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COMPETITION IN THE VEGETABLE MARKET AND CHALLENGES FOR THE INDUSTRY: A BIBLIOMETRIC ANALYSIS OF DOMINANT PUBLICATIONS

Purpose. The purpose of this paper is to identify current and future directions of research using bibliometric analysis of publications indexed in Scopus and Web of Science databases on the problems of competition in the vegetable market and industry development, as well as dominant topics.

Methodology / approach. A comprehensive review of 1246 publications indexed in the Scopus and Web of Science databases was carried out using the VOSviewer and Bibliometrix software packages. The analysis was carried out using Microsoft Excel, Canva, and Datawrapper programs, and after careful consideration, 67 works were selected for in-depth study.

Results. The bibliometric analysis of the published publications revealed research trends; using software analysis, by periods, the main directions of research carried out in the last 60 years were evaluated; participation of countries in the process of scientific research was determined; research clusters were identified according to the countries and authors of dominant publications. The paper provides conclusions about current research problems in the publications on competition in the vegetable market and industry challenges, and offers recommendations for future research directions. It was determined that conducting a similar bibliometric research in developing countries such as Georgia is impossible at this stage due to the lack of a local scientific database, also they do not have enough abilities to publish a large number of articles indexed in Scopus and Web of Science. Impeding factors were identified and ways to solve the problem were determined.

Originality / scientific novelty. Based on the bibliometric analysis, for the first time, investigation is conducted to examine the competition in the vegetable market and industry challenges. The bibliometric analysis revealed that the research field has been developing steadily and continuously over the years, with narrow and specialised topics being transformed in a multifaceted way in the wake of global issues. The research area is geographically unevenly concentrated in the countries of North America, Europe and Asia.

Practical value / implications. The obtained results will help stakeholders, in particular: (i) researchers to identify current issues in the industry; (ii) the major players in the vegetable market in assessing the level of market competition; and (iii) political actors in determining the characteristics of the industry for the implementation of innovative projects.

Key words: competition, vegetable market, vegetable industry, dominant publications, bibliometric analysis.

1. INTRODUCTION

Discussions about bibliometric research began in the 1950s, before the term “bibliometrics” appeared in scientific use (Pritchard, 1969). The large-scale application of bibliometrics as a methodology is considered a recent phenomenon in the scientific field. At the current stage, the Scopus and Web of Science databases have significantly

simplified the mechanisms of obtaining and processing information required for bibliometric analysis. Assessing large volumes of unstructured data poses a number of difficulties for scientists, however, multifaceted and rigorous analysis is crucial to uncovering cumulative scientific knowledge and evolutionary nuances of a research field (Donthu et al., 2021).

Bibliometrics is one of the important directions of scientific research evaluation for the purpose of science management and policy development. At the same time, it allows the selection of relevant research problems for the development of the industry with a holistic approach (Kristia et al., 2023). Bibliometrics, as a set of methods, can be effectively used to determine and measure current research directions in scientific articles. Consequently, bibliometric analysis is a valuable resource for researchers and representatives of the policy field.

Against the background of the accompanying global crises and confrontations of the twenty-first century, the problems of providing the population with food, including vegetables, are becoming more and more acute. At present, 1/10 of the global population is facing hunger. Over 3 billion people have limited economic access to a healthy diet (FAO et al., 2024). Vegetables are essential for a healthy diet. Significant challenges in the vegetable industry over the past five years, including Covid-19, extreme weather, increased production costs, and complex logistics, have contributed to increased food insecurity. As a result, vegetable production in the EU and the USA has decreased, leading to an increase in import dependence. China has become a major player in the vegetable market. However, global vegetable consumption is constrained by fluctuating inflation, influenced by tense geopolitical situations. Despite this, changing consumer preferences, particularly the emphasis on quality products due to increased production control, have slowed down overall vegetable production growth (Rijswick et al., 2024).

Using modern scientific technologies, it is possible to identify unresolved, pressing problems, determine the future directions of research and conduct research on them. Therefore, using the bibliometric methodology to evaluate research on competition and industry challenges in the vegetable market and identify future directions will have significant scientific value.

The purpose of this paper is to identify current and future directions of research using bibliometric analysis of publications indexed in Scopus and Web of Science databases on the problems of competition in the vegetable market and industry development, as well as dominant topics.

2. LITERATURE REVIEW

Vegetable products are an integral part of the human diet and the main component of a healthy diet (The European Food Information Council, 2023). This is confirmed by the culinary interest of the population, in particular, 80 % of the population is in search for new ways of preparing vegetables (Kampen et al., 2023), however, the volume of production cannot fully satisfy the demand for this product.

Based on the above, the scientific analysis of competition in the vegetable market

is relevant. However, it should be noted that bibliometric studies conducted in this direction are general. For example, in 2022, a bibliometric analysis of scientific research on food industry by-products for the period 1976–2021 revealed an increasing trend in studies related to food industry by-products; in this regard, the leadership of Spain and Italy is highlighted (Hasenay and Ačkar, 2022). Of course, there are scientific works that study competition in the vegetable market. However, studies in this case are focused on specific products and regions. For example, based on the export competitiveness mapping approach, the European tomato market is analysed. It is determined that in the EU market, in the pre-crisis period, Spain had a significant competitive advantage, and since 2009 it has given position to the Netherlands. The results of the study suggest that Spain can regain leadership again (Capobianco-Uriarte et al., 2021). A similar study was also conducted in the domestic Indonesian market (Saptana, et al., 2023).

Recently, there has been an increase in bibliometric studies across specific areas of science. Currently, on the basis of bibliometric research in relation to the topic of vegetables, the following are studied: EU and US leadership in fruit and vegetable research (Tatry et al., 2013), bioavailability of pesticides in vegetable products (Andreo-Martínez et al., 2020), domestic and international product prices in the vegetable market (Li et al., 2021).

In terms of content, the bibliometric analysis of vegetable prices is correlated with the research problem. Based on the analysis of the integration function within the framework of the work, the reasons for fluctuations in vegetable prices in the domestic and international markets are identified. Against the background of the inevitability of price fluctuations, the authors proposed a mechanism for insuring the price of vegetables. Unfortunately, at this stage, the level of participation of vegetable-growing farmers in insurance programs is small. In the process of researching the factors affecting the price of vegetables, Chinese and other scientists have made rapid progress, but the changing market economic context creates significant barriers for them. The vegetable sector is attracting more and more scientific attention in the modern era. It has been identified that ensuring food security and sustainability of the vegetable supply chain is significantly challenged by the uneven global distribution of vegetable production and the increasing regional demands (Hassna et al., 2024). Given this, the perishability of vegetable products is an important factor, particularly considering the ongoing issue of excessive pesticide use in the industry (Tambo et al., 2024). Consequently, there is a strong focus on the advancement of machine learning and artificial intelligence within the vegetable industry (Shobharani et al., 2024; Wang et al., 2024).

It is clear that there is a high interest rate in the field of vegetable growing, however the level of competition in the vegetable market and the challenges of the industry are less studied by scientists using bibliometric analysis. To achieve the goal of the research, the following research questions (RQ) were set:

RQ1: What are the dominant publications on competition and industry challenges in the vegetable market provided in the Scopus and Web of Science databases?

RQ2: How did the main directions of research develop and how did they spread geographically?

RQ3: What is the rate of collaboration in research by states?

RQ4: Which clusters are identified within the framework of the study by authors, countries and author's keywords?

RQ5: What will be the future directions of research?

3. METHODOLOGY

The method of bibliometric analysis is applied in the research process. At the initial stage of the research, the search for publications was carried out through the keywords “vegetable” and “market” in the database of Scopus and Web of Science. The data was filtered according to the direction of the economy (Figure 1).

