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Abdoulaye Mahamat Soumaine

yl25306270005@isparta.edu.tr

Isparta University of Applied Sciences

Mevlüt Gül

Isparta University of Applied Sciences

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Abdoulaye Mahamat Soumaine
MSc in Agricultural Economics
Institution: Isparta University of Applied Sciences, Faculty of Agriculture, Department of Agricultural Economics
ORCID: 0009-0007-4314-7108
Address: Çünür mah. P.O. Box: 32000, Isparta, Türkiye
E-mail: yl2530627005@isparta.edu.tr

Mevlüt Gül
PhD in Agricultural Economics
Institution: Isparta University of Applied Sciences, Faculty of Agriculture, Department of Agricultural Economics
Address: Çünür mah. P.O. Box: 32000, Isparta, Türkiye
ORCID: 0000-0002-0147-7228
E-mail: mevlutgul@isparta.edu.tr

Abstract

The present study investigates the competitiveness of the global fresh mango market from 2006 to 2024. HHI scores between 673.75 and 848.18 indicate a high level of competition and market diversification, rather than a monopoly. The CMS analysis reveals that Thailand recorded a positive value of 578,997 tons, while India recorded a negative value of -661,383 tons. In 2024, Peru and Pakistan had scores between 0.86 and 0.95, while India's score decreased sharply from 0.90 in 2006 to 0.35 in 2024. The results of the econometric models for 16 countries show that Agricultural Productivity positively affects overall market competitiveness ($\beta = 0.351$; $p < 0.001$), while Import Unit value Index negatively affects overall market competitiveness ($\beta = -0.353$; $p < 0.001$). A hybrid strategy, however, was effective in boosting competitiveness in Spain even as import prices rose ($\beta = 0.525$; $p = 0.038$), as indicated by country-specific models. The results confirm that quality leadership, value-added products, and market diversification are not only important for achieving economies of scale and bulk production, but also for sustaining a competitive advantage.

Keywords**:** Mango, Export Competitiveness, CMS, RSCA, HHI, Fresh Fruit Trade, Econometric Analysis.

Introduction

The globalisation of the economy and emerging logistics options have led to structural changes in the trade of agricultural products (Altendorf, 2017). In recent years, the development of cold chain and re-export techniques has enabled tropical fruits to enter the global consumer market (CBI, 2022). Advances in cold storage, transportation, and processing have been the basic factors in the rapid growth of fruit production and trade worldwide since the mid-20th century (Gül and Akpınar, 2006). Considering the volume of production and the value of the trade, mango is one of the most strategic commodities (Evans, 2008) and is known as the king of fruits. The international mango market, however, is highly competitive not only because of the variety of mango varieties produced but also because of competition in price, efficiency, market diversity, and mango quality (Altendorf, 2017; Mohamad et al., 2022). To secure a competitive advantage in the global agricultural market, countries must increase productivity, quality, and cost efficiency (Gül and Bayav, 2024).

Even though they are a production giant, they do not have the competitive edge in the global market. In the market, there are major producers such as India, China, and Indonesia that are trying to improve their mass production into commercial superiority (Altendorf, 2017), and specialised actors like Peru, Pakistan, and Mexico, and transit actors like the Netherlands, which is not a mango producer but has strong logistics (CBI, 2022; ITC, 2024). This is an example of the mango trade's non-monopolistic dynamic, driven by competitive strategies among countries rather than by a monopolistic structure.

Most publications have been general in their treatment of production and trade statistics, but empirical studies that consider all aspects of market concentration, changes in comparative advantage, and econometric drivers remain limited. This study aims to fill this critical gap by examining the competitive structure and concentration of market actors, along with the commercial positions, of the global fresh mango market actors during 2006-2024 using the Herfindahl-Hirschman Index (HHI), Constant Market Share (CMS) and Revealed (RCA/RSCA) Comparative Advantage indices. This research is unique in testing the basic factors of competitiveness using RSCA findings as the dependent variable in global averages and country-specific econometric models, including efficiency, price indices, net trade volume, market concentration, and CMS dynamics. In the end, these numbers tell about the erosion of structures in the markets, and the way in which new actors such as Thailand and Egypt are getting into the game and are developing growth strategies to achieve their objectives, which allows policymakers and exporters to plan their way forward in terms of costs and quality.

Mangifera indica L (mango) is commonly recognised as the king of fruits and has high food value and economic importance, and is cultivated in over 100 countries as a strategic fruit. High in carbohydrates, vitamins and bioactive compounds. Small-scale farmers in developing countries produce 99% of the world's tropical fruits. India is the major producer, accounting for 40% of global production, followed by China, Thailand, Mexico, Indonesia, and Pakistan (Altendorf, 2017).In recent years, the global fresh tropical fruit market has experienced unprecedented commercial growth, driven by increased consumer incomes and dietary preferences (Altendorf, 2017).

