eISSN 2544-0659
ISSN 2081-6960 (zawieszony)

Zeszyty Naukowe
Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie

Scientific Journal
Warsaw University of Life Sciences – SGGW

PROBLEMY ROLNICTWA ŚWIATOWEGO

PROBLEMS OF WORLD AGRICULTURE

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Warsaw University of Life Sciences Press
Warsaw 2024

Lista recenzentów jest publikowana w ostatnim zeszycie w roku oraz na stronie internetowej czasopisma. / The list of reviewers is published in the last issue of the year and on the journal's website.
Wersja elektroniczna jest wersją pierwotną. / The primary version of the journal is the on-line version.

Indeksacja w bazach danych / Indexed within:
ERIH PLUS, Index Copernicus, Baza Agro, BazEkon, System Informacji o Gospodarce Żywnościowej, Arianta Naukowe i Branżowe Polskie Czasopisma Elektroniczne, AgEcon search, CEJSH, PBN, Biblioteka Narodowa, Repozytorium Cyfrowe Polona, Google Scholar, DOAJ, Crossref, EBSCO.

prs.wne.sggw.pl

e-ISSN 2544-0659, ISSN 2081-6960 (zawieszony)

Wydawnictwo SGGW / Warsaw University of Life Sciences Press
www.wydawnictwosggw.pl

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Scientific Journal Warsaw University of Life Sciences – SGGW
Problems of World Agriculture volume 24(XXXIX), number 3, 2024: 4-25
DOI: 10.22630/PRS.2024.24.3.9

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Foreign Trade in Agricultural Products between Poland and Ukraine in the Context of the Development of International Economic Integration

Abstract. The economic development of countries is largely determined by their foreign trade. Poland's trade with Ukraine is facilitated by many years of experience, proximity and the influence of international economic integration. Both countries are large producers and exporters of agri-food products, and there is a prospect of deepening relations in the context of developing integration processes. The importance of this study stems from Ukraine's aspirations for European integration, Poland's membership in the EU and the development of trade relations with Ukraine over the years. At the same time, the main issues remain: access to EU markets, harmonisation of product quality standards, trade liberalisation in the context of deepening integration, non-discrimination of countries and so forth. The purpose of the study is to determine the prospects for the development of trade in agricultural products between Poland and Ukraine in the context of international economic integration, identify the most promising areas of integration, assess the importance of agricultural products in foreign trade and analyse the trends in their foreign trade. The study utilises the scientific works of researchers, statistical data from international trade statistics for 2003-2022 and general scientific and specific research methods, including methods of analysis and synthesis, statistical analysis, abstract-logical and system analysis, generalisation and others. Exports from Poland and Ukraine are increasing, with Poland's exports rising more significantly. The share of agri-food products, especially those from Ukraine, is growing. Ukrainian exports of agri-food products to Poland have increased more than total exports. The influence of international economic integration on foreign trade is evident; following the agreement between Ukraine and the EU, Poland's trade with Ukraine has increased. A similar trend is observable in the trade between these countries and the EU. Foreign trade between the countries is growing; the trade balance between Poland and Ukraine for all products is positive, but for agri-food products it has become negative. The EU is the main importer for Poland. The commodity structure of Poland is more diversified than that of Ukraine. The types of products for which it is desirable to establish common production and mutual trade have been identified in order to provide the population with quality products at an affordable price and expand their position in the world market. Product groups with the greatest prospects for integration, particularly in trade, between Poland and Ukraine have been identified. According to calculations based on dynamic series, it is assumed that the trend in the development of trade in agricultural products between the countries will continue in the future, which could contribute to effective integration between them. Thus, international economic integration aids the development of foreign trade between Poland and Ukraine, as well as between Ukraine and the EU. Ukraine needs to promote export diversification as it significantly lags behind Poland – which should contribute to an increase in exports. It is necessary to stimulate the overall production and export of selected types of agricultural and food products, which should help enhance product competitiveness, improve quality, increase the income of producers and enable both countries to expand their positions in the EU and global markets. This is particularly important in the context of developing international economic integration, the availability of natural resources in Poland and Ukraine, the increase in global demand for food and the deepening climate crisis. The issue is even more pressing since Ukraine is in a difficult situation under martial law, yet it remains an important trading partner in the global market.

Keywords: international economic integration, exports, agricultural products

JEL Classification: F2, F13, F14

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Introduction

The development of foreign trade is one of the most important prerequisites for the economic growth of countries. As a result of geographical discoveries and especially the development of scientific and technological progress, there has been an increase in foreign trade, a diversification of its commodity and geographical structure and the emergence of new forms of trade, such as electronic commerce.