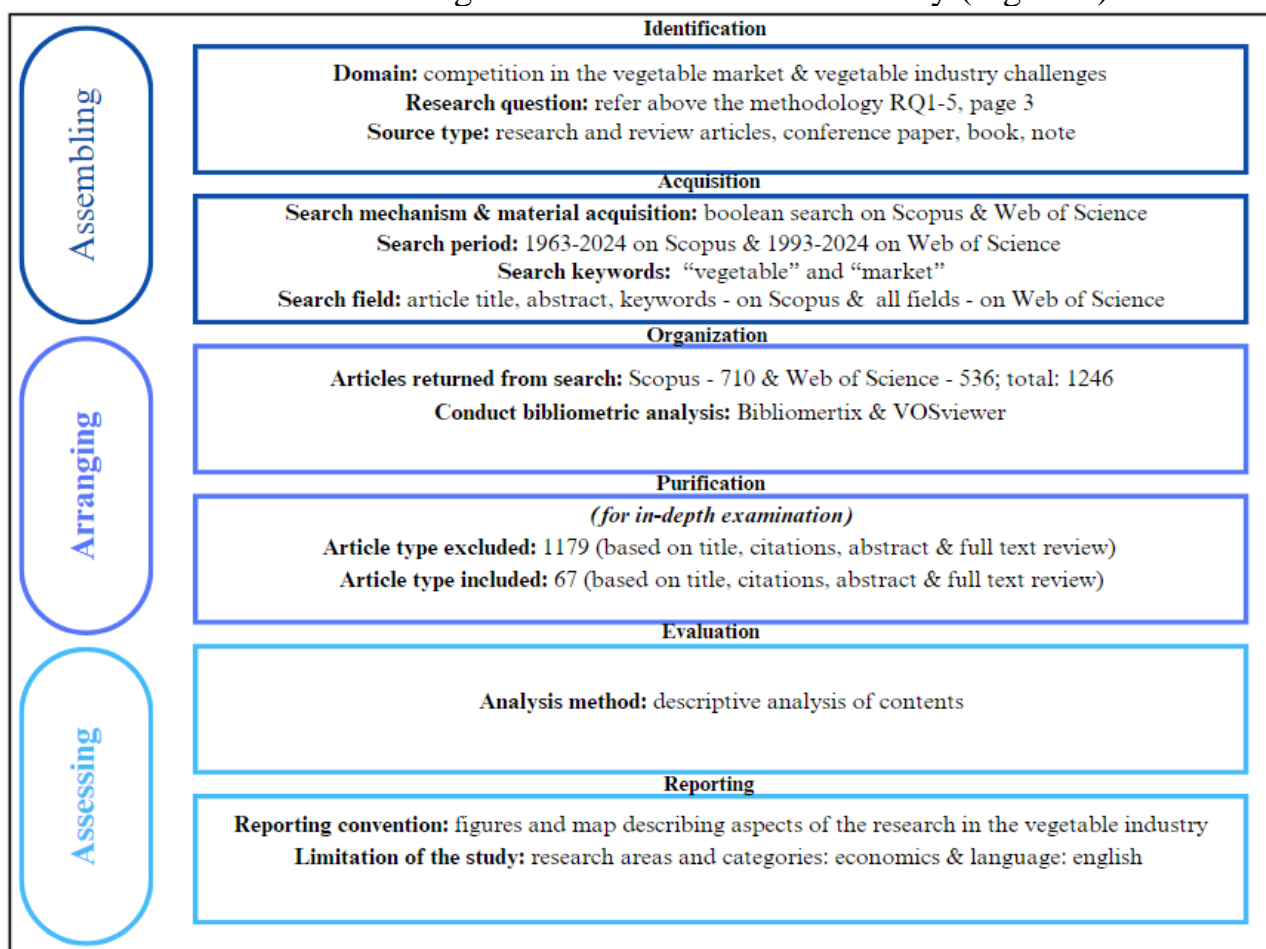


Figure 1. Methodology flowchart for searching and analysis process

Source: created by the authors using Canva.

We combined the data from Scopus and Web of Science in research dynamics. In some cases, such as research evolution, geographical area of research, and research collaboration, we analysed both of them (Scopus and Web of Science) separately, but every case was in one context (Figure 2 and 3, Map 1 and Figure 5 et al.) and based on the comparative analysis of the obtained results, the similarity was confirmed.

For the selected publications, the analysis period (1963–2024) was divided into five-year segments, the exception is 2018–2024*¹, which covers current-year

¹ Here and further, only the data for the first half of 2024 are used.

publications as well. The trend of published publications on the research problem was analysed and the main directions of the research were evaluated. The Scopus database² was selected for the in-depth/evolutionary analysis of the dominant publications according to the main directions. According to the defined periods, the current directions of research were identified by the method of inductive analysis. Using the method of analysis and comparison, the consistency of the obtained results with the data obtained as a result of the complex analysis (by keywords) of the publications presented in the Web of Science database was determined.

Within the framework of the work, the geographical area of the research was evaluated; in particular, based on the Web of Science database, the number of published publications was determined by country. Similar indicators in the Scopus database were processed using the synthesis method. Also, the level of collaboration between countries was assessed and relevant clusters were identified, both by countries, authors and authors' keywords. Other theoretical and empirical methods of scientific research are also used in the process of multi-faceted data analysis.

The bibliometric analysis was performed using VOSviewer and Bibliometrix software packages. Microsoft Excel, Canva, and Datawrapper software packages were used in the process of graphic analysis.

4. RESULTS

4.1. Research dynamics. Due to the importance of the vegetable industry, the study of economic problems related to it is a subject of constant study. This is evidenced by the trend in the number of publications indexed in Scopus and Web of Science databases in 1963–2024 (Figure 2).

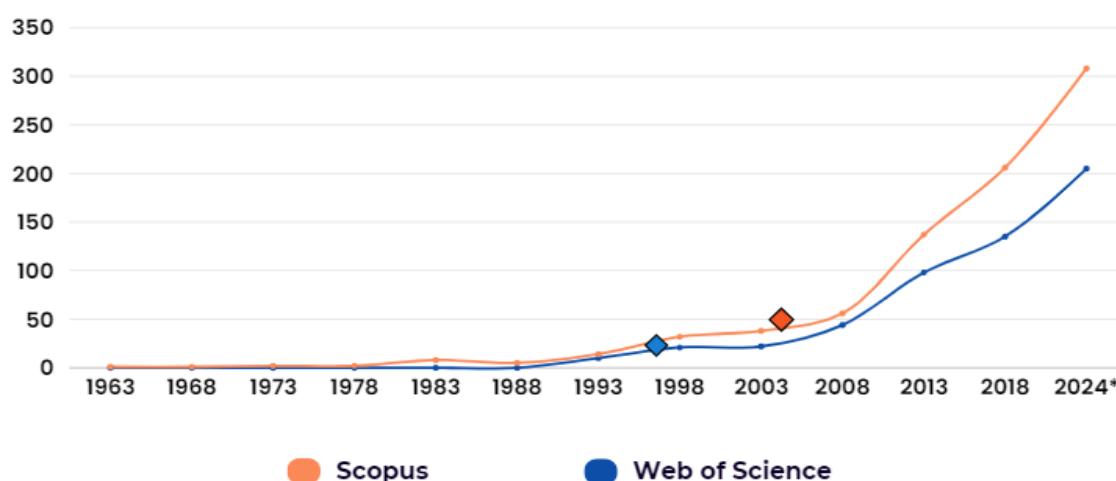


Figure 2. Trend in the number of publications presented in Scopus and Web of Science databases in 1963–2024

Source: created by the authors using Canva based on data from the Scopus and Web of Science database.

The Scopus and Web of Science databases currently include publications that

² The Scopus database generates more publications than the Web of Science.

were published before the formation of these scientific databases. This explains the fact that the first publication indexed in the Scopus database dates back to 1963, while the database was created in 2004. The article deals with the problems of developing the fruit and vegetable canning industry and its markets in South African countries after World War II (Glendining, 1963).

The first publication in the Web of Science database was published in 1990, and this database has been operating since 1997. The paper analyses the risks in the vegetable market, examines the capital structure and suggests ways to overcome seasonality (Prevatt et al., 1990). From 1963 to 1993, the number of indexed publications in the Scopus database increased slightly, from 1 to 14. And in the Web of Science database, only 10 publications were indexed in 1988–1993.

In the Scopus database, the trend of steady growth between 1993–2008, and a leap growth from 2013 to the present is characteristic. In the same period, the same trend can be observed in the Web of Science database. However, it should also be noted that recently, for example, in 2023, the number of works presented in the Scopus database is 1.5 times higher than the similar indicator of the Web of Science database and a similar trend is maintained even in 2024. Therefore, studies are systematic and incremental.

4.2. Research evolution. In the publications indexed in the Scopus database, between 1973 and 2008, the main areas of research are different. Recently, following the development of science, directions of research focused on the global challenges of the industry have been identified. Among them are problems that have not lost their relevance over the years (Figure 3).