The mango, the king of fruits, has emerged in this huge expansion as one of the most strategic and value-added agricultural products in international trade (FAO, 2020). Indices such as Revealed Comparative Advantage (RCA) and Constant Market Share (CMS) are commonly used in studies that compare the commercial positions of traditional market actors to assess the export competitiveness of major producers (Widodo, 2010). Similarly, in the global fresh fruit trade, indices such as RCA and RSCA are effectively utilised to demonstrate how export competitiveness fluctuates periodically among major producing countries in response to market price dynamics (Erdeğer and Gül, 2026). These methodologies have also been well known as standard indicators for assessing the export competitiveness of different fresh fruits, such as peaches (Şirikçi, 2025) and lemons (Kadakoğlu and Gül, 2025). For example, Mexico has continued to strengthen its position as a net exporter, thanks to its geographical advantage, particularly in the North American market, and strong RCA values have been identified (Zavala-Martínez et al., 2023). Similarly, it is noted that in the northern region of South America, Peru and Colombia have been systematically improving their competitiveness by diversifying their foreign markets (Cosio Borda et al., 2026). Despite the huge production of mango in the country, the competitiveness of Indian mango exports in the international market has declined due to problems such as Sanitary and Phytosanitary (SPS) issues, pesticide residues, and microbial contamination, resulting in frequent market rejections (Muthulakshmi et al., 2022).

In addition to static trade indices, modern literature emphasises sustainable export competitiveness and the ability to deliver strong supply chain management (SCM) and compliance with strict international standards (Mor et al., 2018). Non-tariff barriers and Sanitary and Phytosanitary (SPS) measures are often very difficult to overcome in developing countries, particularly in the context of access to high-value markets (Baliyan et al., 2022). Traditional cost leadership strategies are being replaced by quality leadership strategies, which are based on Good Agricultural Practices (GAP) certifications and modern post-harvest technologies (Thaseiam et al., 2025). The creation of effective producer groups and the improvement of storage facilities through the use of CA systems are also important for successful fresh fruit exports to high-quality markets such as the EU (Akpınar et al., 2006). Even in countries where strict standards such as those of the European Union exist, because of innovative operational logistical solutions such as multimodal transport (truck-train-sea), it has been reported that those countries can successfully enter the market and maintain a permanent market share (Sangho et al., 2010). From this perspective, it is evident that actors seeking to address the physical vulnerabilities of the fresh fruit trade are adopting processed, value-added products, but this alternative also requires strong institutional support for market stability (Keerthika et al., 2024).

Materials and Methods

Secondary data from the global markets from 2006 to 2024 were used in this study. Data for production were collected from the FAOSTAT database, and foreign trade data were collected from ITC Trade Map. Analyses were conducted in SPSS and Microsoft Excel. Data from international databases were grouped into the categories

mango, mangosteen, and guava, but 75-80% of this product group is mango, according to FAO data. To represent the mango sector, this dataset was used directly, as is common practice in the literature.

Different indicators, such as Agricultural Productivity (Yield), Compound Annual Growth Rate (CAGR), Export/Import Unit value Indices, and Net Barter Terms of Trade (N), were calculated to assess production performance and growth trends, as well as the purchasing power of foreign trade. All calculated values were used not only as variables in econometric models to test countries' competitive dynamics but also in descriptive analyses.

In addition, the Herfindahl-Hirschman Index (HHI) (which is defined as the sum of the squares of the market shares of the countries (s^2)was used to evaluate the degree of market concentration and monopolistic market structure of the global mango supply.

$$HHI = \sum s_i^2$$

HHI < 1500: Unconcentrated (Competitive) Market; 1500 ≤ HHI ≤ 2500: Moderately Concentrated Market; and HHI > 2500: Highly Concentrated Market.

To decompose the underlying dynamics of export growth, the Constant Market Share (CMS) analysis, popularised by Leamer and Stern (1970), was applied. This model disaggregates the total change in exports into two main components: the World Demand Effect and the Competitiveness Effect:

$$\Delta X = (r \cdot X_0) + (\Delta X - r \cdot X_0) \qquad \mathbf{r} = \frac{\mathbf{W_1} - \mathbf{W_0}}{\mathbf{W_0}}$$

Subsequently, the Revealed Comparative Advantage (RCA) index, developed by Balassa (1965), was employed to measure the export specialisation levels of the selected countries in the global mango market:

$$RCA_{ij} = \frac{(X_{ij}/X_{it})}{(X_{wj}/X_{wt})}$$

Here, Xij represents country i's mango exports, Xit is country i's total agricultural exports, Xwj denotes the world's total mango exports, and Xwt represents the world's total exports. Based on standard literature classifications, the RCA index is evaluated as follows:0 < RCA < 1: No comparative advantage, 1 < RCA < 2: Weak comparative 6advantage, 2 < RCA < 4: Moderate comparative advantage and RCA > 4: Strong comparative advantage.

To resolve the asymmetric distribution of the RCA index (which ranges from zero to infinity) and achieve statistical normality by bounding the values between -1 and +1, the Revealed Symmetric Comparative Advantage (RSCA) model introduced by Dalum et al. (1998) was applied:

$$RSCA = \frac{RCA - 1}{RCA + 1}$$

The RSCA index ranges between -1 and +1. Values greater than zero (0 < RSCA ≤+1) confirm that a country possesses a comparative advantage and market power in the product, whereas values below zero (-1 ≤ RSCA < 0)indicate a competitive disadvantage (Ayyaz et al., 2019).

Model

The determinants of mango export competitiveness (RSCA) of the top 16 exporters (2006-2024) were analysed using a Fixed Effects panel model in SPSS and 16 individual time-series regressions. There was no multicollinearity between any models (checked using VIF). Country-specific findings are reported only for significant variables ($p<0.05$) or borderline significant ($p<0.10$).

$$RSCAit = \beta 0 + \beta 1 YIELD_{it} + \beta 2 Px_{it} + \beta 3 Pm_{it} + \beta 4 Nit + \beta 5 HHİit + \beta 6 CMSit + \mu it$$

RSCA: Dependent variable; β0: Constant term; $\beta 1 YIELD_{it}$: yield; $\beta 2 Px_{it}$: Export Unit Value Index

$\beta 3 Pm_{it}$: Unit Value Index; β4Nit: Net Barter Terms of Trade; β5HHİit:Market concentration

β6CMSit: Constant Market Share; μit: Error term.

