortionary policies can lead to imbalances and inefficiencies within the economy [42]. The following coefficients, derived from the PAM, were used to evaluate the performance of the rose production system:

2.4. Measures of Profitability and Competitiveness

Profitability, Competitiveness, and Efficiency

Private profitability is derived from the first row of the PAM using the private cost ratio (PCR): $PCR = C/(A - B)$, where C denotes the cost of domestic factors, and $(A - B)$ is the value added at private prices. The PCR measures the system's competitiveness by assessing producers' ability to cover internal costs, including a normal return on capital. A PCR below 1 indicates competitiveness under existing market conditions, meaning profits are attainable without policy support. This indicator integrates current market prices, technological efficiency, and the effects of policy interventions [20].

2.5. Social Profitability

Social benefits measure efficiency or comparative advantage. The domestic resource cost (DRC), derived from the second row of the PAM, is calculated as $DRC = G/(E - F)$. It is an indirect indicator reflecting social profitability; minimizing DRC thus equates to maximizing social benefits [20].

2.5.1. Nominal Protection Coefficients

The nominal protection coefficient (NPC) measures the ratio between the observed (private) price of a commodity and its comparable world (social) price. It captures the impact of policy interventions or unaddressed market failures that cause discrepancies between these prices. NPC is divided into two components: the nominal protection coefficient on tradable outputs (NPCO = A/E) and the nominal protection coefficient on tradable inputs (NPCI = B/F). An NPCO greater than 1 means the domestic output price exceeds the social price, indicating that producers receive a subsidy through higher output prices. Conversely, an NPCI below 1 shows that input prices are lower than they would be without policy interventions.

2.5.2. Effective Protection Coefficient (EPC)

EPC = (A − B)/(E − F). This coefficient indicates how policy affects producer incentives through its combined impact on tradable goods markets.

2.5.3. Producer Subsidy Ratio (PSR)

PSR = L/E or (D − H)/E. It represents the proportion of revenue at world prices needed if all macroeconomic policies were consolidated into a single subsidy or tax.

2.6. Market Failure Due to Producer Income Distribution and Welfare Implications

The financial viability of the RPU was assessed using multiple economic indicators, including benefit–cost analysis (B/C) to evaluate investment feasibility, internal rate of return (IRR) to measure profitability, and net present value (NPV) to analyze cash flow. The assessment considered an initial investment involving 66,000 cuttings purchased at MXN $5.00 each and labor costs for eight days at MXN $245.00/day. Incremental cash flows were projected over nine years, with positive returns starting in year two. The reference discount rate was the OECD-recommended social net rate (10%), adjusted for 2020 inflation.

Equation (1). Benefit–cost analysis:

$$^{B}/_{C} = \frac{{}_{t-1}^{t-n}R\,\frac{B_t}{(1+i)^t}}{{}_{t-1}^{t-n}R\,\frac{C_t}{(1+i)^t}} \tag{1}$$

where B is the benefit in each year, C is the cost in each year, i is the discount (interest) rate, and t is time expressed in years (t = 1, 2, 3, . . ., n).

Equation (2). Incremental cash flow:

$$\boldsymbol{FD} = \frac{\mathbf{1}}{(\mathbf{1}+\boldsymbol{i})^{\boldsymbol{t}}} \tag{2}$$

where FD is the incremental cash flow (discount factor), i is the interest rate, and t is time expressed in years (t = 1, 2, 3, . . ., n).

Equation (3). Internal rate of return [35]:

$$\boldsymbol{IRR} = \sum_{\boldsymbol{t-1}}^{\boldsymbol{t-n}} \frac{\boldsymbol{B_t} - \boldsymbol{C_t}}{(\mathbf{1}+\boldsymbol{i})^{\boldsymbol{t}}} = \mathbf{0} \tag{3}$$

where IRR is the internal rate of return, B_t is the benefit for each year, C_t is the cost for each year, i is the interest rate (discount rate), and t is the time in years (t = 1, 2, . . ., n).

Equation (4). Net present value [43]:

Net present value is defined as the monetary amount resulting from the difference between the sum of discounted cash flows and the initial investment.

$$\text{NPV} = B_t - C_t \quad (4)$$

where NPV is the net present value, B_t is the benefit for each year, and C_t is the cost for each year.