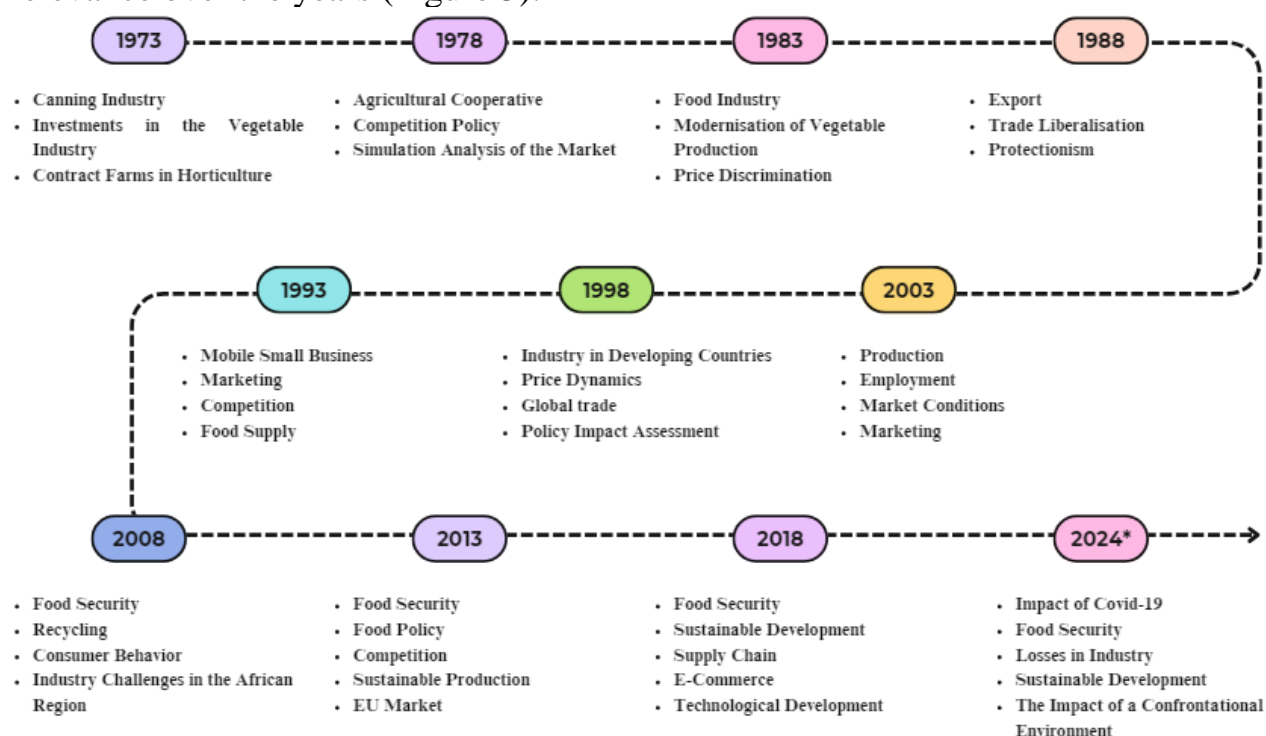


Figure 3. Main directions of research in publication presented in the Scopus database in 1963–2024

Source: created by the authors using Canva based on data from the Scopus database.

The analysis of the main directions of research of the publications given in the Scopus database by periods shows that the priority directions of research in the field of vegetable growing are changing along with economic development. Initially (in 1963–1973)³, along with the canning industry, the subject of scientific research was the impact of base price variability and contract price on competitive markets for vegetable crops (Jesse and Johnson, 1970). It is from the 1970s that the contract system begins to develop rapidly (Vicol et al., 2021) and has not lost its relevance for decades (Key and Runsten, 1999). In the same period, the effectiveness of investments in the processing industry of the vegetable growing sector was evaluated. In addition, a decreasing trend in the volume of vegetables in wholesale markets was identified (Le Fevre and Pickering, 1972).

At the next stage, research directions were analysed according to five-year periods. In 1973–1978, the competition rules defined by the Treaty of Rome (the founder of the European Economic Community) and its subsequent regulation had a significant impact on the food markets. The regulations aimed at increasing industrial productivity and improving product quality (The European Union, 1957). The rules⁴ developed within the framework of the regulation became the basis for the analysis of marketing measures of agricultural cooperatives (Delagneau, 1976).

In 1978–1983, the main focus was on food industry research in general. For example, a study of total advertising expenditure in Great Britain found that the bulk of expenditure (24.3 %) was on food advertising (Ulbricht, 1979). This proves that the industry of food products, including vegetables, was characterised by a high level of competition. Against this background, research on the problems of modernisation of vegetable production was actively carried out, and at the same time, research on ecology was observed (Poche, 1980). Against the background of growing competition, studies on forms of price discrimination and dumping prices were relevant. This issue is assessed by scientists from an economic point of view in the context of “fair value” (Schmitz et al., 1981).

In the next period (1983–1988), the main directions of research were mainly related to the problems of international trade. Representatives of the scientific sphere recommended the issues of limiting protectionism and liberalisation of trade by abolishing import tariffs (Clark, 1985). At the same time, the direction of the research was trade regulations in the vegetable market (Avery, 1985).

In 1988–1993, using tests based on Gardner’s framework, it was hypothesised that the market structure of perfect competition in the food industry includes markets for eight commodity groups, including fresh and processed vegetables (Holloway, 1991), it is also evaluated the impact of political decisions on the vegetable industry. For example, the policy of the European Union, which provided for the destruction of vegetable products removed from the market, was considered critical by the public at that time. A study conducted using a dynamic market simulation model revealed

³ Due to the small number of publications placed in the Scopus database in the given period, a ten-year period is analysed.

⁴ Including delivery of vegetable products to educational institutions (creation of delivery schemes).

that product losses can be reduced without changes in government spending and producers' incomes (Behr, 1990).

Since the beginning of the 1990s (1993–1998), the influence of the EU policy on the vegetable market of developing countries has been actively discussed in the scientific field. In this regard, it is worth noting the Common Agricultural Policy (CAP) and the tariff regime for imported vegetable products. As a result of the implementation of the latter, from 1991 to 2000, the share of fruit and vegetables imported by the EU in the global market decreased by 10 % (from 35 to 25 %; Kelch, 2004). A number of studies have found that the tariff regime imposed by the European Union has a negative effect on the potential third country supplier (Swinbank and Riston, 1995; Alvarez-Coque and Bautista, 1994). For the same period, competitiveness among vegetable crops is evaluated. It is determined that tomato and lettuce were characterised by relative advantage in relation to other products. Increased yield was considered to be a contributing factor for this advantage (Tefertiller and Ward, 1995). Since the field of vegetable growing is labour-intensive, labour resources and its productivity were also the subject of research. Using China as an example, it was proved that in the 1990s, labor is a resource of low marginal productivity. Thus, scientific studies question the relative superiority of grain production over vegetable production (Carter, 1997).

Between 1998 and 2003, the direct proportional effect of high labor costs in the vegetable market on the increase in the use of herbicides by farmers has been estimated (Pingali, 2001). Against this backdrop, the developed world is paying more attention to research into organic products. The Munich Research Association has determined that the organic vegetable market has great potential for development. As a result of their research, it was determined that 60 % of respondents are consumers of organic vegetables (Rämisch, 2001). Following the development of the vegetable industry, the competitiveness index of local vegetable products is determined by the exporting countries. Based on the analysis of export comparative advantage indices, the main competitors of the country have been determined by Turkish researchers: Spain and Greece (Akgüngör et al., 2002).

Under the conditions of market economy development, vegetable production depends on consumer needs and behaviour. Therefore, since 2003 (2003–2008) research on consumers' behaviour was still actively conducted. It has been found that trust between consumers and suppliers is important in the vegetable market. It is the trust factor that determines the reflex action of consumers, in particular, the preference for local products compared to imported certified organic vegetable products (Moore, 2006). Local vegetable products are mainly produced by small farmers. Accordingly, challenges faced by smallholder farmers, such as high transaction costs, lack of educational attainment, asymmetric information, legislative barriers, and poor infrastructure, were also the subject of the study. To solve the above problems, the authors propose to establish cooperatives and substantiates their economic feasibility, especially for the production of such a high-value product as vegetables (Ortmann and King, 2007). Against the background of the development

of the vegetable market, the use of private food safety standards by retailers as a risk management and competitive tool in Europe (Jaffee and Masakure, 2005) and Central America (Berdengué et al., 2005) has been widely discussed in scientific publications.