Results and Discussion

This findings section transitions logically from macro to micro dynamics and from static measurements to dynamic analyses. It first presents the Herfindahl-Hirschman Index (HHI) to outline global market concentration, followed by Revealed Comparative Advantage (RCA) and its Symmetric version (RSCA) to capture standardised country-level competitiveness. Finally, it uses Constant Market Share (CMS) analysis to reveal real market share and competitive dynamics over time, completing the analytical infrastructure required before the econometric model.

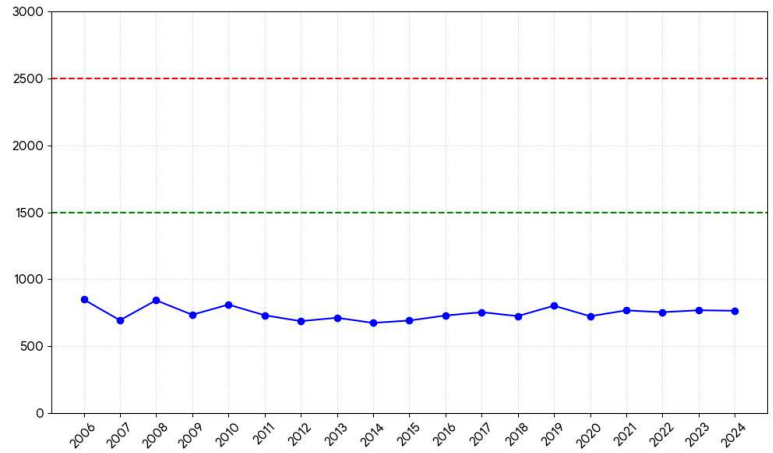


Figure 1. HHI Market concentration

Based on the Herfindahl-Hirschman Index (HHI), the mango market was analysed for market concentration and monopolistic structure in 2006 and 2024 (Figure 1). The literature suggests that an HHI between 0 and 1500 indicates a competitive, multi-player market; an HHI between 1500 and 2500 indicates medium concentration; and an HHI above 2500 indicates a monopolistic or oligopolistic structure. If the data in the Figure are analysed,

it is observed that over the 19 years, the HHI values fluctuated between 673.75 and 848.18 and did not exceed the competitive threshold of 1500 in any year. Such empirical results support the view that the world mango export market has neither a monopolistic nor an oligopolistic configuration; it is a very diverse market, both in terms of its structure and the number of actors involved at the base of the market, with a wide spread of competition. There is no significant correlation between the market with a higher concentration and the countries which dominated it, as during the most competitive period of the market in 2014 and even in 2006 (848.18), 2008 (842.62) and 2010 (810.30), the market became stable and multi-player without approaching the 1500 threshold considered as medium concentration.

Based on the overall concentration level and the intensity of competition in the global market, a Revealed Comparative Advantage (RCA) analysis was conducted to understand the basic competitive roles of the individual actors in the market.

The competitiveness levels of countries were categorised into four stages based on the results of Balassa's Revealed Comparative Advantage (RCA) index presented in Table 1. Table 1 presents Balassa's Revealed Comparative Advantage (RCA) index results, which classify countries' competitiveness levels into four stages. The data refer to the period of 2006-2024: RCA values equal to or below 1 ($0 \leq RCA \leq 1$) mean that the country does not possess a competitive advantage in its products. As mentioned in the introduction, China and the USA are net importers despite being the world's biggest agricultural exporters, as shown in Table 1, where their RCA values for mangoes are close to zero. Indonesia, however, as a large producer, was unable to gain a competitive advantage because its production is utilised in the domestic market and it cannot provide stable exports at international standards.

The range of 1 to 2 ($1 < RCA \leq 2$) in Table 1 means that the unit has a weak comparative advantage. In the period analysed, Spain and Portugal have remained constant at 35-40%. Though not among the major world producers, they have become marginally competitive in delivering fresh mangoes to the local market in Europe by virtue of their proximity and low freight costs.

An RCA index between 2 and 4 ($2 < RCA \leq 4$) indicates a moderate comparative advantage. Table 1 data show the Netherlands as the most stable example, as it remained in this range for almost the entire 19-year period. It is not a producer in its own right, but is the prime distributor to Europe via its port, Rotterdam, and its high re-export capacity. India, which was once a strong competitor, however, fell from this strong group in the market due to losses and slipped into this moderate group between 2017-24.

The RCA value for 4 and above ($RCA > 4$) means that there is high comparative advantage and actors that are dominant in the market, as shown in Table 1. These three countries, Peru, Pakistan, and Brazil, have maintained their dominant status throughout the period because exports of this product dominate their export baskets. Peru, in particular, is the most specialised country in the world for mangoes, with values ranging from 25 to 43. Egypt and Thailand, which were originally in the moderate range, were the bright spots in the group with their aggressive policies and market-seeking as they increased their RCA values to exceed 4. However, the Philippines, which was among the group at the beginning of the period, had to suffer from heavy competitive erosion, falling below the 4 limit and losing its strong advantage.