This is especially important in the context of globalisation, as countries are becoming increasingly dependent on one another. The level of competitiveness of products, export volumes and the ability to meet the needs of the population all depend on the development of foreign trade and participation in integration groups. This is particularly significant for agri-food products as countries establish high trade barriers, including quantitative restrictions, and participation in integration groups contributes to the harmonisation of product quality standards. The importance of the agricultural sector is also growing due to heightened demand for agri-food products and the environmental crisis. These issues are also being addressed through foreign trade between countries. It is worth noting that Poland and Ukraine are significant producers and exporters of agricultural products and have engaged in mutual trade for many years. This should contribute to the economic growth of these countries, increasing their share in the global market for agricultural products, etc.

For example, Donaldson (2015) notes that the past two centuries have witnessed a dramatic change in the ability to trade goods and services across and within national borders. Container megaships have replaced steamships, which replaced sailboats; emails have replaced telegrams, which replaced carrier pigeons. Waves of post-World War II multilateral and preferential trade agreements have eroded many of the tariff barriers that apply when trade crosses international borders. This liberalised mobility of goods and services across locations has given rise to greater integration of the markets for these products at different points in space. Lyzun (2020) writes that economic integration is perhaps the most important process contributing to the sustainable development of the world's leading and developing countries. The expansion of mutual trade, elimination of obstacles to the free movement of capital flows, labour and industrial, as well as scientific, cooperation are among the main tasks of any form of regional integration. International economic integration (IEI) promotes the development of intra-industry trade and foreign trade as a result of the elimination of trade barriers at the initial levels of integration. Currently, the most developed integration group remains the European Union (EU). Begg (2021) notes that the economic core of the EU is the single market, characterised by the four freedoms of movement of goods, services, labour and capital. After enduring a decade of crises, the EU is keen to move in new directions – notably by putting the European Green Deal and digitalisation not only at the centre of its economic development strategy, but also of the Next Generation EU (NGEU) recovery package. At the same time, trade continues to develop between neighbouring countries, and very often such countries integrate with each other and sign free trade agreements. Poland remains one of the most important trading partners for Ukraine. In addition to the common border between the countries, it is important to take into account Poland's membership in the European Union (EU); Ukraine signed an Association Agreement with the EU. Given the importance of the agricultural sector in general, and especially for Poland and Ukraine, it is worth analysing trade between the countries in agri-food products in the context of the development of international economic integration.

The purpose of the study is to determine the importance of agri-food products for the foreign trade of Poland and Ukraine, to analyse and identify the features of foreign and bilateral trade in agri-food products between these countries and determine the prospects for its development in the context of international economic integration (IEI).

Scientists have studied the development of foreign trade between Poland and Ukraine under modern conditions. Taking into account the integration processes in Europe, it is worth determining the importance of agri-food products for the foreign trade of these countries. This analysis examines trade between Ukraine and Poland, highlighting individual stages in the context of international economic integration.

Literature Review

Balassa (1961) defined economic integration as a process and as a state of affairs. Regarded as a process, it encompasses measures designed to abolish discrimination between economic units belonging to different national states; viewed as a state of affairs, it can be represented by the absence of various forms of discrimination between national economics [p. 174]. Donaldson (2015) notes that if the barriers that impede trade are technological in nature, then any reduction in these barriers enlarges the overall gains from trade, and this is likely to benefit all regions. However, if the trade barriers in question are trade taxes that generate tax revenue for the taxing region, and the region in question is large enough to influence its terms of trade with outside regions, then, even though free trade is better than autarky, there is an intermediate positive value of the trade tax that is optimal for that region (while globally inefficient). Balassa and Stoutjesdijk (1975) explored economic integration among developing countries, considering it as one of the policy options available to them and as part of their overall strategy for economic development. They wrote that providing incentives to exports would benefit sales in all foreign markets, regional integration would boost exports to countries in the same geographical area and preferential schemes extending to other regions would stimulate exports to developing countries in those regions. Scientists considered economic integration through the liberalisation of trade. Hamulczuk (2020) writes that the degree of integration of spatial markets is one of the most important determinants of economic welfare, and the selection of appropriate methods of analysis is important. The assessment of spatial integration can be based on trade flows, price information and trade costs. He notes that quite often, the notion of integration is reduced to some units (e.g., commodity markets, sections and sectors, regions or whole economies), which are treated as separate wholes, and considers the spatial integration of commodity markets. Hamulczuk (2020) draws conclusions that the main barriers to the practical verification of the occurrence, strength and changes in the spatial integration of agricultural commodity markets include the lack of full homogeneity of goods and difficulties in estimating the costs of trade. Traore and Diop (2021) note that the analysis of market integration is a powerful tool for understanding the relationships between geographically distant markets, analysing the impact of liberalisation policies, as well as identifying regions exposed to systematic shocks. However, choosing the right tool is not straightforward. It is guided by data availability and the results of tests carried out, but also by the understanding of the formal and informal relationships existing between the markets considered.