In the following period, in 2008–2013, research on food security was also actively conducted. Studies evaluated the impact of GlobalGap (food safety standard) in Thailand (Kersting and Wollni, 2012), Senegal (Maertens and Swinnen, 2009), Kenya (Ouma, 2010; Asfaw et al., 2009) and other developing countries' vegetable markets. In order to address the complex supply security problem, the scientific field examines the ways in which Kenya and India have dealt with increased food security risks (Narrod et al., 2009). Over the same period, a high level of loss-making persisted. For example, a study of the US vegetable market determined that the value of vegetable losses at the retail and consumer level in 2008 amounted to USD 27.7 billion. In this regard, tomato and potato crops were particularly distinguished (Buzby et al., 2011). The use of large amounts of pesticides contributed to the increased losses. Therefore, research activities have been carried out to promote sustainable production and identify the potential of organic vegetable production, for example, Thailand (Rointer-Schobesberger et al., 2008), Benin, Ghana and Burkina Faso (Probst et al., 2012). However, as we have already mentioned, the export of vegetables produced by them is hindered by the tariffs imposed by the European Union. Taking into account the influence of seasonality in the study of the Mediterranean countries, the periods of the year are identified, the liberalisation of which can positively affect the international trade of vegetables (Emlinger et al., 2008).

An additional barrier to the export of vegetables is a special feature of product supply chains – the quality constantly deteriorates over time. Therefore, in 2013–2018, the focus of scientific research was on the development of recommendations on the improvement of supply chains (Besik and Nagurney, 2017; Bogataj et al., 2017; Balaji and Arshinder, 2016). In this direction, the most important role of technologies is evaluated. It should be noted that the positive influence of technological development in the process of ensuring food security is also worth mentioning. This has not lost its relevance in recent years. For this period, food safety issues have been studied in Vietnam (Wertheim-Heck et al., 2014) and Kenya, which exported vegetable products produced through informal channels without GlobalGap certification to the EU market (Dannenberg and Nduru, 2013). Sustainable development was considered as a way to solve the mentioned problem. For example, scientific studies have identified factors affecting sustainable vegetable production in Turkey and Morocco (Cordon et al., 2014). Also, by the example of China, the willingness of the population to pay for sustainable consumption has been studied (willing to pay 47 % more; Yu et al., 2014). Also, for the mentioned period, the dependence of the change in the price of vegetables on the amount of consumption was determined. A study found that a 30 % reduction in market price increases vegetable consumption by 20 % (Klerman et al., 2014).

In the recent period, from 2018 to 2024, widespread global crises also reflected

on the main directions of vegetable market research. Restrictions imposed as a result of the Covid-19 pandemic have affected traditional vegetable supply chains. Scientific research on the subject has taken on a global character, in particular, disruptions in the vegetable supply chain have been assessed in India (Mahajan et al., 2023), China (Ruan et al., 2021), Canada (Richards and Bradley, 2020), Ethiopia and sub-Saharan African countries (Worku and Ülkü, 2022). Each study found supply chain disruptions to be a major driver of price increases. In the same period, the formation of digital supply chains took place. For example, during the pandemic in Taiwan, demand for online grocery shopping services increased by 4.9 %, and overall sales increased by 5.7 % (Chang and Meyerhoefer, 2021). A study of new supply chains in the Chinese and Canadian vegetable markets showed that the number of intermediaries was significantly reduced and the “small” supply chains formed by the pandemic were strengthened (Zhang et al., 2019; Lauren et al., 2021). Ultimately, the pandemic exacerbated the food security problem. Naturally, there is an active interest of researchers in this direction as well. Maximum residue limits (MRL) of pesticides aimed at ensuring food safety were found to reduce vegetable trade by 8.8 %. Especially noteworthy are the strict regulations of the European Union, which reduces the export of vegetables from the USA by 13.8 % (Hejazi et al., 2022). For the same period, the number of losses in the field of vegetable growing is still problematic. A study conducted in the USA determined that 65 % of vegetables produced were healthy, however, the absolute number did not meet the visual requirements of consumers. Accordingly, the number of losses was determined to be 57 % (Johnson et al., 2018). To solve the problem, scientists recommend the intensification of sustainable production (Kurgat et al., 2018). In the context of sustainable production, attention was also focused on the packaging of vegetable products. In this direction, the environmental impact of packaging is analysed in the context of Spanish fruits and vegetables. As a result of the study, it was determined that reusable plastic boxes should be chosen (Abejón et al., 2020). Also, there is still a growing demand for organic vegetable products, the consumer is willing to pay the premium offered by the producer (Bhattarai, 2019). This requires certification, which at the same time is one of the determining factors for maintaining the competitiveness of small farmers along with technological development (Ngenoh et al., 2020).

At the current stage, against the background of the complicated confrontational environment, it is expected to activate the research interest of the vegetable market. This is evidenced by the keyword analysis of the publications presented in the Web of Science database. Along with instability and uncertainty, recent topics include: supply chains, technology efficiency, government regulations (Figure 4).

As shown in Figure 4, the main research areas represented in the Scopus and Web of Science databases are consistent. Indeed, the following research problems are also relevant in the Web of Science database: demand, consumption, preferences, risks, productivity (China, India, developing countries, etc.), labour market, small farmers, agricultural cooperatives, food market, food security etc. Thus, studies have undergone an evolution from specific to global problems.