Table 1. Revealed Comparative Advantage (RCA)

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Brazil	9.59	7.98	9.13	7.04	7.15	6.68	6.46	6.03	6.49	7.44	6.48	5.69	4.73	5.39	5.75	5.01	4.43	5.71	6.06
China	0.02	0.02	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.09	0.13	0.14	0.08	0.10	0.13	0.10	0.10	0.10	0.16
Ecuador	27.44	21.37	12.59	18.00	12.43	12.91	17.15	15.08	11.23	15.76	17.91	14.14	13.25	10.19	10.61	10.31	11.26	5.59	10.72
Egypt	2.88	4.19	9.46	14.39	14.79	10.43	9.93	8.16	11.59	14.27	14.31	12.04	7.03	6.79	8.23	8.15	15.34	20.63	21.89
Guatemala	7.38	13.72	15.14	12.74	10.22	11.68	11.19	10.98	11.47	7.33	5.07	5.99	6.05	3.92	2.41	4.10	4.41	3.96	3.58
India	18.63	15.76	16.72	13.74	12.14	8.06	6.39	6.41	5.40	5.28	5.10	3.68	3.14	2.49	2.42	2.64	3.47	2.20	2.06
Indonesia	0.73	0.72	0.83	0.73	0.76	0.74	1.19	0.39	0.43	0.97	0.97	0.19	1.22	1.41	2.45	1.77	1.87	2.70	3.25
Mexico	10.87	6.23	5.80	6.58	6.58	6.61	7.79	7.77	6.31	6.66	7.07	6.82	6.24	5.10	5.23	5.76	6.77	5.99	6.12
Netherlands	2.49	2.51	2.86	2.23	2.77	3.27	2.79	2.93	3.35	3.00	3.40	2.91	3.07	2.76	2.96	2.96	2.44	2.52	2.04
Pakistan	14.87	23.37	20.00	20.89	15.94	21.40	20.51	22.45	15.00	14.24	21.49	12.99	20.08	23.20	22.48	32.82	26.02	23.62	21.48
Peru	37.74	32.36	30.87	29.10	30.42	30.29	28.87	31.06	31.34	43.38	35.46	25.57	32.09	28.15	32.17	28.14	34.54	25.80	26.20
Philippines	9.75	10.94	8.37	7.15	10.22	24.18	15.48	11.04	18.33	11.90	7.75	5.97	5.72	4.64	4.96	4.61	3.92	4.58	3.32
Portugal	0.32	0.29	0.39	0.23	0.34	0.43	1.80	1.64	2.51	3.07	2.64	2.79	3.11	2.41	2.41	1.85	1.88	2.00	2.73
Spain	0.77	0.66	0.74	0.88	1.02	1.27	1.70	1.44	2.16	1.75	1.61	1.64	2.07	1.50	1.78	1.85	1.98	1.46	1.62
Thailand	2.11	3.20	3.22	5.17	5.00	5.26	6.36	7.79	7.79	6.16	5.12	7.04	7.90	13.57	12.17	13.84	12.84	13.62	13.03
USA	0.24	0.21	0.21	0.16	0.18	0.20	0.22	0.25	0.22	0.20	0.17	0.16	0.15	0.17	0.17	0.18	0.18	0.15	0.16

To reduce the asymmetry in the static deviation of the competition table, as shown by the RCA index, symmetrical index calculations (Symmetric (RSCA) index) were used to make the results applicable to the Econometric model.

The results for the Revealed Symmetric Comparative Advantage (RSCA) index for 2006-2024 were presented in Table 2, which shows countries' competitiveness on a scale of -1 (disadvantage) to +1 (advantage). Examination of the data shows that the RSCA values for China and the USA (net importers) remained consistently between -0.60 and -1.00, indicating a structural disadvantage for these countries in mango trade. Conversely, Spain (2010), Portugal (2012), and Indonesia (2018), which had negative RSCA values in 2006, over time moved into a positive position, with Spain and Portugal, in particular, benefiting from European logistics integration. The Netherlands, which cannot produce within its own ecology, remained within the range 0.34 to 0.55 during the period and played its part as Europe's distribution centre, thanks to its very well-developed re-export infrastructure.

Peru and Pakistan, which focus their export programs on mango, demonstrated strong competitiveness at the table (0.86–0.95); Mexico, Ecuador, and Brazil also registered positions (values above 0.60). Amid market dynamics, Egypt increased its value from 0.48 to 0.91, and Thailand from 0.36 to 0.86, aggressively gaining market share. On the other hand, problems with compliance with phytosanitary standards and domestic market pressures led to significant losses in competition for the historical giants, from 0.90 to 0.35 for India and from 0.81 to 0.54 for the Philippines.

Table 2. Revealed Symmetric Comparative Advantage (RSCA)