The welfare or development levels were assessed using per capita financial results from the RPU, which were then compared against poverty thresholds defined by the National Council for the Evaluation of Social Development Policy (CONEVAL). The methodology, following [44], calculates net income distributed among family labor involved in agricultural production systems. In this analysis, income was based on the RPU's NPV, considering eight individuals, each performing multiple roles within the production process. Welfare status was classified using two CONEVAL poverty lines: the extreme income poverty line (LPEI), reflecting the monthly rural basic food basket cost (MXN $1279.00), and the income poverty line (IPL), incorporating both food and non-food monthly basket costs for rural areas (MXN $2482.00) [45].

3. Results

3.1. Characterization of the Rose Production Unit

The RPU modeled for Tenancingo and Villa Guerrero municipalities was classified as small-scale, covering less than 5.0 hectares. Similar production areas were reported by [9] among small-scale floriculture producers in the State of Mexico, who also highlighted the socioeconomic relevance of rose cultivation in these municipalities. Ref. [1] describes flower production under protected cultivation on areas of one to three hectares, operated by large operations with access to appropriate technology and established marketing channels in international markets. These systems rely on vegetative propagating material (bulbs, cuttings) and specialized infrastructure—automated greenhouses, irrigation systems, and cold rooms—as well as labor organization aimed at ensuring production quality.

The RPU employed a semi-technified greenhouse system, using sprinkler and drip irrigation, complemented by post-harvest infrastructure (cold storage and sorting facilities) and administrative areas. The evaluated plantation was five years old, with a plant density of 66,000 plants ha^{-1}, predominantly of the Freedom variety. Of total production, 25% was destined for international markets and 75% for domestic consumption. Communal land tenure accounted for 75% of the cultivated area.

RPU management encompassed fertilization, pest and disease management, weed control, irrigation, and other husbandry practices. Soluble mineral fertilizers were delivered through fertigation and complemented with organic amendments and plant growth regulators to promote vegetative growth and flowering; humic acids and fermented biofertilizers further supported the production process. Input applications and formative pruning were scheduled to align with demand in domestic and export markets. Harvests occurred in December, February, and May, overlapping with 44.3% of Mexico's flower export volume to the United States [15] and targeting the winter seasonal niche [1].

Flower production in Mexico is influenced by cultural practices, production methods, and crop diversification [46]. Due to the inelastic nature of rose demand, production schedules and product variety are closely linked to international market trends, which require diverse colors and varieties within relatively brief intervals [47]. Fashion influences flower colors and varieties, with European stylists regularly intervening—an effect that shapes market dynamism [48].

Pest management utilized both chemical and organic products, applied on a weekly and bi-weekly schedule. Disease control measures were adapted to regional incidence levels and local agro-climatic conditions. Cultivation practices included formative pruning and weed management, while irrigation occurred twice weekly throughout the dry season. Labor demand was consistent, averaging eight labor-days ha^{-1} at a daily wage of MXN $245, with harvesting and grading tasks (five labor-days) predominantly conducted by women. Consistent with [1,48], export-oriented firms generate comparable levels of employment. Cutting and grading, tasks predominantly performed by women and typically staffed by around five workers, demand strict adherence to quality standards to meet the higher requirements of export markets; specifically, the stage of bud opening and the stem length are carefully controlled to ensure product finish and presentation.

The commercial product consisted of 24-stem rose bouquets, packaged in corrugated cardboard sleeves extending to within 10 cm of the basal cut and maintained in moist conditions. Export bouquets were priced at MXN $92 each. The modeled RPU's estimated yield was 2793 gross ha^{-1} (1 gross = 144 stems), significantly lower than the state average (8825 gross ha^{-1}) and national greenhouse average reported by [16].

3.2. Measures of Government Policy Impact on Rose Cultivation in Key Production Centers

The absolute effects of policy distortions on rose production in Tenancingo and Villa Guerrero were assessed using three indicators from the Policy Analysis Matrix (Table 2): input cost divergence (ICD), factor transfer (FT), and net transfer (NT). Additionally, five relative indicators were employed: nominal protection coefficient on output (NPCO), nominal protection coefficient on inputs (NPCI), effective protection coefficient (EPC), profitability coefficient (PC), and producer subsidy ratio (PSR).

Table 2. Policy Analysis Matrix (IT) for cut-rose production in Tenancingo and Villa Guerrero, Mexico (2019).

