International Journal of
Agriculture, Environment and Food Sciences
e-ISSN: 2618-5946 https://dergipark.org.tr/jaefs

DOI: https://doi.org/10.31015/2025.1.8 Int. J. Agric. Environ. Food Sci. 2025; 9 (1): 57-67

Export similarity index as a barometer of Turkey's agricultural machinery and equipment export competitiveness

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Article History
Received: January 7, 2025
Revised: February 21, 2025
Accepted: February 27, 2025
Published Online: March 9, 2025

Article Info
Article Type: Research Article
Article Subject: Agricultural Economics

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Available at
https://dergipark.org.tr/jaefs/issue/90253/1614997

DergiPark AKADEMİK

Abstract

This is study aims to evaluate Turkey's agricultural machinery and equipment export performance with the aid of the Export Similarity Index (ESI) from a relative and holistic perspective with the leading countries in the global export market (China, Germany, United States of America [USA], Japan, Italy). For this purpose, export data for 2002-2021 were extracted from the Trade Map database. According to the Harmonized System (HS) as a 6-digit code system, the ESI value was calculated for 39 agricultural machinery and equipment product groups (sub-product groups 69, 82, 84, 87). The results of the study showed that, the ESI values regarding Turkey's agricultural machinery and equipment exports with China, Germany, the USA, and Italy increased in this mentioned period. These increase in ESI values indicated that, the countries export similar products and therefore the competition between them has increased. However, the decreases in Turkey's ESI values compared to Japan mean that, the similarity in the products they export and the competition between the two countries have decreased. Turkey's ESI value of "67.19" with Italy in 2021 shows that ,Turkey is in high competition with Italy in agricultural machinery and equipment exports. In addition, Turkey's ESI value of "26.46" with China in 2002 increased to "46.23" in 2021. This increase in the ESI value shows that, Turkey and China are increasingly exporting similar products and that competition between the two countries is increasing. China's performance is a serious threat to Turkey. To strengthen Turkey's agricultural machinery and equipment export performance, comprehensive export strategies that include both companies in the sector and state-led efforts are needed.

Keywords: Export, Competitiveness, Export Similarity Index, Agricultural Machinery and Equipment Sector

Cite this article as: Aktas Cimen, Z., Ertekin, C. (2025). Export similarity index as a barometer of Turkey's agricultural machinery and equipment export competitiveness. International Journal of Agriculture, Environment and Food Sciences, 9 (1): 57-67. https://doi.org/10.31015/2025.1.8

INTRODUCTION

Agriculture, one of the most important sectors for humanity, is the practice of cultivating natural resources to sustain human life and provide economic gain. It is one of the most powerful sectors to end extreme poverty, increase shared prosperity and nourish people. Agricultural lands are the basic building blocks of agricultural production. According to the World Bank (World Bank [WB], 2024), agricultural lands constitute 34.04% of the world's surface area. In this area, China ranks first with a share of 10.89%, the United States (US) ranks second with a share of 8.49%, Australia ranks third with a share of 7.60% and Turkey ranks thirty-fourth with a share of 0.80%. The ratio of Turkey's agricultural land area to Turkey's surface area is 0.48%. With this ratio, Turkey ranks 34th in the world among 210 countries (ANNEX 1). The increasing global population puts great pressure on the agricultural sector. The rapid growth of the world's population also causes an increase in food demand. This means that agriculture should produce more. In addition, it is important to make agriculture more efficient, productive and environmentally friendly for a sustainable future. Therefore, in agriculture, in addition to other approaches, limited areas should be used more effectively and efficiently. This can be achieved with precision agriculture

practices that carry out agricultural production more intelligently and efficiently. In addition, agricultural lands decreased by 1.62% worldwide from 2002 to 2021, while the world population increased by 25.19% in the same period. In Turkey, agricultural lands decreased by 7.54% in the period 2002-2021, while the population increased by 25.50% (WB, 2024). The increase in food demand caused by the increasing population and the globalization of food markets increase international competition in agriculture. This increase in competition makes it important to reduce production costs and use resources effectively and efficiently to be strong in the global market (Hartanto et al., 2019). Agricultural machinery and equipment that shape agriculture (ANNEX 2) play an important role in increasing the efficiency of food production against increasing food demands. Especially developing biotechnology, robotics, and automation systems increases the capacity of agricultural machinery and equipment and encourages sustainable agricultural practices. In this context, the agricultural machinery and equipment sector stands out not only as an industry branch, but also as an important factor in shaping the global agricultural economy and food security. In addition, agricultural machinery and equipment help achieve environmental sustainability goals as well as productivity increase (Patel et al., 2024a). Sustainability is an important driving force in shaping the future of agricultural machinery. Developments such as smart agricultural technologies and digitalization, water-saving irrigation systems, and biological solutions for pest control offer solutions to minimize environmental impacts. Information technology and data-driven processes have changed the processes in the plantation and cattle industry. Machines are no longer alone, but are connected to the cloud and other machines and equipped with special sensors for precision agriculture (Patel et al., 2024a). There is increasing emphasis on developing eco-friendly equipment that reduces carbon footprints. Electric and hybrid tractors that run on renewable energy sources are becoming increasingly popular in line with global efforts to address climate change. Moreover, the agricultural machinery and equipment market is trending towards integrated farming systems. This involves combining various agricultural activities such as crop cultivation and livestock management to create synergies that increase agricultural productivity, which is driving the growth of the agricultural machinery and equipment market (IndustryARC, 2024a). Moreover, agricultural machinery and equipment are an important input in the agricultural process and play a major role in increasing yields as well as reducing input costs such as labor, seeds, and fertilizers, thus increasing agricultural incomes (Banerjee and Punekar, 2020) (Table 1).