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Brazil	0.81	0.78	0.80	0.75	0.75	0.74	0.73	0.72	0.73	0.76	0.73	0.70	0.65	0.69	0.70	0.67	0.63	0.70	0.72
China	-0.96	-0.96	-1.00	-0.98	-0.98	-0.98	-0.98	-0.96	-0.96	-0.83	-0.77	-	-	-	-	-	-	-	-
												0.75	0.85	0.82	0.77	0.82	0.82	0.82	0.72
Ecuador	0.93	0.91	0.85	0.89	0.85	0.86	0.89	0.88	0.84	0.88	0.89	0.87	0.86	0.82	0.83	0.82	0.84	0.70	0.83
Egypt	0.48	0.61	0.81	0.87	0.87	0.83	0.82	0.78	0.84	0.87	0.87	0.85	0.75	0.74	0.78	0.78	0.88	0.91	0.91
Guatemala	0.76	0.86	0.88	0.85	0.82	0.84	0.84	0.83	0.84	0.76	0.67	0.71	0.72	0.59	0.41	0.61	0.63	0.60	0.56
India	0.90	0.88	0.89	0.86	0.85	0.78	0.73	0.73	0.69	0.68	0.67	0.57	0.52	0.43	0.42	0.45	0.55	0.38	0.35
Indonesia	-0.16	-0.16	-0.09	-0.16	-0.14	-0.15	0.09	-0.44	-0.40	-0.02	-0.02	-	0.10	0.17	0.42	0.28	0.30	0.46	0.53
												0.68							
Mexico	0.83	0.72	0.71	0.74	0.74	0.74	0.77	0.77	0.73	0.74	0.75	0.74	0.72	0.67	0.68	0.70	0.74	0.71	0.72
Netherlands	0.43	0.43	0.48	0.38	0.47	0.53	0.47	0.49	0.54	0.50	0.55	0.49	0.51	0.47	0.49	0.49	0.42	0.43	0.34
Pakistan	0.87	0.92	0.90	0.91	0.88	0.91	0.91	0.91	0.88	0.87	0.91	0.86	0.91	0.92	0.91	0.94	0.93	0.92	0.91
Peru	0.95	0.94	0.94	0.93	0.94	0.94	0.93	0.94	0.94	0.95	0.95	0.92	0.94	0.93	0.94	0.93	0.94	0.93	0.93
Philippines	0.81	0.83	0.79	0.75	0.82	0.92	0.88	0.83	0.90	0.84	0.77	0.71	0.70	0.65	0.66	0.64	0.59	0.64	0.54
Portugal	-0.52	-0.55	-0.44	-0.63	-0.49	-0.40	0.29	0.24	0.43	0.51	0.45	0.47	0.51	0.41	0.41	0.30	0.31	0.33	0.46
Spain	-0.13	-0.20	-0.15	-0.06	0.01	0.12	0.26	0.18	0.37	0.27	0.23	0.24	0.35	0.20	0.28	0.30	0.33	0.19	0.24
Thailand	0.36	0.52	0.53	0.68	0.67	0.68	0.73	0.77	0.77	0.72	0.67	0.75	0.78	0.86	0.85	0.87	0.86	0.86	0.86
USA	-0.61	-0.65	-0.65	-0.72	-0.69	-0.67	-0.64	-0.60	-0.64	-0.67	-0.71	-	-	-	-	-	-	-	-
												0.72	0.74	0.71	0.71	0.69	0.69	0.74	0.72

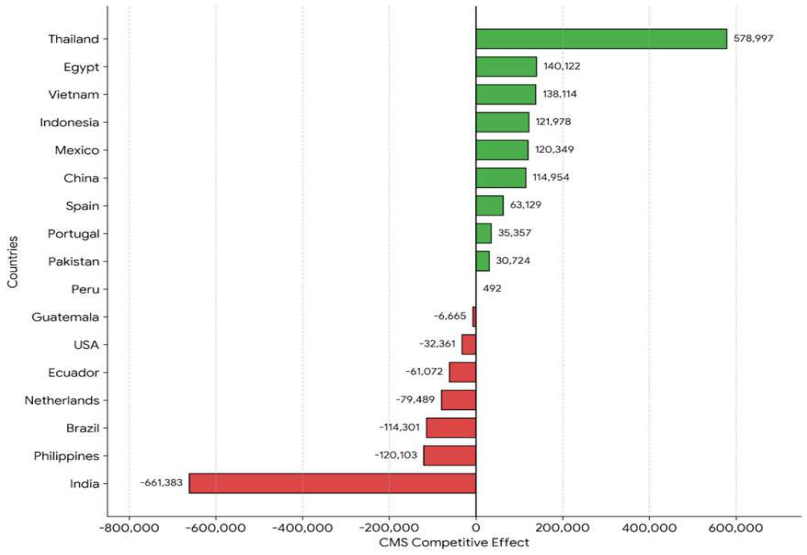


Figure 2. Constant Market Share (CMS) by Countries

If Figure 2 is studied, the resulting net CMS values moving in opposite directions along the axis clearly illustrate who gained from this gap and transferred market share from their competitors, and who were left behind the global pace and lost their market share to others.

The countries with positive values in the green region of the figure are dynamic players whose export potential far exceeds the natural expansion of global demand. The majority of the countries that increased their market shares did so by no accident: primarily Thailand (578,997), followed by Egypt (140,122), Vietnam (138,114), Indonesia (121,978) and Mexico (120,349). The high CMS values for these economies were directly linked to their higher total export growth, i.e., the countries are actively taking market share from less competitive countries.

The countries in the red zone of the figure gave away their share of the pie to these dynamic competitors because they were unable to keep up with the growth potential in global demand. The total change captured by India was far short of the huge potential demand from the world the country could be expected to supply, with an unprecedented collapse of -661,383 units. India had lost its major share of the growth to competitors at the peak of the graph. The collapse is not only due to absorption in the domestic market. However, it is also strongly influenced by the implementation of strict Sanitary and Phytosanitary (SPS) barriers, particularly the import ban on fruits originating in India in high-value markets such as the European Union and the USA, due to the fruit fly issue.

In the same way, the Philippines (-120,103), Brazil (-114,301), and the Netherlands (-79,489) experienced structural market share erosion, as their total changes were smaller than the world demand effect. Peru (492) in the middle neither stole share from its rivals nor lost share to them, because the change it gained was nearly equal to the change it lost. The only difference was a drift on the global wave, which had a neutral competitive effect.