	Revenues (MXN $)	**Costs (MXN $)**		**Profit (MXN $)**
		Tradable-Input Costs	**Factors of Production**	
Private prices	1,490,400	107,190	1,370,877	12,332
Social prices	1,006,607	111,776	1,115,504	(220,673)
Divergence	483,793	(4586)	255,373	233,005

Factors of production include land and the imputed rent on land (IT). Source: Authors' calculations.

3.2.1. Divergence Affecting Input Costs

The divergence (J) indicates that intermediate inputs: fertilizers, agrochemicals, and fuel received a subsidy of MXN $4586 per ha.

3.2.2. Factor Transfers

Production factors faced an implicit tax totaling MXN $255,373, with labor accounting for 77% of this amount (Table 3). This reflects derived demand for labor, meaning that as demand for roses increases, labor prices also rise [47]. In line with [46], floriculture significantly strengthens the domestic market through job creation, acting as an economic driver for local development. Wage levels primarily reflect workforce quality, as rose production requires skilled and experienced labor. Consequently, the marginal productivity of labor is high, further enhanced by access to better capital goods [47]. The observed policy distortion thus originates from market failures in wage determination, as labor supply remains relatively inelastic and less responsive to market signals.

Table 3. Cost breakdown at social prices (IT) for the RPU in Tenancingo and Villa Guerrero, Mexico (2019).

Tradable Inputs	9.1%	Factors of Production	84.8%	Indirectly Tradable Inputs	6.1%
Fertilizers	2.0	Manual labor	77.0		
Fungicides	0.7	Working-capital credit (AVIO)	2.0	Machinery & equipment	
Insecticides	0.2	Land	1.5	Water-storage facilities	
Acaricides	0.2	Water fee	0.2	Hydraulic infrastructure	6.1
Gasoline	0.5	Electricity	2.3	Greenhouse structure	
Lubricants	0.3			Cold-storage chamber	
Post-harvest consumables	0.6			Civil works	
Packaging materials	4.6				

Source: Authors' field data (2019).

3.2.3. Net Transfers

Gross transfers to the RPU totaled MXN $483,793, primarily resulting from VAT refunds on transportation and fuel. This illustrates a distortionary policy providing international price protection while imposing indirect tax burdens domestically. Small producers, often operating informally, typically cannot access these benefits due to restrictive eligibility criteria and burdensome bureaucratic processes [49]. Thus, the current fiscal policy results in foreign exchange losses from product exports, maintains artificially high international prices, and transfers indirect costs onto domestic consumers. The net economic transfer attributable to these policies for the RPU during this period was MXN $233,055.

3.3. Measures of Government Policy Impact on Rose Cultivation in Key Production Centers

The summary coefficients extracted from the PAM for cut-rose production in Tenancingo and Villa Guerrero (Table 4) quantify both production efficiency and the magnitude of government transfers, expressed as relative indicators.

Table 4. Competitiveness and protection indicators from the PAM for rose production units in Tenancingo and Villa Guerrero, State of Mexico.

	Competitiveness/Efficiency		Transfers							
			Nominal Protection Coefficient Input Transfers					Producer/Product Transfers		
	PCR	DCR	$NPCO_p$	NPC_f	NPC_a	NPC_c	$NPCI_p$	EPC	PSR	PC
RPU	0.03	1.25	1.48	0.81	1.23	1.16	0.96	1.55	0.23	−0.19

Source: Authors' calculations based on the Policy Analysis Matrix (PAM) for rose production. PCR = private cost ratio; DCR = domestic cost ratio; $NPCO_p$ = nominal protection coefficient on output; NPC = nominal protection coefficient (f = fertilizer; a = agrochemicals; c = fuel and lubricants); $NPCI_p$ = nominal protection coefficient on post-harvest inputs; EPC = effective protection coefficient; PSR = producer subsidy ratio; PC = profitability coefficient.

3.4. Measures of Profitability and Competitiveness

Profitability, Competitiveness, and Efficiency

The PAM (Table 4) indicates that the RPU is competitive at private prices, yet profitability remains marginal, with a private cost ratio (PCR) allowing only a 3% payment capacity. Consistent with [30], rose production in the study area showed profitability without significant differences in cost structures between roses for domestic consumption and exports. In contrast, the Agri-Food and Fisheries Information Service (SIAP) attributes the low profitability of ornamental production systems to real price declines (64%) and yield reductions (21%) from 2000 to 2021 [16]. Inefficiency was further reflected by a Domestic Cost Ratio (DCR) greater than one, largely driven by intensive labor use. Cut flowers, being luxury goods, involve limited mechanization, low technological adoption, and persistently high labor costs [50].