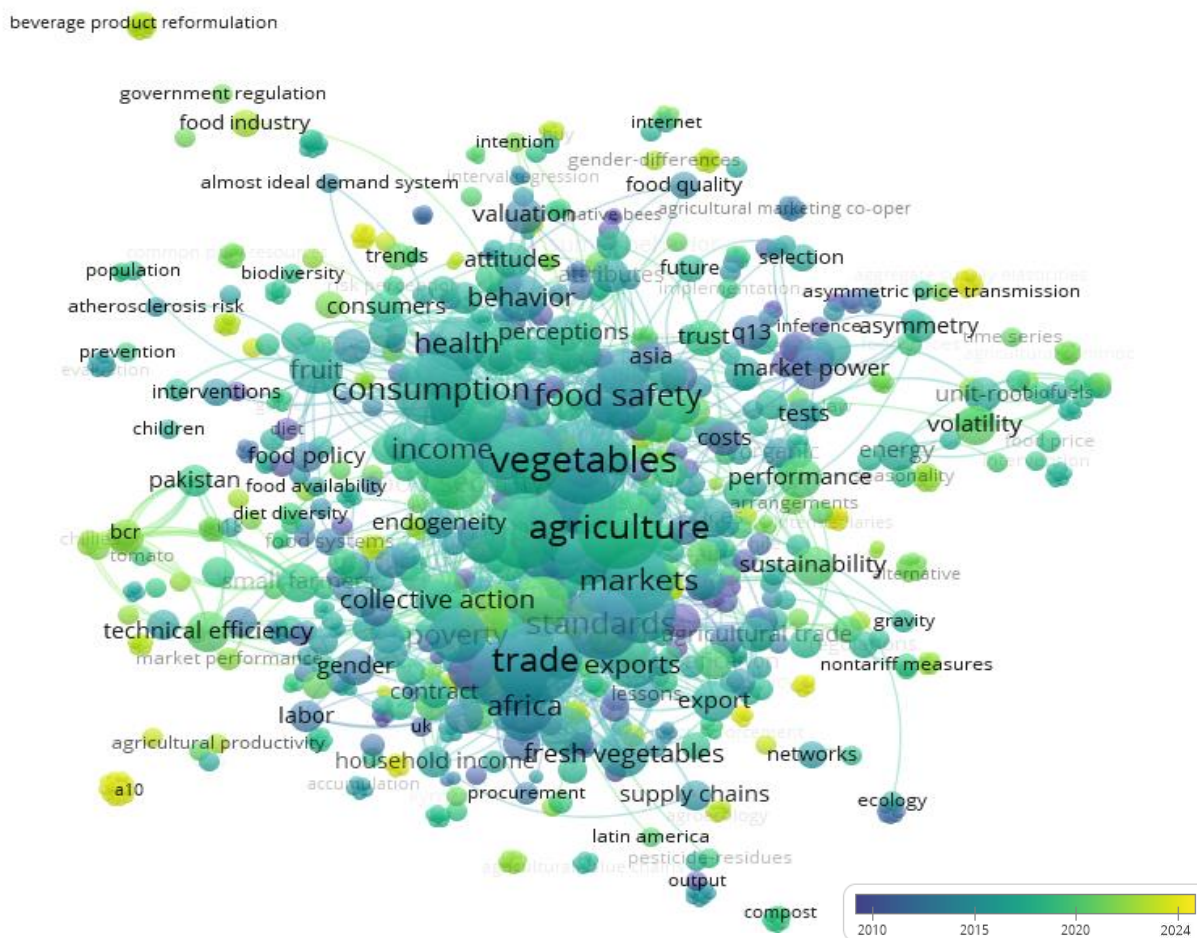
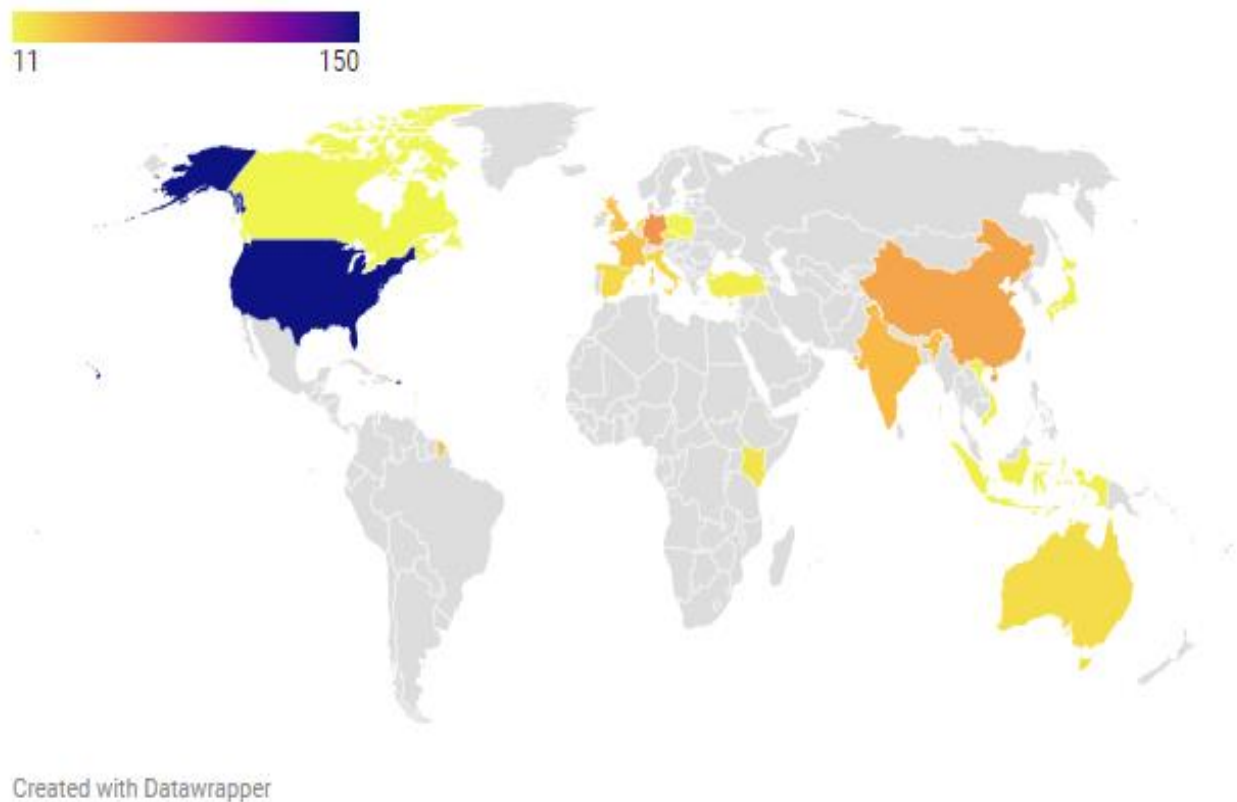


Figure 4. Main directions of research by keywords in the publications presented in the Web of Science database in 1993–2024

Source: created by the authors using VOSviewer based on data from the Web of Science Database.

4.3. Geographical area of research. Of course, the scientific publications indexed in the Scopus and Web of Science databases are collected from many countries of the world. Among them, it is worth noting the five advanced states involved in research: the USA, Germany, China, India, the United Kingdom (Map 1).

The United States is the undisputed leader in the number of research and published publications on the problems of competition and industry development in the vegetable market. It is worth noting that this advantage is not limited to this particular area. In general, Americans place a high priority on world leadership in scientific achievement and are making ever-increasing investments in research. It is worth noting the level of public trust in science, which is confirmed by the statistical data obtained from the research conducted by the Pew Research Center, in particular, seven out of ten Americans believe that it is important for the country to be a leader in scientific achievements (Funk et al., 2020). A similar public attitude is observed in the United Kingdom, India, China, Spain, Japan and in other countries. Thus, the level of competition in the scientific field also increases (Science and Technology Action Committee, 2023). This is also confirmed by the geographical analysis of publications presented in the Scopus database (Figure 5).



Country	Number of publications	Country	Number of publications
the USA	150	Kenya	18
Germany	50	the Netherlands	18
China	43	the Czech Republic	14
India	34	Turkey	14
the United Kingdom	31	Indonesia	13
France	31	Japan	13
Italy	23	Vietnam	13
Spain	22	Canada	11
Australia	21	Poland	11

Map 1. Distribution of publications in the Web of Science database by countries in 1993–2024

Source: created by the authors using Datawrapper based on data from the Web of Science database.

The number of publications in the Scopus database in the USA and Germany, compared to other countries (China, France, India), has been increasing sharply since 2012. However, between 2019 and 2024, the growth rate of the number of publications between the USA and India is almost equal. This can be explained by India's increased investments in scientific research and development at the expense of the private sector, focused on the development of the agroindustry (Government of India..., 2020). Although there has been a significant increase in publications related to the research problem in India in recent years, the United States still has a clear advantage in this regard, with major scientific journals associated with the vegetable market.

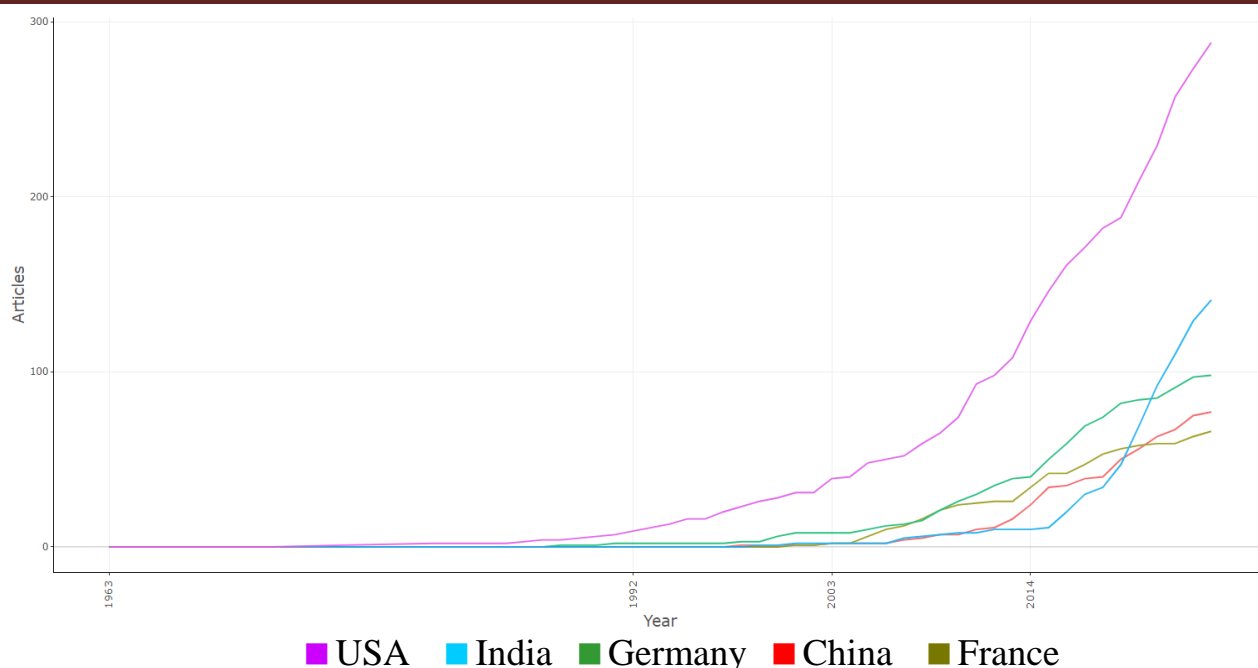


Figure 5. Trend of publications presented in the Scopus database by leading countries in 1963–2024