Weiyi Zhang (2023) notes that global geopolitical relationships are expected to become more sensitive and capricious, and international agricultural trade may face more challenges; however, long-term demand and supply dynamics suggest it remains essential. An imbalance between limited natural resources and a growing appetite for farm products makes agricultural trade critical to meeting global food demand and presents further opportunities for agricultural producers, agribusinesses and investors. It is quite important to consider the export potential of agri-food products from Ukraine and Poland with the aim of expanding their positions in the world market.

Abrhám, Vošta, Čajka and Rubáček (2021) conclude that the production of agricultural commodities is of great importance to the economies of individual states, as it contributes to the creation of direct, indirect and induced jobs. The agrarian sector is a key sector, especially for less developed countries. The analysis confirmed the high tradability of some agricultural commodities, including soya, which is documented by their involvement in the international division of labour in the global projection. At the same time, it is worth noting that Ukraine is one of the largest producers of soybeans.

International organisations have a significant influence on the development of foreign trade. Thus, Lingran Yuan, Qizheng Zhang, Shuo Wang, Weibin Hu and Binlei Gong (2022) claim that they found trade hindered agricultural production and productivity in the GATT period but improved agricultural production and productivity in the WTO period. At the same time, it is worth considering the regional trade agreements of countries and the participation of member countries in integration groups within international organisations.

Korchun (2013) highlights the reasons for the strategic importance of developing foreign economic relations with Poland for Ukraine: geographical proximity (the presence of a common border); close ties throughout historical development; similarities in territory size, population, language group and mentality; similar natural-geographical conditions and resources; the possibility and necessity of Ukraine adopting the European civilisational approach, as well as Poland's experience in achieving full membership in the European Union. Totska (2022) argues that forecasts indicate expected growth in Ukraine's export-import commodity operations with all analysed countries. The forecasts for exports of goods to Poland and Romania are the most likely (the R^2 values of the trend models constructed for them are more than 0.8). Petrova, Malyuta and Berezhnyuk (2018) consider foreign trade in goods between Ukraine and the countries of the Visegrad Group as one of the stages of Ukraine's integration into the economy of the European Union. Poland is singled out as a major economy in the region, a country with a high per capita income, a high human development index and one of the main partners among the Visegrad Group countries. Eliseeva (2014) notes the versatility of relations between Poland and Ukraine, the stable development of trade and economic cooperation between them, but also the need to increase the efficiency of transport infrastructure use, effective cooperation in the energy sector and more. The countries have the opportunity to further expand economic cooperation both in the format of bilateral relations and within the framework of the implementation of the European Union programme – "Eastern Partnership". Gubitsky and Melnik (2021) draw attention to the active cooperation between Poland and Ukraine in the fields of trade, investment, market access and the role of Poland in Ukraine's integration into the capabilities and resources of the European Union. In addition, it is noted that as a result of the conclusion of the Association Agreement between Ukraine and the EU, an increase in trade volumes was predicted, including with Poland. Stoetsky (2007) emphasises the significant impact of Poland's accession to the European Union on the

development of trade and economic cooperation between Poland and Ukraine, due to the fact that European Union tariffs are lower than those of Poland. Thus, international economic integration – depending on the trade policy of the integration group – cannot only reduce, but also increase trade with third countries.

Sulym (2020) proposes to more actively utilise the opportunities of Ukrainian-Polish trade and economic relations through the creation of state-targeted programmes to stimulate the development of cross-border cooperation, mitigate the investment climate, develop an investor protection system and attract Polish investors to open production facilities in Ukraine. Promising directions for the development of trade relations are highlighted, particularly the use of the established Export Credit Agency of Ukraine to promote Ukrainian goods in the Polish market, the creation of joint customs offices and the increase of checkpoints on the borders with Poland, among others. Korneliuk (2020) considers Ukrainian-Polish economic cooperation as a factor in enhancing the competitiveness of the economy. To further develop cooperation, it is suggested to foster joint entrepreneurship, attract investment resources based on public-private partnerships, form and develop cross-border clusters, utilise cooperation opportunities by participating in neighbourhood programmes and implementing joint cross-border projects and to create institutions that will contribute to the development of cross-border cooperation – particularly chambers of commerce and industry, business centres, regional development agencies, associations, fairs, etc. Studinskaya and Studinsky (2019) substantiate the existence of historical traditional ties between the national economies of Poland and Ukraine, noting that trade relations between them have experienced various stages over the course of almost a thousand years of history.