Table 1. Farming Machines and Tools: An Overview Benefits Analysis (Patel et al., 2024b).

Equipment	**Function**	**Types**	**Benefits**
Tractors	Power source for various farming tasks	Utility, row-crop, orchard, garden, inustrial	Versatility, efficiency
Plows	Turning and loosening soil	Moulboard, chisel, disc	Improved soil structure, weed control
Harrows	Breaking up soil clods, levelling soil	Disc, tine, chain	Seedbed preperation, moisture retention
Cultivators	Stirring soil around crops	Spring-tooth, field	Weed control, aeration
Seeders	Sowing seeds uniformly	Broadcast, air	Efficient planting, precision
Planters	Precise planting of sees	Row crop, precision	High germination rates, reduced seed waste
Transplanters	Planting seedlings	Vegetable	Efficient transplanting, labor savings
Sprinkler systems	Distribution water	Centre pivot, lateral move	Uniform water application, reduced labor
Drip irrigation	Watering plants at root level	Drip lines, emitters	Water conservation, increased efficiency
Flood irrigation	Flooding fields with water	Furrows, basins	Simple, low-cost
Sprayers	Applying pesticides and herbicides	Boom, air-blast	Pest and disease control, efficient application
Dusting equipment	Applying powdered chemicals	Usters, blowers	Targeted application, reduced drift
Combine harvester	Harvesting grains	Self-propelled, tractor mounted	Efficient harvestng, high capacity
Forage harvesters	Harvesting forage crops	Self-propelle, trailed	Efficient harvestng, high-quality forage
Balers	Compressing crops into bales	Square, round	Hay and straw storage, transportation
Mowers	Cutting grass or crops	Rotary, sickle, flail	Efficient mowing, pasture management
Grain handling equipment	Moving an storing grains	Augers, conveyors, grain dryers	Efficient handling, preservation
Grain storage bins	Storing harveste grains	Steel, concrete	Secure storage, pest control
Feeding equipment	Distributing feed	Feeders, mixers	Efficient feeeing, Reduced labor
Watering equipment	Providing water to animals	Waterers, troughs	Clean water Access, animal welfare
Manure spreaders	Distributing manure as fertilizer	Broadcast, injection	Nutrient recycling, soil improvement
Agricultural Drones	Monitoring crops, spraying	Multi-rotor, fixed-wing	Precision agriculture, data collection
GPS Systems	Precision farming, mapping fields	Receiver, software	Accurate field operations, data analysis

The size of the global agricultural machinery and equipment market was assessed at USD 192.10 billion in 2023. This market is expected to reach USD 206.80 billion in 2024 and reach USD 324.88 billion by 2030 with a CAGR of 7.79% (GII Global Information, 2024). The agricultural machinery and equipment market, largely defined by the need to increase agricultural productivity and efficiency, is of vital importance to meet global food demand fueled by population growth. According to Trade Map 2021 data, Turkey, which ranks thirtieth in world exports with a share of 1.02%, is a country where agricultural mechanization is important due to its ability to produce in all seasons in terms of climatic conditions. Turkey's machinery exports are ranked fifth in agricultural machinery and equipment exports among 22 sectors (TARMAKBIR, 2022). Aktas Cimen and Ertekin (2023), in their studies on the 2001-2021 period using Trade Map data, showed that the share of agricultural machinery and equipment exports in world exports has remained quite stable, but the share of agricultural machinery and equipment exports in Turkey's total exports has generally increased steadily. As the global economy grows, the need for a deeper understanding of the various benefits of trade also increases. This article aims to reveal Turkey's competitiveness by comparing its export similarity to the world market in the agricultural machinery and equipment sector with the leading countries in the world in the sector. This study comparatively reveals Turkey's export similarity to the global market against ten countries in the ranking of export revenues in the world agricultural machinery and equipment sector for the period 2002-2021. No existing study has been found in the literature that determines the competitiveness of the agricultural machinery and equipment sector on a global scale. As a result, this study is expected to fill this gap in the literature.