3.5. Social Profitability

3.5.1. Nominal Protection Coefficients

The NPCO reveals that international rose prices are subsidized, whereas domestic prices face a penalty: exported roses sell at a 48% discount relative to their reference price, resulting in negative transfers to domestic consumers and reduced export incentives [51].

The NPCI indicates that input prices on the world market are 96% higher than domestic prices, revealing substantial implicit subsidies due to market distortions. Within the RPU, policy effects vary; fertilizers and post-harvest inputs face taxation, while agrochemicals and fuel receive subsidies.

3.5.2. Effective Protection Coefficient (EPC)

The result of the EPC was 1.55.

3.5.3. Producer Subsidy Ratio (PSR)

Additionally, the producer subsidy ratio (PSR = 0.23) confirms direct government intervention, representing a net transfer of 23% to rose producers [52]. In contrast, a negative profitability coefficient (PC = −0.19) implies that rose growers lose 19% of their resources during export sales. These results collectively highlight how current distortionary policies negatively impact efficiency and competitiveness in the rose sector [52].

3.6. Market Failure Due to Producer Income Distribution and Welfare Implications

The IRR for the RPU was 6.35%, significantly below the 10% social discount rate recommended for agricultural projects by the Inter-American Development Bank and IICA [53,54]. All other financial indicators followed a similar downward trend (Table 5). The benefit–cost analysis for the single-period assessment confirmed the findings of the private cost ratio (PCR), highlighting limited capital accumulation and low investment among rose growers in Tenancingo and Villa Guerrero, State of Mexico. Consistent with [7,46], the region's low profitability is associated with inadequate public policies and insufficient investment in infrastructure, innovation, technology, and market access.

Table 5. Financial viability indicators (NPV, IRR, and benefit–cost ratios) for rose production units in Tenancingo and Villa Guerrero, State of Mexico.

	NPV (MXN $)	IRR (%)	B/C (Multi-Period)	B/C (Single Period)
Rose	282,720	6.35	1.12	0.03

Source: Authors' calculations based on the rose PAM.

Profitability of the export-oriented RPU resulted largely from positive policy transfers. At private prices, the financial benefits and costs demonstrated a positive net contribution to social welfare [53], thus justifying ongoing public support as compensation for risk and encouragement of innovation [47].

The distribution of capital across production factors highlights the social importance of labor in rose cultivation. Average monthly per capita income for workers is MXN $2945, exceeding both the general income-poverty line (IPL) reported by CONEVAL (Table 6) and the rural IPL of MXN $2207 documented for the State of Mexico [55].

Table 6. Per capita welfare level from rose sales in Tenancingo and Villa Guerrero, State of Mexico.

Production System	Per Capita Income (MXN $)	EIPL (MXN $)	IPL (MXN $)
Rose	2945.00	1306.00	2551.00

EIPL = extreme income poverty line; IPL = income poverty line. Source: Authors' calculations based on NPV data and CONEVAL (2020).

4. Discussion

Floriculture represents a crucial source of paid employment, particularly benefiting rural women through competitive wages and access to social security in export-focused greenhouse operations [56]. Consistent with [1,19], women's earnings in floriculture are competitive in Mexico and across Latin America, and export-oriented greenhouse enterprises commonly provide social-security coverage. Furthermore, the authors of [1,48] report that women's roles in these firms are differentiated and multi-activity, marked by longer hours in peak seasons and remuneration tied to productivity.

This income is especially relevant given that the RPUs analyzed operate as small family-run enterprises. As noted by [10,57], floriculture earnings are often complemented by diverse economic activities and product portfolios; however, total income remains closely tied to farm size.

Despite marginal profitability and inefficient resource use in cut-rose production, the sector maintains specialized operations whose per capita incomes exceed Mexico's income-poverty line. According to [55], the jobs created are situated in a context where 44.6% of the employed population in Mexico's primary sector earns the daily minimum wage [15].

At the regional level, export-oriented floriculture has created permanent waged employment for women under more competitive employment conditions than those prevailing in traditional crops. By contrast, smallholders serving domestic markets operate seasonally and depend on temporary harvest labor [1]. Flower production has also catalyzed commercial, industrial, and service activities, reinforcing value chain linkages and enhancing their distributional effects in the local economy.