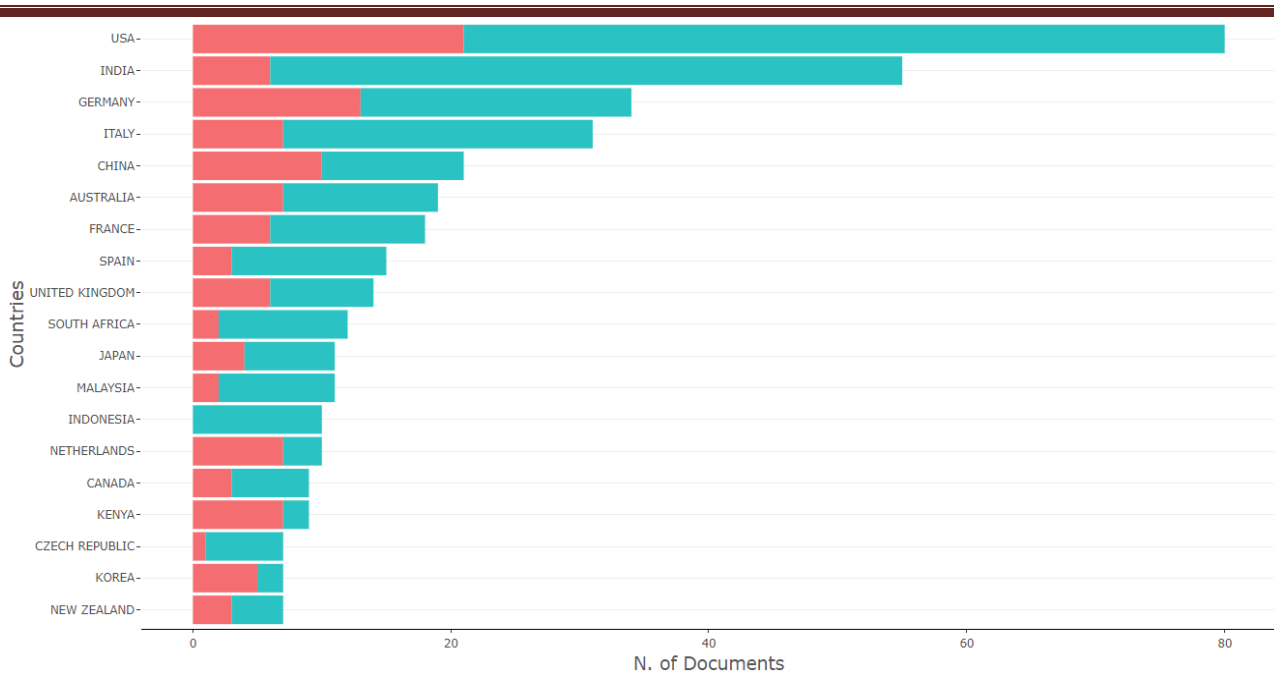
Source: created by the authors using Bibliometrix based on data from the Scopus database.

Among them: Food Policy (number of publications published in 1963–2024 – 61); American Journal of Agriculture (number of publications published in 1963–2024 – 33); Agribusiness (number of publications published in 1963–2024 – 26); Journal of Agricultural Economics (number of publications published in 1963–2024 – 24)⁵. Thus, the research highlights the advantages of developed countries, while the contribution of developing countries is insignificant.

4.4. Research collaboration. Stagnation of the ideas developed as a result of the mentioned scientific studies is inevitable without collaboration. The world is evolving and technological complexity is growing. Against this background, collaboration in the scientific field becomes more important than ever (Wilson, 2023). Based on its importance, the level of collaboration of publications (on the problems of competition and industry development in the vegetable market) located in the Scopus database was determined within the scope of the research (Figure 6).

As Figure 6 shows, in the period 1962–2024, publications are mostly published without collaboration, although collaborative processes are actively taking place in the recent period. Although, from a quantitative point of view, the USA (21), Germany (13) and China (10) have published more publications in collaboration on the problems of competition and industry development in the vegetable market, the picture changes in the opposite way if we evaluate their share in the total number of published publications: China ($10/21 = 47.6\%$); Germany ($13/34 = 38.2\%$) and the USA ($21/75 = 28.0\%$). The following countries also stand out in this direction: Kenya, the United Kingdom, Korea, the Netherlands, etc. The analysis proved that the level of collaboration is low, most of the developing countries are left behind.

⁵The data was processed by the authors using Bibliometrix software.



■ With Collaboration ■ Without Collaboration

Figure 6. Distribution of publication presented in the Scopus database by collaboration by countries in 1963–2024

Source: created by authors using Bibliometrix based on data from the Scopus database.

4.5. Research clusters (by countries, authors and authors' keywords). In the process of research, due to active cooperation, clusters are formed between scientific countries (Figure 7).

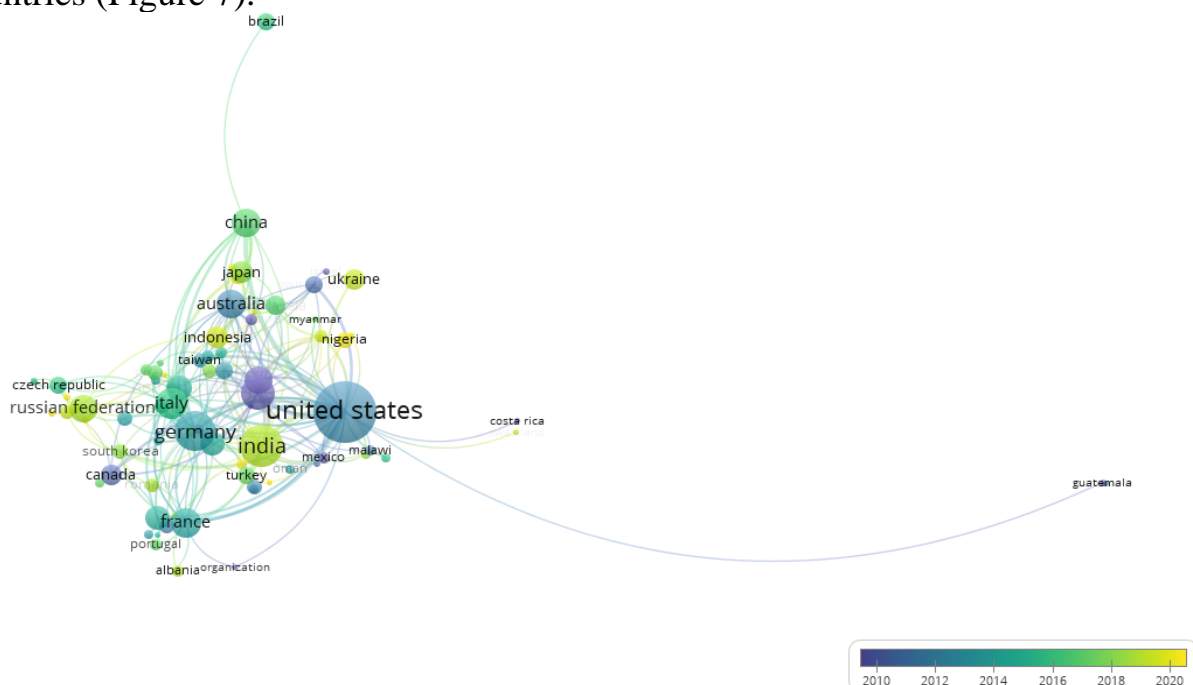


Figure 7. Clusters of publications presented in the Scopus database by countries in 1963–2024

Source: created by the authors using the VOSviewer based on data from the Scopus database.