Overview of the Agricultural Machinery and Equipment Market

The agricultural machinery and equipment sector continues to be equipped with modern technologies in line with the goals of increasing productivity, optimizing the workforce, and environmental sustainability. The global agricultural machinery market volume is 171.4 billion USD, of which 8.3 billion USD is France, 8.2 billion USD is Germany and 3.3 billion USD is Turkey (Centre for Sustainable Agricultural Mechanization, 2023). When the export data for the agricultural machinery and equipment sector in Turkey and the world is examined, an increase is observed (Table 2).

Tablo 2. Course of Agricultural Machinery and Equipment Exports in Turkey and the World (2002-2021).

Years	Turkey Agricultural Tools and Equipment Export (x1000 US $)	Turkey Change (%)	Turkey Agricultural Tools and Equipment Export (x1000 US $)	World Change (%)
2002	103085	-	25693391	-
2003	228288	121.46	29587322	15.16
2004	262052	14.79	36383071	22.97
2005	283701	8.26	40514027	11.35
2006	317204	11.81	44807336	10.60
2007	414278	30.60	54540516	21.72
2008	564629	36.29	70206795	28.72
2009	485673	-13.98	50780145	-27.67
2010	532938	9.73	54769620	7.86
2011	626603	17.58	70406035	28.55
2012	806325	28.68	72907729	3.55
2013	853309	5.83	74700191	2.46
2014	1022732	19.85	73441172	-1.69
2015	945804	-7.52	63892286	-13.00
2016	860669	-9.00	62107793	-2.79
2017	951580	10.56	70440948	13.42
2018	1127056	18.44	75898338	7.75
2019	1243226	10.31	73187422	-3.57
2020	1264995	1.75	73160595	-0.04
2021	1646014	30.12	90904116	24.25

Reference: Prepared by the authors based on Trade Map (2023) data.

As can be seen from the table, Turkey's agricultural machinery and equipment sector exports in the 2002-2021 period (excluding crisis years) show a better outlook than the sector's world exports. In the 2009 financial crisis, Turkey's agricultural machinery and equipment sector exports decreased by 13.98%, while the sector's world exports decreased by almost twice as much as Turkey's exports (27.67%). A similar situation was experienced in

the sector in 2015, 2019 and 2020. While world agricultural machinery and equipment exports decreased by 2.79% in 2016 alone, Turkey's agricultural machinery and equipment exports experienced a decrease of more than 3 times the sector's world exports (9.00%) due to the coup attempt, losses in the tourism sector, and global and geopolitical developments. However, in the period 2002-2021, Turkey's agricultural machinery and equipment sector exports have increased much more than the sector's world exports and contribute more to the national income.

Among the top ten countries contributing to the world economy with agricultural machinery and equipment exports, China's export performance is remarkable (Table 3).

Table 3. Top Ten Countries and Their Shares in World Agricultural Machinery and Equipment Export Revenues Ranking According to HS Codes (2021, x1000 US $).

HS 69	Export Value	Country Share (%)	**HS 82**	Export Value	Country Share (%)
China	30695409	42.41	China	23196436	30.29
Italy	6429404	8.88	Germany	10387146	13.56
Spain	5150524	7.12	USA	4740156	6.19
Germany	4392013	6.07	Japan	3964131	5,18
India	2314625	3.20	Taipei, China	3590191	4.69
USA	2297719	3.17	Switzerland	2216323	2.89
Japan	1831989	2.53	Korea	2113170	2.76
Turkey	1616311	2.23	Italy	2054260	2.68
Mexico	1493034	2.06	Poland	1864043	2.43
Poland	1316015	1.82	Belgium	1761357	2.30
			Turkey (28th)	326131	0.43
WORLD	72380725	79,49		76590397	73.40

HS 84	Export Value	Country Share (%)	**HS 87**	Export Value	Country Share (%)
China	547585389	21.99	Germany	245903308	16.31
Germany	268562339	10.79	Japan	137909344	9.14
USA	209284552	8.41	USA	122202361	8.10
Japan	147382033	5.92	China	120021475	7.96
Italy	108057165	4.34	Mexico	115018307	7.63
HK*, China	95090192	3.82	Korea	67015410	4.44
Holland	90145570	3.62	Spain	54144088	3.59
Mexico	85268563	3.42	Belgium	51734829	3.43
Korea	76018245	3.05	France	50825662	3.37
Singapur	69218450	2.78	Canada	45798628	3.04
Turkey (26th)	20778367	0.83	Turkey (18th)	25030889	1.66
WORLD	2489983257	68.97		1508078598	68.67

Reference: Prepared by the authors based on Trade Map (2023) data.