Income levels reflect disparities in economic welfare and contribute to developing human capital. Mexico allocates slightly higher agricultural subsidies (7.5%) compared to its trading partners [58], but these funds primarily support market prices rather than productivity improvements, resulting in resource deficiencies in rural areas [57]. In contrast, trading partners focus subsidies on research, training, and extension services [59]. The transfer structure observed in the RPU highlights inefficiencies in tradable inputs and primary factors, underscoring how existing policies undermine competitiveness, particularly among small-scale, export-focused producers.

The Mexican government frequently implements policies that generate both direct and indirect transfers, creating a complex mix of incentives and disincentives for producers in the floriculture sector. For instance, the government's objective of stimulating foreign exchange earnings through export promotion often results in policies that confer benefits on exporters, while, at the same time, broader fiscal policies can impose an implicit tax burden on labor that ultimately disadvantages producers [60]. This intricate policy environment, characterized by both supportive and restrictive measures, creates a distortionary framework in which the ultimate economic incidence of these policies often falls on consumers, despite the initial intent to promote export-led growth.

The competitiveness of the export floriculture sector rests on factor endowments, namely favorable agroclimatic conditions and an abundant labor force. Nevertheless, the industry exhibits technological gaps, limited access to finance, and dependence on continuous technological innovation [1,14,19].

A critical factor consistently identified as limiting competitiveness is the high cost of labor, which calls for a comparative examination of labor coefficients in alternative specialty horticulture systems. Such an evaluation reveals that, although Mexican rose production faces specific challenges, the high labor intensity characteristic of floriculture generally leads to a larger share of labor costs in total operating expenses compared with less labor-intensive agricultural sectors [61]. For instance, high-value ornamental crops in various international contexts often exhibit labor cost components ranging from

30% to 50% of total production expenses, a level that, while substantial, is frequently offset by higher per-unit revenues and access to specialized markets [62]. Conversely, in many developing economies, abundant labor and relatively low wage levels can confer a competitive advantage in labor-intensive agricultural exports. However, this advantage is diminished when productivity falls behind or when social security contributions and benefit costs substantially increase the effective wage rate [4]. In Mexico, the cost structure shows that domestic factors of production, including labor, account for more than 80% of total costs, highlighting their substantial impact on profitability and competitiveness [30].

This study establishes the economic contribution and welfare conditions of labor in the Mexican rose industry by examining how income distribution among workers affects their overall financial well-being. Given the labor-intensive nature of horticulture, understanding the precise mechanisms of income distribution is crucial for a comprehensive welfare assessment [4]. Although aggregate per capita income figures offer a valuable starting point, a more detailed interpretation calls for an explicit explanation of the underlying distribution of capital across production factors and its implications for family labor contributions [63,64]. It is important to clarify whether the reported average monthly per capita income of MXN $2945 treats family labor as a single, indivisible unit or assumes an equal distribution across all individuals engaged in rose cultivation, since this distinction substantially affects the interpretation of welfare outcomes relative to the CONEVAL poverty lines. This research primarily focuses on wage employment within the rose industry, where individual workers receive direct compensation, rather than on family-based labor contributions treated as a composite unit. This approach allows for a direct comparison of individual earnings against per capita poverty thresholds, providing a more detailed understanding of economic well-being for each worker. To determine per capita income, total profitability was divided by the number of workers.

This study analyzes how economic policies and market dynamics shape the long term viability of rose production, contributing to a wider understanding of sustainable agricultural practices [65]. By assessing competitiveness and profitability in Mexico's rose sector, it highlights how policy analysis can identify opportunities to improve environmental and social sustainability [66]. From this perspective, the research seeks to broaden the scope of agricultural economics by integrating principles of sustainable development, moving beyond traditional economic indicators to encompass environmental and social dimensions of well-being [67]. The study also shows that agricultural economic policies in Mexico have often failed to adequately address the multifaceted needs of the rural sector, leading to inefficiencies that affect both economic output and sustainable resource management. It specifically analyzed economic policy distortions and market failures affecting the export-oriented rose cultivation sector, evaluating their combined effects on producer welfare in Tenancingo and Villa Guerrero, Mexico, regions that are central to regional economic stability and sustainable livelihoods [68].