Conclusions were drawn about the need to strengthen the trend of replacing raw materials exported by Ukraine with high-tech alternatives, which is possible with fundamental changes in the sectoral structure of the national economy of Ukraine. Taking into account the parity of trade relations, prospects for economic cooperation between countries should be formed; this is feasible in a brand-oriented format for the development of the domestic economy. Raboshuk and Shymanska (2016) highlight among the promising areas of cooperation between Poland and Ukraine the introduction of modern methods of transport and forwarding services, ensuring a balanced structure of exports and imports while considering the level of development of national economies and regional risks to protect the trade interests of these countries. Hryshchuk (2017), examining the issues of socio-economic cooperation between Poland and Ukraine, concludes that new strategic guidelines should focus on strengthening trade relations through the implementation of a policy of import substitution and stimulating Ukraine's export of not only goods, but also services. First and foremost, this concerns improving the supply of transport, insurance, computer and other services, as well as establishing investment cooperation resulting from the penetration and consolidation of Ukrainian capital into the Polish economy through the implementation of joint investment projects and the creation of joint ventures. Martynova and Chernaya (2018) prove that the intensification of trade and economic cooperation between Poland and Ukraine can enrich the strategic partnership between them with new content and prepare the Ukrainian economy to function in accordance with the standards of the European Union. According to the results obtained, trade and economic cooperation between these countries is characterised by incomplete use of their existing potential. Alexiyevets, Alexiyevets, Il'chuk (2015) note that Polish capital played a positive role in

the banking system of Ukraine, especially from 2000 to 2005. The development of the Ukrainian economy was facilitated by significant investments and the opening of credit lines. The dynamics of economic cooperation between Poland and Ukraine will depend on resolving the issue of ensuring a favourable investment climate for the development of bilateral trade and investment relations. Chorna (2016) notes that Poland's accession to the EU affected economic cooperation with Ukraine; however, unlike previous forecasts, it did not have sharp negative consequences for Ukraine. Structural incompatibility of economies, the low level of purchasing power of Ukrainians, the irrational structure of foreign trade, the unsatisfactory condition of border control points, an unclear product certification system, limited access to information necessary for doing business, etc. all hinder cooperation between the countries. The economic potential of interaction between Poland and Ukraine has not been fully realised. Perepelytsia et al. (2021) identify two tasks for Poland and Ukraine: intensifying bilateral trade and developing the export potential of both countries in world markets by deepening inter-company cooperation and participation in global value chains. According to research by Babets (2023), the dependence of Ukraine's economic growth on imports of goods from Poland was revealed. The research confirmed the dependence of Ukraine's economic growth on changes in the volume of iron ore exports to Poland and imports of cosmetic industry products from Poland. The impact of exports of Ukrainian goods with a higher degree of processing was statistically insignificant, which can be explained by the small volume of exports of these goods compared to exports of raw materials.

Research data and methods

The research is based on the analysis of scientific works by various scientists, statistical data from international trade statistics and the use of general scientific and specific methods.

Methods of analysis and synthesis, including mathematical techniques, were used to identify the peculiarities of trade and economic relations. Statistical analysis was employed to recognise trends in foreign trade, while generalisation helped form conclusions. Abstract-logical and systemic analysis were utilised to develop proposals for further cooperation, and graphic methods were applied for the visual presentation of the analysis results.

A trade map (international trade statistics) was used, which consists of trade statistics. Data from 2003 to 2022 was used to analyse how the foreign trade of countries changed before and after integration. In particular, in 2004, the treaty on the accession of Poland and other new countries to the EU came into force, and in 2017, the Association Agreement between the EU and Ukraine was established. Calculations are presented using data on total trade and agri-food products to show the impact of IEI on trade in these products and changes in the share of agri-food products in world exports. The commodity structure of exports from Poland and Ukraine, both in general and in bilateral trade, was analysed to identify more promising markets, create common enterprises and expand positions in the world market. An analysis of the geographical structure of exports allows for the selection of the main directions of exports, taking into account the impact on participation in integration processes.