China ranks first in the agricultural machinery and equipment product groups coded HS 69 (42.41%), HS 82 (30.29%) and HS 84 (21.99%), while it ranks fourth in the world in the HS 87 (7.96%) coded product group, which is understood to be advantageous in its competitiveness in agricultural machinery and equipment exports. The USA ranks third in the world in the export of the three agricultural machinery and equipment product groups coded HS 82, 84 and 87, and sixth in the world in the export of the HS 69 coded product group. Japan, the world's third largest economy after the USA and China, ranks fourth in the world in the export of agricultural machinery and equipment coded HS 82, 84, and second in the export of agricultural machinery and equipment coded HS 87 with a share of 9.14%, while it ranks seventh in the export of the HS 69 coded product group. Germany, which ranks fourth after the USA, China and Japan with its strong economy, ranks second in the world in HS 82 and 84 coded agricultural machinery and equipment exports, ranks first with a share of 16.31% in the HS 87 coded product group, and ranks fourth in the world in the HS 69 coded product group. Italy, the 3rd largest national economy in the Eurozone, ranks second in the HS 69 coded agricultural machinery and equipment product group, eighth in the HS 82 coded product group, fifth in the HS 84 coded product group and tenth in the HS 87 coded product group. Turkey, which ranks thirtieth in world exports, has been determined to be eighth in the HS 69 coded product group, seventeenth in the world exports in the HS 87 coded product group, twenty-sixth in the world exports in the HS 84 coded product group and twenty-eighth in the world in the HS 82 coded product group. In the global market for agricultural machinery and equipment exports, Turkey seems to have a greater advantage in the export of the HS 69 coded product group compared to the export of the HS 82, 84 and 87 coded product groups when compared to the developed economies of the world.

Literature Review: Competition Between Exporting Countries

World production has grown beyond expectations since the 1960s (Bayoumi, 1995). With increasing growth, countries have wondered about the effects of structural changes in international trade on trade performance and how countries can adapt to these changes (Nguyen et al., 2017). In addition, production increases have given rise

to the concept of "competitiveness" in the 1970s (Siudek and Zawojska, 2014). However, defining and measuring the concept is an interesting and controversial issue (Falciola et al., 2020). Competitiveness, a multidimensional concept, is classified in the literature at the firm, industry and country levels. Competitiveness at the firm level is defined as the firm's ability to design, produce and/or market products that are superior to those offered by its competitors, considering price and non-price attributes (Ajitabh and Momaya, 2004). Industry-level competitiveness refers to the ability of large firms within the national industry to compete in the global market (Aktan and Vural, 2004). Competitiveness at the country level is defined as the ability of a country to create, produce, distribute and/or provide services while gaining increasing returns on its resources in international trade (Buckley et al., 1988). This ability is shaped particularly through the firms and industries of that country. The global competitiveness of countries may be concentrated in certain sectors, and no country has the same advantages in terms of competitiveness in all sectors (Aktan and Vural, 2004). National competitiveness also reflects the power of a country against its competitors in the global economy. The interest of countries in global competition is increasing day by day, and this interest seems to be relatively higher in developed and developing countries (World Economic Forum, 2024). At the same time, competition is a type of relationship between countries, and these relationships can also “play a binding role” between different countries or regions (Liu et al., 2020). Due to the lack of a universally accepted definition of “competitiveness”, countries' export data is used as a tool to evaluate a nation's “sales ability”. Because foreign trade data allow comparisons to be made between countries (Saxena and Salze-Lozac’h, 2010).Bir ülkenin uluslararası pazardaki rakiplerini belirlemek için kullanılan İhracat Benzerlik Endeksi (Export Similarity Index-ESI), ilk olarak 1960'larda tanıtılmıştır. Tarım alet ve ekipmanları sektöründe ESI ile yapılan çalışmalara rastlanmamıştır. Bu nedenle yerli ve yabancı literatürde ESI’nin kullanıldığı çalışmalara yer verilmiştir.

Aktas Cimen and Kosekahyaoglu (2023), analyzed the concentration of Turkey and BRICS (Brazil, Russia, India, China, South Africa) exports on a country basis for the period 2001-2021 using the Gini-Hirschman Index (GHI) according to Trade Map 2021 data, while the Export Similarity Index (ESI) was used for export similarity to the European Union (EU) common market. The findings of the study show that, according to GHI values, product diversity in Turkey's exports to the United Kingdom, the United States, and Germany has increased significantly over time, while product diversity in exports to Italy and Spain has followed a fluctuating course. The ESI results determined that Turkey and BRICS are in high competition in the relevant product groups in the EU market (ESI value 60.75) and pose a threat to each other.

Wang and Liu (2015), examined the world, American and Indian markets on the export similarity of agricultural machinery between China and the European Union (EU) between 2007-2013 using the export similarity index. For this purpose, they used the export similarity index, showing that China and the EU have a higher export similarity index in the developed countries market, which leads to fierce competition in export products. Accordingly, it is emphasized that effective measures should be taken to strengthen inter-regional trade cooperation between China and the EU and reduce bilateral trade friction.