Econometric Model Results

$$RCSA = 1.170 + 0.035(Yield) - 0.001(Px) - 0.002(Pm) + 0.00000588(N) - 0.001(HHI) - 0.0002(CMS)$$

The general econometric model, which captures global mango market competitiveness (RCSA), is highly significant ($p < 0.001$), and it accounts for 29.7% of the variance ($R^2 = 0.297$). The moderate R^2 value is due to the study's focus on production and trade determinants of competitiveness rather than on institutional and logistical factors. The VIF values range from 1.010 to 1.221, indicating no multicollinearity in the model and that the variables are fully independent. The Import Unit Value Index (Pm) has the largest negative regression coefficient ($\beta = -0.353$; $p < 0.001$): increasing costs of transit supplies and inflation of agricultural inputs are putting pressure on profit margins. In response to this, Agriculture Productivity (Yield) is the strongest positive variable ($\beta = 0.351$; $p < 0.001$), indicating that maximisation of tonnage with a minimum of fixed costs is crucial to be competitive. The Export Unit Value Index (Px) exhibits a highly significant negative effect (-0.235; $p < 0.001$), indicating that the price-sensitive market, driven by a cost leadership (low prices) strategy, has a strong effect. Furthermore, the lack of significance of the Market Concentration (HHI) value ($p = 0.111$) indicates that it is a volume guarantee and not a risk. Lastly, the modest negative relationship of the Constant Market Share Effect (CMS) ($\beta = -0.100$; $p = 0.074$) suggests that merely maintaining past market share is not sufficient to maintain competitiveness in the future.

The basic macro model reflects fundamental market forces, but national conditions directly affect the economic equation. In this section, each country's econometric model was analysed to determine its competitive advantages for each actor. In contrast to the overall results, these country-specific results provide information only on the statistically significant variables.

The Brazil model is highly statistically significant ($p = < 0.001$). It explains 65.6% of the change in RCSA ($R^2 = 0.656$). The highest VIF value is 1.386, indicating no multicollinearity problem. Only Agricultural Productivity (Yield) has a statistically significant negative effect on the model ($\beta = -0.760$; $p < 0.001$). This negative correlation means that production alone does not necessarily provide an international competitive advantage; commercial performance relies greatly on other market structures and export strategies.

The China model is statistically very significant ($p<0.001$). It explains 88.1% of the change in RCSA ($R^2 = 0.881$). The maximum VIF is 4.540, indicating no multicollinearity. In the model, the Export Unit Value Index (Px) ($\beta = 0.676$; $p = 0.006$) and Agricultural Productivity (Yield) ($\beta = 0.512$; $p = 0.006$) have a positive effect, while the Net Barter Terms of Trade (N) ($\beta = -0.516$; $p = 0.003$) has a negative effect. This reflects the regional market's pricing power in China, but also indicates that structural changes in net trade volumes put pressure on China's competitiveness in the market.

It is statistically significant in Ecuador ($p = 0.004$). It explains 57.5% of the change in RCSA ($R^2 = 0.575$). The maximum VIF is 2.213, indicating no multicollinearity. The only highly significant and negative coefficient (β) is for the Export Unit Value Index (Px) ($\beta = -0.824$; $p = 0.005$). This indicates a very price-sensitive market, and thus Ecuador pursued a cost-leadership strategy (low prices).

The result of the Indonesia model is statistically significant ($p = 0.011$). It explains 64.4% of the change in RCSA ($R^2 = 0.644$). The maximum VIF was 1.668, indicating no multicollinearity. Only the Export Unit Value Index (Px) has a positive effect ($\beta = 0.480$; $p = 0.040$) in the model. It indicates that Indonesia, as a structurally competitive nation, can maintain its competitiveness by developing Asian niche markets with higher prices or exotic premium markets to contribute to national income.

The Philippines model is statistically significant ($p = 0.018$). It explains 47.9% of the change in RCSA ($R^2 = 0.479$). There was no multicollinearity, as the highest VIF value is 1.604. Market Concentration (HHI) has a negative effect at the 5% level ($\beta = -0.481$; $p = 0.030$), and Export Unit Value Index (Px) has a borderline negative effect at the 10% level ($\beta = -0.415$; $p = 0.099$). This means that relying on a limited number of markets increases commercial risk, which is why market diversification is key. It also shows that the markets they target are very price-sensitive.

The India model is statistically very significant ($p < 0.001$). It explains 88.1% of the change in RCSA ($R^2 = 0.881$). The multicollinearity problem does not exist, with the highest VIF value of 3.047. The Agricultural Productivity (Yield) has a very significant and negative effect ($\beta = -0.715$; $p < 0.001$). This negative relationship is because the additional production does not directly lead to better export performance, at least not to a large extent, since the large domestic market absorbed it. Therefore, international competitive advantage cannot be determined solely by volume.

The Spain model is significant ($p = 0.024$). It explains 52.9% of the change in RCSA ($R^2 = 0.529$). Multicollinearity is not an issue, as the highest VIF was 1.573. Net Change (N) has a negative effect ($\beta = -0.603$; $p = 0.014$), while Import Unit value Index (Pm) has a positive effect ($\beta = 0.525$; $p = 0.038$). This indicates that Spain lacks competitiveness in terms of volume and low prices; instead, it imports and re-exports products of high value and high margins. The net of changes in trade volume indicates that maintaining this niche, high-value structure of trade is more important for Spain's competitiveness than expanding tonnage.