For a more detailed analysis, indicators of the development of international trade between Poland and Ukraine were calculated:
- trade balance:

$$C_t = X_t - M_t \quad (1)$$

C_t - trade balance; X_t - value of commodity exports; M_t - value of commodity imports.
- exports to imports ratio (goods):

$$I_{i/e} = \frac{X}{M} \cdot 100\% \quad (2)$$

turnover of goods (exports + imports) (Tsygankova, 2003, p. 26-29).

- the index of Grubel and Lloyd to measure the intensity of intra-industry trade:

$$GL_i = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} \quad (3)$$

The indicator varies between 0 and 1. It takes the maximum value of 1 when all the trade flows observed in the industry 'i' is intra-industry in nature. It settles at 0 when all trade in this industry is inter-industry (Dutta Sourish, 2022).

For a more detailed analysis, the average indicators of the time series were calculated (Malychenko, 2010):
- the average arithmetic simple:

$$y = \frac{\sum y_i}{n} \quad (4)$$

n - number of periods:

- the average absolute increase $\bar{\Delta}$ characterises the average rate of growth (or decrease) of the levels of dynamics:

$$\bar{\Delta} = \frac{y_m - y_0}{m} \quad (5)$$

m - number of the chain absolute increase ($m = n - 1$).

- average growth rate $\bar{K}$ shows how many times on average each level is greater (or less) than the previous level:

$$\bar{K} = \sqrt[m]{\frac{y_m}{y_0}} \quad (6)$$

y_0, y_m - initial and final levels of the dynamics series.

- the average rate of increase $\overline{T}$ shows by what percentage on average this level increases (decreases) compared to the previous one:

$$\overline{T} = \overline{K}\% - 100\% \tag{7}$$

Research results

Trade and economic cooperation between Poland and Ukraine has a long history. Considering the proximity of the countries' borders, long-term trade relations and the concluded Association Agreement between Ukraine and the EU, of which Poland is a member, it is advisable to study foreign trade between them, particularly regarding agricultural and food products, in the context of the development of international economic integration (IEI).

The participation of countries in integration groups has a particular impact on foreign trade. In trade with the EU, Poland's total exports in 2022 compared to 2003 increased by 6.3 times, and agri-food exports by 12.9 times (Table 1). The share of agri-food products increased from 7.0% to 14.3%.

Table 1. Agri-food exports of Poland and Ukraine to the EU-27, bln USD

Product	Years										
	2003	2004	2005	2010	2015	2016	2017	2018	2020	2021	2022
Polish exports to the EU-27											
Agri-food products	2.9	4.5	6.4	12.7	18.7	18.3	21.3	25.4	26.7	31.5	37.1
Share of total exports	7.0	8.0	9.7	11.1	13.4	12.9	13.2	13.1	14.3	13.3	14.3
Export of Ukraine to EU-27											
Agri-food products	0.6	0.7	0.8	1.9	3.9	4.0	5.5	5.9	6.1	7.7	13.0
Share of total exports	6.8	6.6	8.1	14.7	30.9	30.4	32.0	30.2	34.2	28.7	46.4

Source: calculations of author based on the International Trade Centre database.

In May 2004, the agreement on the accession of new countries to the EU, particularly Poland, came into force. It can be concluded that integration contributed to an increase in exports, especially of agri-food products. Ukraine's total exports to the EU-27 increased by 3.3 times, while agri-food exports rose by 22.6 times; the share of agri-food products increased from 6.8% to 46.4%. Let's consider how exports changed before and after the entry into force of the Association Agreement with the EU in 2017. In 2016, compared to 2002, total exports increased by 1.6 times and agri-food exports by 9.5 times; in 2022, compared to 2016, they increased by 1.6 times and 2.4 times, respectively. Consequently, the growth of total exports was the same in both periods, while agri-food exports grew more in the first period, although the time before the agreement was significantly longer. The largest importers of certain types of agri-food products from Poland and Ukraine, particularly Poland, are mainly EU countries (Table 2).