Özoğul (2018) examined the distribution of trade by country, and stated that developed countries are in a leading position in the trade of agricultural machinery and equipment as well as agricultural products. This situation shows that intra-industry trade is widespread in the agricultural machinery sector. The main reason for this is that developed countries can meet the demand in the sector within themselves thanks to their state-of-the-art machinery production. In 2015, China became the largest exporter of agricultural machinery worldwide. This country is followed by the USA, Germany, Japan and the Netherlands. China is the most important exception among exporting countries. Thanks to its cheap labor, China has started to come to the fore in the agricultural machinery sector as in every field. For this reason, it is emphasized that it is in a more advantageous position especially in the production of cost-effective but low-quality machinery.

Celik et al. (2020), announced that, Turkey’s main countries for agricultural machinery export in 2017 USA, Azerbaijan, Italy, Iraq, and Sudan. Agricultural machinery sector is the 7th in the machinery sector.

This article aims to fill the gap in the existing literature by providing an empirical analysis of the course of Turkey's export similarity to the global market and the change in its competition over time with the leading countries (China, Germany, USA, Italy, Japan) in the global agricultural equipment export market.

DATA SET AND METHOD

This study evaluates the export competitiveness of Turkey's agricultural tools and equipment sector in the global market through ESI analysis.

Data Set

The research data in the study were obtained by selecting the "machinery" classification within the "goods" classification via the Trade Map database. The classification according to the Customs Tariff Statistics Position Numbers (GTIP) for agricultural machinery and equipment is given in ANNEX 2. The data covers 200 countries worldwide at different development levels that export agricultural tools and equipment for the period 2002-2021. In addition, 10-year trade data is considered sufficient to examine the trade competitiveness and trade potential of any commodity (Jagadeesh et al., 2024).

Method

Competitiveness in trade is generally defined as the capacity of a sector to increase its share in international markets against its competitors. The competitiveness index is an indirect measure of a country's international market power assessed through its share of world markets in selected export categories (Mikic and Gilbert, 2009).

Export Similarity Index (ESI)

ESI is an index that measures the similarity of export sections of any two countries (or groups of countries) to a third market (Finger and Kreinin, 1979). The ESI value can measure the comparative threat that a country poses to another in the global market and reveal the course of the relative development of the country's exports (Schoot, 2004). ESI, which measures the degree of overlap in the export structures of countries, provides an idea about the competitive pressures that countries face in different periods (Riad et al., 2012). The limitation of the index is that it only takes into account the structure of exports, not their level, and therefore the index values can be misleading when the size of the economies included in the analysis is very different (Mikic and Gilbert, 2009). Unlike other indices, ESI emphasizes structural rather than quantitative aspects of exports by using standardized international trade data (Schoot, 2004). ESI values also help measure competitive threats between countries and assess the complexity of exports (Pomfret, 1981). The index expresses the share of total exports of a specific product from the examined region in total world exports of the same product. The ESI proposed for analysis is formulated as follows (Finger and Kreinin, 1979; Mikic and Gilbert, 2009; Vlasenko et al., 2020):

$$ESI=\sum \min[X\_k\,(jw), X\_k\,(mw)]\times 100$$

Here;

Xk (jw) is the share of the export value of product k (product group) of country “j” to the world in its total exports to the world,

Xk (mw) is the share of the export value of product k of country “m” to the world in its total exports to the world. In other words, it takes the smaller of the sectoral export shares (in percentage) in each product category and adds them up (Mikic and Gilbert, 2009).

The index takes a value between “0” and “100”. The value of “0” indicates that the export outlooks of the countries are not similar (there is no competition between countries) in terms of sector or product (product group), while the value of “100” indicates that the countries have perfect similarity (competition between countries) in terms of sector or product (product group) (Schoot, 2004; Saricoban and Kosekahyaoglu, 2017; Li et al., 2022; Wani et al., 2024). Increases in the ESI value may trigger increased competition and trade wars in the future. High ESI values indicate the existence of intense global market competition and limited prospects for inter-sectoral trade through regional arrangements (Schoot, 2004). ESI can evaluate the competitiveness of Turkey with the top five countries in agricultural machinery and equipment exports.

RESULTS

Turkey, on the other hand, ranks eighth in the HS 69 coded product group, seventeenth in the HS 87 coded product group, twenty-sixth in the HS 84 coded product group, and twenty-eighth in the HS 82 coded product group in the global agricultural machinery and equipment export market. Based on the data set and method explained in the previous section, Turkey's export similarities with the top five leading countries in the global agricultural machinery and equipment export market (China, USA, Germany, Italy, and Japan) were analyzed. In the study, where the export data of the HS 69, 82, 84, and 87 coded product groups for the period 2002-2021 were taken into account, the course of Turkey's agricultural machinery and equipment export similarities with China, USA, Germany, Italy, Japan in the global market over 20 years is observed in Figure 1.