The Egypt model is statistically significant, with a p-value of 0.012. It explains 50.5% of the change in RCSA ($R^2 = 0.505$). The highest VIF value is 1.040, indicating no multicollinearity. Export Unit value Index (Px) has a positive effect ($\beta = 0.609$; $p = 0.005$), while Agricultural Productivity (Yield) has a negative effect ($\beta = -0.402$; $p = 0.046$). This means that Egypt can export its premium-quality products at high prices to neighbouring countries due to its geographic location. Now, though, yields are down, likely because too much is not competitive, as it either falls short of export requirements or poses challenges for cold chain logistics.

The Pakistan model is on the cusp of statistical significance at the 10% level ($p = 0.099$). It explains 33.4% of the change in RCSA ($R^2 = 0.334$). The highest VIF value is 1.203, which was not considered a multicollinearity issue. Only Agricultural Productivity (Yield) has a positive effect ($\beta = 0.567$; $p = 0.025$). This is a testament to Pakistan's effective pursuit of an economies-of-scale strategy; one that benefits from higher production volumes, which directly lead to a strong market share advantage.

The Thailand model turns out to be statistically significant, with a p-value of 0.003. It explains 72.2% of the change in RCSA ($R^2 = 0.722$). The maximum VIF was 2.272, indicating no multicollinearity. There is only a strong, positive, significant relationship between the Export Unit value Index (Px) and the dependent variable (Table 1), with a beta value of 0.702 ($P = 0.007$). This shows that Thailand is a quality leadership country rather than a price-competition country, with high-value products for high-value Asian and Middle Eastern markets.

None of the USA, Guatemala, Peru, Netherlands and Portugal models proved to be statistically significant and thus could not be explained using classical competitive variables (Price, Yield, Market Share). This is to be expected: the USA is a big market that absorbs, Guatemala is constrained by geographic, climatic, or market factors, while the Netherlands and Portugal are re-exporters driven by infrastructural factors other than pricing, including port capacity and cold chain logistics. If pure logistical re-exporters were not found in Spain, the country is seen as a value-adding hybrid producer-distributor. The good performance of its import Unit Value Index (Pm) confirms that Spain does not compete in bulk transport, but rather in high-quality imports and high-margin exports, such as Osteen.

The findings of this study, which are organised from general to specific and from static to dynamic analysis, clearly establish that the global fresh mango market is not monopolistic, multi-player and dynamic. The calculated HHI scores over the 19 years indicate an unconcentrated market structure, consistent with the literature, which states that global trade in tropical fruits increasingly relies on flexible supply chains (Altendorf, 2017). The erosion of market share in traditional giants, such as India and Brazil, revealed by the CMS analysis in our study, is in line with earlier studies that claim market share cannot be achieved solely through sheer production volume (Diz, 2008). But with aggressive countries such as Thailand and Egypt gaining ground in the global average and taking market share, the empirical evidence remains strong that market-seeking, not quantity, is the key to competitiveness (Liu, 2019). Our macroeconomic models have found that market concentration (HHI) is statistically insignificant, furthering the notion that switching to large markets like the USA and EU provides strategic volume insurance protection for the strong supplier rather than commercial risk (Sanket and Sekhon, 2020).

Within the study, our country-specific econometric models confirm the negative impact of the Import Unit value Index on overall competitiveness and on agricultural productivity as a sectoral driving force. Logistical constraints and input inflation seriously harm the competitive position of emerging players by driving up transit costs, as the literature on the additional costs imposed by market entry requirements (Wickrama et al., 2024) suggests. This situation aligns with empirical research conducted over the last few years in other major fruit industries, which shows that the volatility of product prices, the supply-demand ratio, and production costs most directly affect the sustainability of international competitiveness (Kadakoğlu and Gül, 2025). This macro-level vulnerability is further supported by micro-economic farm data, which reveals that rising input costs and marketing expenses severely threaten economic sustainability, making economies of scale a vital requirement for maintaining profitability (Erdeğer and Gül, 2026). Our research, however, has drawn the most original economic conclusion: that Spain has gained competitiveness in the European market despite higher import costs by adopting a high-profit-margin domestic production and distribution strategy based on high-value-added products such as premium varieties like Osteen (Calatrava et al., 2009). This is a successful example of this unusual model and proves that the old economies-of-scale principles and bulk production in international trade are now definitely shrinking profit margins. Finally, this study has demonstrated multidimensionally that the quality leadership paradigm is the only critical pathway to sustainable superiority in global competition by providing value-added products for high-standard niche markets (Mor et al., 2018).

Conclusion and Recommendations

This study of the global fresh mango market (2006-2024) provides insight into a competitive and diverse landscape where large production volumes are no longer a competitive advantage in international markets. Old-established markets such as India and Brazil weakened, while aggressive markets (Thailand, Egypt) and transit markets (Spain) grew ahead of them; the Netherlands, however, held on to its dominance in value distribution despite a loss of volume. The econometric analyses show that if firms produce in bulk and adopt cost-leadership, their margins are driven down to an unsustainable level, whereas if they use niche production, high standards, and value-added products, they will have a sustainable edge. This is a new, extremely successful form of competition, illustrated by Spain's strategy of branding and re-exporting high-quality imports at high prices.