To assess these impacts comprehensively, a Policy Analysis Matrix was used in combination with CONEVAL poverty line metrics, thereby integrating both economic performance and social welfare indicators into the analytical framework [69]. The results show that, although the rose sector is supported by distortionary policies, it continues to be competitive and financially viable, highlighting the resilience of the industry in the presence of suboptimal policy conditions [23,60].

5. Implications and Limitations of the Study

Several limitations should be considered when interpreting these results. The analysis is based on a small number of export-oriented rose production units in Tenancingo and Villa Guerrero and on a static Policy Analysis Matrix with CONEVAL poverty lines, so it does not capture interannual shocks or dynamic adjustments in technology, labor demand, and land use [70]. Furthermore, data were obtained through nonrandom snowball sampling of small export-oriented producers, highlighting the need for future studies to expand the geographical scope and apply probabilistic sampling designs. In addition, per capita income is derived from average profitability divided by the number of workers and mainly reflects wage employment, without fully accounting for intra-household allocation of family labor, non-wage income, or diversified livelihood strategies. Finally, the sustainability assessment is restricted to economic and social dimensions and approximates policy distortions through observed price gaps, leaving environmental externalities, occupational health risks, and value chain distributional effects outside the scope of the PAM framework [71].

Despite these limitations, the study has clear policy and research implications. The evidence that export-oriented rose production remains competitive and can generate per capita income above the national poverty line, even in a distortionary policy environment, indicates that high-value floriculture can serve as an important source of rural employment and livelihood security, particularly when paired with decent working conditions and social protection for workers [71].

6. Conclusions

In the analyzed model, low profitability in the sector is linked to a market failure associated with its treatment as a luxury good rather than a necessity, which accounts for its restricted growth. At the same time, the productive framework is driven by macroeconomic and sectoral policies that foster regional specialization grounded in natural resource-based comparative advantages. In this setting, international markets require technological innovation, qualified labor, and adherence to voluntary and mandatory standards, none of which are fully evidenced in the present study.

The substitution of technology for labor has generated a distortionary policy environment that leads to market failure. This indicates that the region's specialization does not rest on a genuine comparative advantage and instead requires technology transfer and training. Establishing collaborative agreements with educational and research institutions to develop human capital and implement product and personnel certification processes may be the most effective path for future development.

Rose production had a positive effect on the regional economy by generating employment with wages above the food basket threshold established by CONEVAL. The study also revealed a marked feminization of the workforce in this crop, which represents an opportunity for a clearly vulnerable group whose labor has historically been undervalued.

The identified policy distortion imposes an indirect tax burden on domestic consumers while strongly protecting the export crop. The analysis shows that resource allocation is inefficient, since exports represent only a small fraction of total production. Therefore, prioritizing the domestic market could mitigate the adverse effects of these distortions on national consumers, particularly because rose exports in this setting do not contribute substantially to foreign exchange revenues.

It is necessary to review and, where appropriate, adjust fiscal policies to enable a more efficient allocation of resources that strengthens the domestic market. As this study suggests, such measures could improve the living conditions of farmers engaged in this activity and promote more sustainable production systems.

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Abbreviations

The following abbreviations are used in this manuscript:

PAM	Policy Analysis Matrix
RPU	Rose Production Unit
PU	Production Unit
TIIE	Interbank Equilibrium Interest Rate
IEPS	Special Tax on Production and Services
VAT	Value-Added Tax
CIF	Cost Insurance and Freight
FOB	Free on Board
PCR	Private Cost Ratio
DCR	Domestic Resource Cost
NPC	Nominal Protection Coefficient
NPCO	Nominal Protection Coefficient on Tradable Outputs
NPCI	Nominal Protection Coefficient on Tradable Inputs
EPC	Effective Protection Coefficient
PSR	Producer Subsidy Ratio
PC	Profitability Coefficient
IRR	Internal Rate of Return
NPV	Net Present Value
B/C	Benefit–Cost ratio
CONEVAL	National Council for the Evaluation of Social Development Policy
LPEI	Extreme Income Poverty Line
IPL	Income Poverty Line
ICD	Input Cost Divergence
FT	Factor Transfer
NT	Net Transfer
IT	land and the Imputed rent on land
AVIO	Manual Labor Working Capital Credit
SIAP	Agri-Food and Fisheries Information Service

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