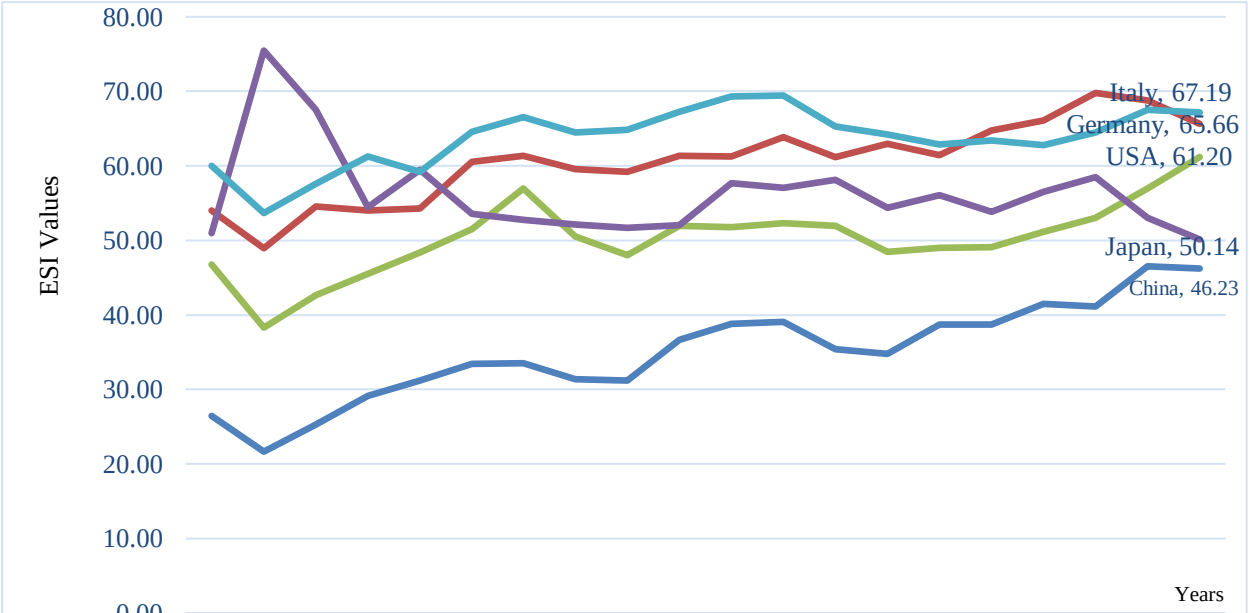
Export Similarity of Turkey and China

China ranks first in the HS 69, 82, and 84 coded product groups and fourth in the HS 87 coded product group in the global agricultural machinery and equipment export market. Figure 1 shows that the global agricultural machinery and equipment export similarity between Turkey and China increased over the 20 years between 2002 and 2021. Turkey and China, which had the lowest ESI value in 2003 (21.67) in the analyzed period, reached the highest ESI value (46.23) in 2021. The agricultural machinery and equipment ESI value of Turkey and China increased from 26.46 in 2002 to 46.23 in 2021. The increase in the ESI value indicates that Turkey exports similar products to China in the global agricultural machinery and equipment export market, and therefore the competition between Turkey and China in agricultural machinery and equipment exports has increased.

Export Similarity of Turkey and Germany

Germany ranks first in the HS 87 coded product group, second in the HS 82 and 84 coded product groups, and fourth in the HS 69 coded product group in the global agricultural machinery and equipment export market. In the twenty-year period in which the agricultural machinery and equipment export similarity of Turkey and Germany was analyzed for the period 2002-2021, it was observed that the export similarity of both countries generally followed a horizontal course until 2019, with small increases and decreases; and a decrease in the ESI value was

observed as of 2020. In the analyzed period 2002-2021, Turkey and Germany, which had the lowest ESI value in 2003 (48.96), reached the highest ESI value (69.80) in 2019. The agricultural machinery and equipment ESI value of Turkey and Germany increased from 54.03 in 2002 to 65.66 in 2021. This increase in the ESI value shows that Turkey exports similar products to Germany in the global agricultural machinery and equipment export market and that competition between them has increased.



Years

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
China	26.46	21.67	25.30	29.18	31.19	33.43	33.56	31.35	31.18	36.67	38.80	39.04	35.41	34.79	38.70	38.71	41.52	41.14	46.54	46.23
Germany	54.03	48.96	54.60	54.05	54.30	60.54	61.36	59.57	59.25	61.31	61.30	63.83	61.15	62.97	61.44	64.77	66.10	69.80	68.81	65.66
USA	46.76	38.31	42.66	45.53	48.43	51.54	56.99	50.53	48.03	51.97	51.74	52.32	51.98	48.47	49.02	49.12	51.19	53.05	56.97	61.20
Japan	51.01	75.47	67.52	54.47	59.44	53.61	52.73	52.10	51.68	52.06	57.73	57.09	58.10	54.39	56.06	53.85	56.56	58.54	53.01	50.14
Italy	60.01	53.68	57.58	61.24	59.19	64.57	66.51	64.53	64.85	67.28	69.36	69.44	65.30	64.24	62.85	63.42	62.76	64.45	67.54	67.19

Figure 1. Course of ESI Values (2001-2022).