Naturally, even in the case of the analysis of the countries by clusters, the countries actively involved in the research of the vegetable market, namely the USA,

India, Germany, the United Kingdom, and France, play a leading role. The multiplicity of their cooperative “networks” provides a significant opportunity for development to such developing states as Georgia. Thus, being in a cluster of the vegetable industry creates a valuable opportunity in terms of sharing knowledge and practical experience, working together on industry problems and introducing innovative approaches. It is important to join the large-scale US cluster, which has a wide range of cooperation with countries such as Germany, the United Kingdom, India, Italy, China, Australia and France.

Of course, any country in the above cluster is represented by a scientist involved in the research. Therefore, the analysis of the clusters of the Web of Science database was carried out according to the authors of the publications placed in the database (Figure 8).

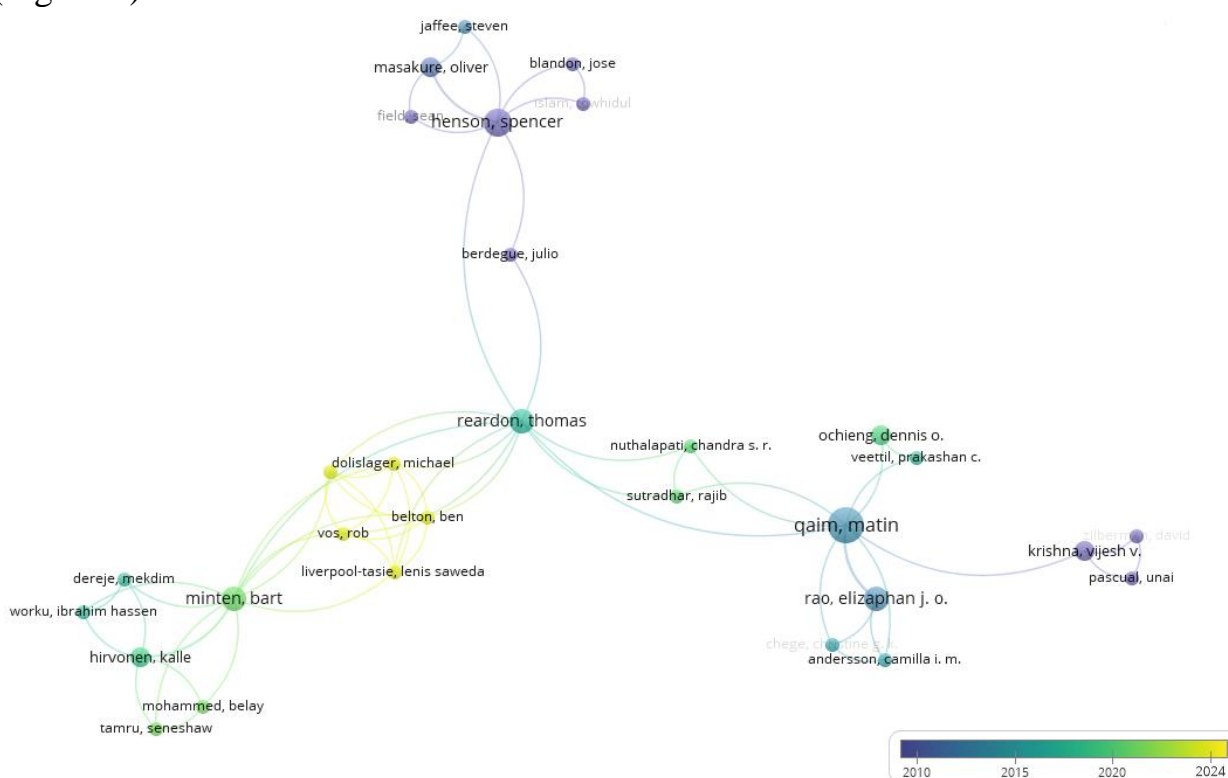


Figure 8. Clusters of authors of publications presented in the Web of Science database in 1993–2024

Source: created by the authors using VOSviewer based on data from the Web of Science database.

As can be seen from the Figure 8, four main clusters of authors of publications on the problems of competition and industry development in the vegetable market are outlined. Among them are Martin Qaim (Germany, 1 cluster, 7 doc., 9 links, total link strength – 11, avg. pub. year: 2014), Thomas Reardon (the USA, 5 cluster, 3 doc., 11 links, total link strength – 11, avg. pub. year: 2017), Spencer Henson (Canada & UK, 3 cluster, 4 doc., 7 links, total link strength – 8, avg. pub. year: 2010), and Bart Minten (Belgium, 2 cluster, 3 doc., 11 links, total link strength – 12, avg. pub. year: 2021). Each of them is a representative of international research institutions and plays an important role in the process of conducting collaborative research. Of particular note

is the new cluster formed by American researchers (Michael Dolislager, Ben Belton, Rob Vos and Saweda Liverpool-Tasie), which focuses on finding ways to develop the field in the face of modern challenges.

According to the keywords used by the authors, 10 main clusters were identified, on the basis of which it is possible to define the main topics of the current research (Figure 9).



Figure 9. Clusters by documents coupling – documents' coupling map by authors' keywords

Source: created by the authors using Bibliometrix based on data from the Scopus database.

From 67 publications were selected 15 publications for evaluating the main research topic clusters. In terms of the number of papers, the largest cluster was found to be agricultural production, vegetable, Africa. This cluster covers 55 research papers indexed in the Scopus database. The scientific interest of studying the vegetable industry in the African region stems from the international consensus that Africans consume less vegetable than needed for nutrition. In the region, local production is limited and supply chains are disrupted. The scale of the problems encourages scientists in the industry to engage in research activities aimed at developing local production. From the point of view of increasing the supply of local products to the vegetable market, the need for the development of small and medium enterprises is evident (Reardon et al., 2024). In terms of competition, small and medium-sized entrepreneurs need to implement rational marketing activities. Recently, there have been several outstanding studies in this area. For example, the impact of socio-economic factors on the marketing activities of local vegetables in the region is studied (Kanzungu, 2024).

Through analysing the clusters of the main research topics, it became clear that the research interest in Africa is revealed not only in the regional perspective, but also at the level of individual states. In this regard, the cluster of Kenya, agricultural market,

developing world is worth to be mentioned. Studies on the case of Kenya mainly focus on identifying the challenges and perspectives of small producers (Otiende et al., 2024). Gender preferences and geographic location have been found to play an important role in small household farming (Ouya et al., 2024).

Although the Asian region is an undisputed leader in the production of vegetables, it is unambiguous that research is more concentrated in the African region. However, in terms of the research impact rate, the Covid-19, food market, China cluster is outstanding. China is the major producer of vegetables in this cluster. In the research studying the case of China, special attention is paid to the political decision taken by Japan in 2006 to impose strict food safety requirements on imported Chinese vegetables. Having observed the market for several years, Jin et al. (2024) found that the strict standard requirements imposed by Japan resulted in less harm to small entrepreneurs. In addition, studies referring to improving the quality of food products are being actively conducted. It is substantiated by Chinese researchers that certification of vegetables increases the eco-efficiency of farms by 2.7 %. The so called “green” and organic certification is particularly important as they increase eco-efficiency by 4.6 and 16.3 % (Kang et al., 2023). Despite these trade restrictions, Chinese vegetable enterprises are the ones who set the agenda for competition in the global market.

In addition to China, vegetable market is actively studied in Indonesia and India. The following main thematic clusters of the study evidence this: vegetable oil, Indonesia, commodity market, and food security, nutrition, India. Indian scientists argue that vegetable production significantly improves household welfare (Dey & Singh, 2023) and motivates local small farmers to participate in the vegetable market. Scientists particularly emphasise the competitive advantage of local fresh vegetable products (Sreerag et al., 2023). In addition, Indonesia is actively promoting women’s participation in the vegetable production process (Sayekti et al., 2023).

Based on the cluster analysis of the main topics, it was found that the scientific community discusses the fruit and vegetable market in a complex way. This is evidenced by the clusters of agricultural market, crop production, fruit; and fruit, vegetable, consumption behaviour. In fact, joint programs supporting fruit and vegetable production or marketing are popular in practice. Accordingly, scientists assess their economic efficiency (Panzone, et al., 2024). In addition, fruits and vegetables belong to healthy and organic food group (Li et al., 2024). Determining consumer preferences for these products in competitive markets is a crucial practical step towards resolving the issue of food security (Campos et al., 2024).