All supply chain actors have to abandon strategies based solely on volume to sustain and expand market share. It is crucial for producer countries to shift to quality-driven models that fully meet Good Agricultural Practices (GAP) and international phytosanitary standards, and to invest in premium varieties and post-harvest technologies (such as improved cold chains) to enhance their commercial value. At the same time, exporters need to actively diversify their geographical portfolio by entering into bilateral deals to decrease their vulnerability and overreliance on absorbing markets such as the US and the EU. To optimise commercial wealth in non-producing transit countries, logistics infrastructure needs to be modernised and increasingly directed towards value-added re-export activities, including packaging and branding, rather than simple volumetric transport.

Competing Interests

M. Gül and A.M. Soumaine declare that they have no conflicts of interest.

References

Akpınar, M. G., Gül, M., & Dağıstanlı, E. (2006). AB Sürecinde Türkiye Meyve Dış Ticaret Yapısı ve Gelişimi. *Türkiye VII. Tarım Ekonomisi Kongresi*, 836-848.

Altendorf, S. (2017). *Global prospects for major tropical fruits*. Food and Agriculture Organisation of the United Nations (FAO).

Erdeğer, S., & Gül, M. (2026). Analysis of Grapefruit Producers' Prices and the Export Competitiveness. *Applied Fruit Science*, 68(178).

Erdeğer, S., & Gül, M. (2026). Cost and Profitability in Grapefruit Farms in Türkiye. *Applied Fruit Science*, 68(208).

Baliyan, K., Kumar, S., & Chandra, M. (2022). Constraints in Mango Export from India. *Indian Journal of Ecology*, 49(2), 483-490.

Calatrava, J., Sayadi, S., Sarmiento, D., & Guirado, E. (2009). Return analysis of Osteen and Kent mango orchards in south-eastern mainland Spain. *Acta Horticulturae*.

Cosio Borda, R. F., vd. (2026). Impact of market diversification and prices on mango exports in emerging economies in the period 2004-2024. *F1000Research*, 15(363).

CBI (Centre for the Promotion of Imports from developing countries). (2022). *The European market potential for fresh mangoes*. Hollanda Dışişleri Bakanlığı. https://www.cbi.eu/market-information/fresh-fruit-vegetables/mangoes/market-potential

Diz, L. A. C. (2008). *Competitividade Internacional das Exportações Brasileiras de manga e de uva*. Universidade de São Paulo.

FAO. (2020). *Major Tropical Fruits Market Review 2019*. Food and Agriculture Organisation of the United Nations.

Gül, M., & Akpınar, M. G. (2006). Dünya ve Türkiye Meyve Üretimindeki Gelişmelerin İncelenmesi. *Akdeniz Üniversitesi Ziraat Fakültesi Dergisi*, 19(1), 15-27.

Gül, M., & Bayav, A. (2024). Anatomy of Competition in the Global Agricultural Market: A Cross-Country Comparative Analysis. *E3S Web of Conferences*, 574, 02008.

ITC (International Trade Centre). (2024). *Trade Map - Trade statistics for international business development*. (Mango ihracat/ithalat verileri).

Kadakoğlu, B., & Gül, M. (2025). Analysis of Lemon Prices and Global Competitiveness of Lemon Exports. *Applied Fruit Science*, 67, 337.

Keerthika, B., vd. (2024). An insight into the trend and instability of processed fruits export from India. *Journal of Applied Horticulture*, 26(2), 196-201.

Liu, J. (2019). *Research on competitiveness of export trade and strategy of Thai Mango*. Siam University.

Mohamad, A. H. H., Ab-Rahim, R., & Mohamad, N. N. (2022). Competitiveness of Mangoes in Southeast Asian Region. *International Journal of Academic Research in Business and Social Sciences*, 12(5), 192-204.

Mor, R. S., Bhardwaj, A., & Singh, S. (2018). A structured literature review of the Supply Chain practices in Food Processing Industry. *Proceedings of the International Conference on Industrial Engineering and Operations Management*, 598-605.

Muthulakshmi, K., vd. (2022). Export Competitiveness of Mango in India. *Asian Journal of Agricultural Extension, Economics & Sociology*, 40(11), 557-561.

Sangho, Y., Labaste, P., & Ravry, C. (2010). *Growing Mali's Mango Exports: Linking Farmers to Markets through Innovations in the Value Chain*. The World Bank.

Sanket, C., & Sekhon, M. K. (2020). Trade Direction and Competitiveness of Mango Export from India. *Journal of Agricultural Development and Policy*, 30(2), 40-49.

Sukmaya, S. G., vd. (2022). Export Performance and Comparative Advantage of Indonesian Tropical Fruits. *E3S Web of Conferences*, 361(02005).

Şirikçi, B. S. (2025). An Evaluation of Türkiye's Peach Production and Global Competitive Performance. *HortiS*, 42(3), 116-125.

Thaseiam, J., vd. (2025). *Implementing Good Agricultural Practices Among Thai Mango Farmers*. WPI & Chulalongkorn University.

Wickrama, S. P., vd. (2024). Assessing the impact of non-tariff measures on Sri Lankan mango exports. *Frontiers in Sustainable Food Systems*, 8(1293263).

Widodo, T. (2010). Market Dynamics in the EU, NAFTA, North East Asia and ASEAN: the Method of Constant Market Shares (CMS) Analysis. *Journal of Economic Integration*, 25(3), 480-500.

Zavala-Martínez, J. M., Caamal-Cauich, I., & Pat-Fernández, V. G. (2023). Behavior of economic variables and trade indicators for the Mexican mango. *Agricultura, Sociedad y Desarrollo*, 20(3), 332-346.