Export Similarity of Turkey and the USA

The USA ranks third in the HS 82, 84, and 87 coded product groups and sixth in the HS 69 coded product group in the global agricultural machinery and equipment export market. In the 2002-2021 period, when the global agricultural machinery and equipment export similarity of Turkey and the USA was analyzed, it was seen that there was a general upward trend, although there were significant increases and decreases in the twenty years (Figure 1). The ESI values of Turkey and the USA showed an increasing trend between 2004-2008, while they decreased in 2009 and 2010. The ESI values of Turkey and the USA, which showed small increases and decreases in the 2011-2015 period, have been showing an increasing trend, especially since 2016. In the analyzed period of 2002-2021, Turkey and the USA, which had the lowest ESI value in 2003 (38.31), reached the highest ESI value (61.20) in 2021. The agricultural machinery and equipment ESI value of Turkey and the USA increased from 46.76 in 2002 to 61.20 in 2021. This increase in the ESI value of Turkey and the USA means that they export similar products in the global agricultural machinery and equipment export market and that competition between them has increased.

Export Similarity of Turkey and Japan

Japan ranks second in the HS 87 coded product group, fourth in the HS 82 and 84 coded product groups and seventh in the HS 69 coded product group in the global agricultural machinery and equipment export market. In the study analyzing the similarity of Turkey and Japan's global agricultural machinery and equipment exports for the period 2002-2021, significant increases and decreases are observed in the twenty years and it is observed that the general trend is decreasing (Figure 1). It is understood from Figure 1 that the ESI values of Turkey and Japan have shown a steady decrease, especially since 2019. In the study, it is seen that Turkey and Japan had the lowest ESI value (50.14) in the period 2002-2021 in 2021. This decrease in the ESI values of Turkey and Japan indicates that the exports of similar products and the competition between them have decreased in the global agricultural machinery and equipment export market.

Export Similarity of Turkey and Italy

Italy ranks second in the HS 69 coded product group, fifth in the HS 84 coded product group, eighth in the HS 82 coded product group, and eleventh in the HS 87 coded product group in the global agricultural machinery and

equipment export market. Figure 1 shows that the global agricultural machinery and equipment export similarity between Turkey and Italy increased over the 20 years between 2002 and 2021. It is seen that Turkey and Italy, which had the lowest ESI value in 2003 (53.68) in the analyzed period, reached the highest ESI value (69.44) in 2013. The agricultural machinery and equipment ESI value of Turkey and Italy increased from 60.01 in 2002 to 67.19 in 2021. This increase in the ESI value shows that Turkey exports similar products to Italy in the global agricultural machinery and equipment export market, and therefore the competition between Turkey and Italy in agricultural machinery and equipment exports has increased. In the study analyzing Turkey's export similarities to China, the USA, Germany, Italy, and Japan in the agricultural machinery and equipment sector, the countries were ranked as Italy (60.01), Germany (54.03), USA (46.76), Japan (51.01), China (26.46) according to the ESI values in 2002, while the ranking changes to Italy (67.19), Germany (65.66), USA (61.20), Japan (50.14), China (46.23) in 2021. The biggest difference in ESI values in the twenty years in China (19.77), USA (14.44), Germany (11.63), Italy (7.18), and Japan (-0.87). Turkey's positive ESI difference values with China, the USA, Germany, and Italy indicate that they exported increasingly similar products in the agricultural machinery and equipment sector in the 2002-2021 period and that competition between them increased, while the negative difference in the ESI value between Turkey and Japan indicates that the similarity between the agricultural machinery and equipment export products of the two countries has decreased, and therefore the competition between them has weakened. In addition, the largest difference in ESI values is seen in Turkey's export similarity with China. According to Trade Map 2021 data, it is understood that China, which is the leader in world exports with a share of 15.20%, exported increasingly similar products to Turkey in agricultural machinery and equipment exports to the global market in the 2002-2021 period. This result means that China is increasingly posing a threat to Turkey in the global agricultural machinery and equipment export market.

CONCLUSION

Global population growth and environmental pressures caused by the climate crisis, combined with limited agricultural land, create pressure to increase agricultural production and increase productivity. The increasing world population also increases the demand for food, but limited agricultural land and environmental factors necessitate the development of more efficient and sustainable methods to meet this demand. At this point, modern agricultural machinery and equipment both increase production volumes and reduce environmental impacts. The production of agricultural machinery and equipment has necessitated international trade with its roles in providing agricultural production and productivity increases. While developed countries export high-tech agricultural machinery and equipment, developing countries are trying to increase their agricultural production efficiency by importing these products. Exports of agricultural machinery and equipment facilitate access to these machines and equipment.