Unfortunately, food security still remains a problem globally. Thus, logically it is presented in two clusters of the main research topics: food security, nutrition, India; and food safety, vegetable, food market. The second cluster is one of the largest and includes 40 scientific papers related to the topic of food security. The food security problem is particularly acute for African region. However, it also remains a problem for developed countries. For instance, a study of 253 pregnant women conducted in 2022–2023 in Flint, Michigan showed that 93.1 % of women did not have access to the

recommended amount of vegetables (Saxe-Custack et al., 2024). Promoting local small enterprises is critical for providing food for such low-income families. A study by Baliki et al. (2024) found that supporting vegetable production improves food security by 21 % in the short-term and by 19 % in the mid-term. However, the impact was cancelled out two years after the end of the intervention as a result of prolonged confrontation.

Under such conditions, the level of education of farmers plays a key role in the development of the vegetable market. When analysing the clusters of the main topics from this perspective, we find a small cluster – cooperative sector, decision making, farmers' knowledge. In the future, it is important to develop research in this direction as well.

5. DISCUSSION

Considering the peculiarities of the research, the following studies on the vegetable market were selected for the analysis of the obtained results in the discussion part: (i) a bibliometric analysis of literature on vegetable prices by Li et al. (2021), (ii) a bibliometric analysis of farmers' markets by Török et al. (2024), and (iii) a study by Matuszczak and Bieniek-Majka (2018) on horizontal integration processes of vegetable producers. The authenticity and originality of the results of the present research were substantiated in various directions through comparing them with the research results obtained by the above researchers.

The results of the bibliometric research on the competition on the vegetable market reflect the evolution of the research topic in international bases such as Scopus and Web of Science. In particular, the research showed that studying the competition on the vegetable market began in 1963. From this perspective, the results of a bibliometric study of vegetable prices by Chinese researchers are of particular interest (Li et al., 2021). Based on the analysis of publications in the Web of Science and China National Knowledge Infrastructure, they assumed 1928 as the starting point of the research. Accordingly, scientific studies first began with the study of vegetable prices, and later (since 1963) more emphasis is placed on the analysis of competition.

The results of both researches, the present one and conducted by Li et al. determine that 2009 is the initial period of intensive research on the vegetable market. This is the date when a new cluster was formed in the field of vegetable growing (Török et al., 2024).

The geographical area of the research on the vegetable market has also begun to expand from the same period (from 2009). Through bibliometric analysis, the present study identified the five leading states participating in scientific research according to international bases Scopus (the USA, Germany, China, India, and the United Kingdom) and Web of Science (the USA, India, Germany, China, and France). Even though there is a small positional or qualitative difference between the countries, the superiority of the USA in research activity is unequivocal. Chinese researchers also emphasise the dominance of the USA in their bibliometric research on vegetable prices. This is explained by market size, marketing channels and price fluctuations for vegetables.

However, according to our research, the competitive advantage of the USA is determined by the growing investment in the scientific field and the fact that Americans have a high level of trust in scientific research.

In addition, the bibliometric analysis of competition in the vegetable market revealed that publications related to the research topic are mostly published without collaboration. The level of cooperation between countries is low. The USA, Germany and China are distinguished by the absolute rate of collaborative research. The study analysing research clusters of vegetable prices (Li et al., 2021) also emphasised the leadership of the USA and China. A particular attention was paid to the European research cluster of Germany, the United Kingdom, France and Turkey. Collaboration between the countries was explained by geographical location, climatic conditions and consumer preferences. Our research also focuses on the relative rate of collaborative research. In this regard, the positions of the countries are distributed differently: China, Germany, the USA. The importance of the cooperation between these countries is further confirmed by the analysis of the author clusters conducted within the framework of the present research.

Unlike other studies, bibliometric research on competition on the vegetable market from 1973 to 2023, chronologically examines the main directions of the research, and presents their evolutionary development from specific to global problems. It is unequivocal that the study of competition on the vegetable market has always been relevant during that period. The market is constantly under transformation. At present, the development of the vegetable industry is a difficult and risky process (Li et al., 2021). Matuszczak and Bieniek-Majka (2018) also indicate that the position of vegetable farmers deteriorates in the market economy, in terms of a fragmented agrarian structure. However, their situation is improved by the possibilities of technological development. Ensuring social and economic sustainability is becoming more and more important for overcoming the asymmetric information and production process challenges characteristic for vegetable industry (Török et al., 2024).

The dominant research themes that we have identified in relation to competition in the vegetable market are in line with the above themes. It is evident that the studies referring to the need for ensuring sustainable development have remained topical since 2013. In addition, current scientific interest focuses on losses in vegetable growing, the impact of the Covid-19 pandemic and food security. When studying markets, Török et al. (2024) also note that recent research focuses on the issues of Covid-19, food waste, and food insecurity. Contrary to the bibliometric studies conducted on vegetable market, the present study also discusses the confrontational environment along with other current topical issues. Undoubtedly, the current geopolitical situation will have a significant impact on the future direction of development of vegetable industry. Therefore, it is expected to activate research in this direction.

In their bibliometric analysis of vegetable prices, Chinese scientists Li et al. (2021) link the prospects of research development to the countries such as the USA, China, Japan, and Australia. Unlike them, our research also focuses on the role of developing countries and argues that they play an important role in the development

processes of scientific research and the vegetable industry. Polish scientists Matuszczak and Bieniek-Majka (2018) also share this opinion. They consider that developing countries, including Poland, solve agrarian issues using the industrial agricultural model. This allows the increase in agricultural production, which, in turn, contributes to solving the problem of food supply. In the process, they focus on the importance of developing local vegetable production so that low-income households have improved access to healthy and organic food products. The bibliometric research by Matuszczak and Bieniek-Majka (2018) also proves that there is a need for this. The findings of the research show that SNAP (Supplemental Nutrition Assistance Program) has become a dominant topic in the scientific literature since the 2000s. Against this background, the contribution of scientists to the problems of the evolutionary development of the vegetable market is important.

Thus, the growing scientific research in the field of vegetable production is driven by the importance and high competitiveness of the sector, which will continue in the coming years. In the current period, the revenue generated in the vegetable market is USD 97.66 billion, and according to the forecasts, its annual growth is expected to be 9.05 % (Statista, 2023). Accordingly, the scientific research conducted on the vegetable industry will also move to a new phase of development. Active cooperation with leading countries should play an important role in this process.

6. CONCLUSIONS

In order to conduct relevant research, it is important to systematically analyse published publications, identify relevant research problems, and determine future research directions. These objectives can be achieved through bibliometric analysis.

The bibliometric analysis of competition in the vegetable market and challenges of the industry showed that at the current stage, it is advisable to conduct research on the following main issues: food security, analysis of the impact of confrontational environment, minimisation of losses in the industry, sustainable development of the vegetable growing sector, and search for directions that support technological development. Scientific research on these and other topical issues is positively correlated with the development of the vegetable industry.

Conducting bibliometric scientific research in Georgia, such as in other developing countries, involves a number of problems. In particular, it is impossible to conduct a systematic analysis of works published in the Georgian language. The formation of appropriate bases is required. Implementation of this requires investment in research processes, especially the involvement of the private sector is important. In addition, the active participation of scientists in collaborative research, both locally and globally, is fundamental. The development of this process will lead to the formation of clusters and effective management of collaborative processes. Participation at least in one of the 10 clusters identified in the research is key to the development of the vegetable industry. Conducting collaborative research on vegetable production problems and introducing innovative approaches will create valuable opportunities in terms of sharing knowledge and practical experience.

7. LIMITATIONS AND FUTURE RESEARCH

The main limitation of research is databases of scientific articles, as well as language barriers. Only the analysis of English-language publications indexed in Scopus and Web of Science can lead to the exclusion of a specific research context and cannot fully reflect the participation of developing countries in the geographical area of research. However, data analysis of the two main bases showed overlap in a number of directions, which ensured the development of general conclusions. Studies conducted in developing countries can identify specific “cases” and methodologies on competition that will help develop the field of vegetable growing.

Thus, it is important to expand the scope of research with the involvement of developing countries. It is necessary to identify the reasons hindering the research and develop appropriate measures. In this process, it is advisable to strengthen the interest and involvement of representatives of science, policy and practical spheres.

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