The similarity of Turkey to the global agricultural machinery and equipment export market with the top five countries (China, USA, Germany, Italy, Japan) in the global market for the period 2002-2021 was analyzed using ESI. In the index calculation, agricultural machinery and equipment export similarities between Turkey and leading countries were calculated in the HS 69, 82, 84, and 87 coded product groups included in the agricultural machinery and equipment classification (based on 39 product groups subject to export). According to ESI values, China ranks first in the HS 69, 82, and 84 coded product groups, and fourth in the HS 87 coded product group in the global agricultural machinery and equipment export market. Germany ranks first in the HS 87 coded product group, second in the HS 82, and 84 coded product groups and fourth in the HS 69 coded product group. The USA ranks third in the HS 82, 84, and 87 coded product groups, and sixth in the HS 69 coded product group. Japan ranks second in the HS 87 coded product group, fourth in the HS 82 and 84 coded product groups, and seventh in the HS 69 coded product group. Italy ranks second in the HS 69 coded product group, fifth in the HS 84 coded product group, eighth in the HS 82 coded product group, and eleventh in the HS 87 coded product group. Turkey ranks eighth in the HS 69 coded product group, seventeenth in the HS 87 coded product group, twenty-sixth in the HS 84 coded product group, and twenty-eighth in the HS 82 coded product group.

In the 2002-2021 period, it is seen that Turkey has increasingly exported similar products to China, the USA, Germany, and Italy in the agricultural machinery and equipment sector, and that competition between them has increased. The decrease in Turkey's ESI values with Japan means that the similarity of agricultural machinery and equipment export products of the two countries has decreased, and therefore the competition between them has weakened. In 2021, Turkey's agricultural machinery and equipment ESI value rankings for China, the USA, Germany, Italy, and Japan in the global market are Italy (67.19), Germany (65.66), the USA (61.20), Japan (50.14), and China (46.23). These ESI values show that Turkey exports very similar products to Italy in the agricultural machinery and equipment market and that there is high competition between them, while Turkey exports less similar products to China in the agricultural machinery and equipment market and that the competition between them is weaker. However, the biggest difference in ESI values in the 20 years from 2002 to 2021 is seen in Turkey's export similarity with China. This result shows that Turkey and China are increasingly exporting similar products in the global agricultural machinery and equipment export market and that competition between the two countries

is increasing. According to Trade Map 2021 data, it can be said that world export leader China (with a share of 15.20%) poses more of a threat to Turkey.

In this case, to cope with the environmental threats created by the global climate crisis as well as the increase in food demand caused by the increasing Turkish population, it is extremely important for Turkey to quickly implement policies to improve its competitiveness in agricultural machinery and equipment product groups, where it does not have much of a competitive advantage so that the agricultural machinery and equipment sector can remain strong in global competition. In addition, it is of great importance to support and develop Turkey's agricultural machinery and equipment export performance with appropriate export and trade policies. For this, there is a need to develop comprehensive export strategies that include both companies in the sector and state-led efforts. In addition, incentives, tax reductions, etc. Supporting the agricultural machinery and equipment sector with policies will be very important applications in both maintaining a competitive advantage and gaining a competitive advantage in product codes where the competitive advantage is weak.

It is thought that agricultural machinery and equipment play important roles in meeting the food demand of the increasing world population and coping with the dangers created by the climate crisis. Therefore, findings regarding competition in the agricultural machinery and equipment export market can deepen the knowledge of stakeholders such as researchers, academics, institutions, and decision makers. It can be effective in making strategic decisions for both companies and countries in the global economy. The limitations of this study are that the ESI analysis was conducted with the top 5 countries in agricultural machinery and equipment exports. Subsequent scientific studies can deepen the ESI analysis regarding agricultural machinery and equipment exports by including more countries or to a large common market such as the European Union.

Automation and new technologies should meet the needs of farmers, and be easy to use and efficient. Therefore, farmers should be encouraged to invest in these high technologies. Especially the increase in farm sizes and the use of high technology are very important for manufacturers in the sector.

The number of machines sold may decrease in parallel with the growth of agricultural land and the increase in the capacity and size of the machines used. However, this does not negatively affect the turnover because more expensive machines will be sold. Farmers want innovative machines to be used for special use and production, multi-purpose machines are important and they want features that can be used in niche production areas to be included.

Machines that consume minimum energy, safety, efficiency, comfort, and versatility are also among the factors that should be taken into consideration. The future of the tractor and agricultural machinery sector will develop in parallel with the future of the agricultural sector. The main goal of development should be to increase the financial power of farmers.

Compliance with Ethical Standards

Peer-review

Externally peer-reviewed.

Declaration of Interests

The authors state there is no competing interest.

Author contribution

The contribution of the authors to the present study is equal.

Data availability

Data will be made availabale on request.

Consent to participate

The authors consent to participate.

Funding

No funding was received to conduct this research.

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