Table 2. The largest importers of certain types of agri-food products imported by Poland and Ukraine in 2022

Product	Importers of product exported by Poland, %	Importers of products exported by Ukraine, %
10 Cereals	Germany (43.6 %), Netherlands (8.6), Nigeria (5.1), South Africa (3.1), Spain (3.1), United Kingdom (3.0), Israel (2.6), Denmark (2.3), Morocco (2.0), France (1.9)	Romania (13.9 %), China (12.1), Spain (10.7), Turkey (9.5), Poland (7.0), Egypt (5.9), Italy (4.4), Hungary (4.4), Netherlands (3.7), Republic of Korea (2.1)
07 Edible vegetables and certain roots and tubers	Germany (23.0), United Kingdom (13.9), France (8.3), Ukraine (6.3), Italy (5.5), Netherlands (5.5), Belgium (3.9), Czech Republic (3.6), Romania (3.0), Sweden (2.3)	Türkiye (23.4), Poland (15.4), Italy(6.6), Pakistan (5.3), Malaysia (5.2), Moldova, (4.9), Germany (3.4), Hungary (2.6), Belarus (2.3), Romania (1.8).
08 Edible fruit and nuts; peel of citrus fruit or melons	Germany (22.7), Netherlands (7.4), Belarus (6.1), France (5.3), United Kingdom (5.3), Belgium (4.9), Ukraine (4.3), Sweden (4.2), Czech Republic (3.4), Romania (3.2).	Poland (34.4), Germany (9.3), Italy (6.3), France (6.3), Netherlands (5.2), Austria (4.4), Czech Republic (3.6), Azerbaijan (3.1), Romania (2.4), Greece (2.4)
15 Animal, vegetable or microbial fats and oils and their cleavage products; prepared edible fats	Germany (23.5), Netherlands (12.6), Czech Republic (8.1), Spain (6.2), United Kingdom (5.9), Estonia (5.5), Hungary (4.8), Slovakia (4.4), Lithuania (4.0), Austria (3.8)	Poland (13.2), India (12.9), Turkey (11.1), Romania (7.2), Netherlands (6.5), China (5.9), Italy (5.4), Bulgaria (4.8), Spain (4.4), Iraq (3.3).
04 Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere	Germany (20.8), Netherlands (7.7), Czech Republic (6.8), Italy (6.4), Romania (4.3), Algeria (4.1), United Kingdom (3.8), France (3.7), Slovakia (3.3), Lithuania (3.2).	Poland (19.7), Moldova (10.5), Germany (8.5), Netherlands (4.9), Kazakhstan (4.7), Latvia (4.2), Israel (4.0), Italy (3.9), Lithuania (3.3), United States of America (2.7).
19 Preparations of cereals, flour, starch or milk; pastrycooks' products	Germany (20.8), United Kingdom (9.1), Czech Republic (5.7), France (5.5), Italy (4.0), Romania (4.0), Hungary (3.3), Netherlands (3.2), Belgium (3.1), Spain (3.0).	Romania (12.5), Kazakhstan (12.4), Moldova (11.1), Poland (7.7), Germany (6.2), Georgia (4.2), Latvia (3.9), Azerbaijan (3.1), Lithuania (2.9), Bulgaria (2.8).
20 Preparations of vegetables, fruit, nuts or other parts of plants	Germany (24.5), Netherlands (11.1), United Kingdom (7.5), Austria (6.0), Czech Republic (4.7), United States of America (4.6), Russian Federation (4.5), France (3.2), Romania (2.8), Slovakia (2.7).	United States of America (32.1), Poland (24.5), Germany (11.6), Austria (8.7), Turkey (3.6), Moldova (3.0), Netherlands (1.8), United Kingdom (1.8), Belarus (1.6), Canada (1.5).

Source: calculations of author based on the International Trade Centre database.

For Poland, the main export partner is Germany, the share of exports to which did not fall below 20.8% (04 Dairy produce; birds' eggs, natural honey, pastrycooks' products), followed by the Netherlands and the Czech Republic. Ukraine is also among the top ten largest buyers of Polish exports. Additionally, Poland is one of the principal importers of Ukrainian goods. Among Ukraine's largest importers, there are more non-EU countries than Poland. This also indicates the significant influence of IEI on the foreign trade of members of integration groups. Besides EU countries, Poland's largest importers mainly include those with which the EU has concluded regional trade agreements (RTAs), such as Great Britain, Ukraine, Israel, Morocco, South Africa and Algeria. This trend is also typical for Ukraine. The determining factor for exports is the demand from countries, with the

USA and several Asian countries being among the main importers of Ukrainian goods, despite the absence of an RTU.

Total exports of Ukraine from 2003 to 2022 increased by 1.9 times, and agri-food products by 8.6 times, although one should take into account the decrease in total exports in 2022, which was lower than in 2011-2012 by 1.5 times, when it amounted to 68.4 and 68.7 billion USD, respectively (Fig. 1).

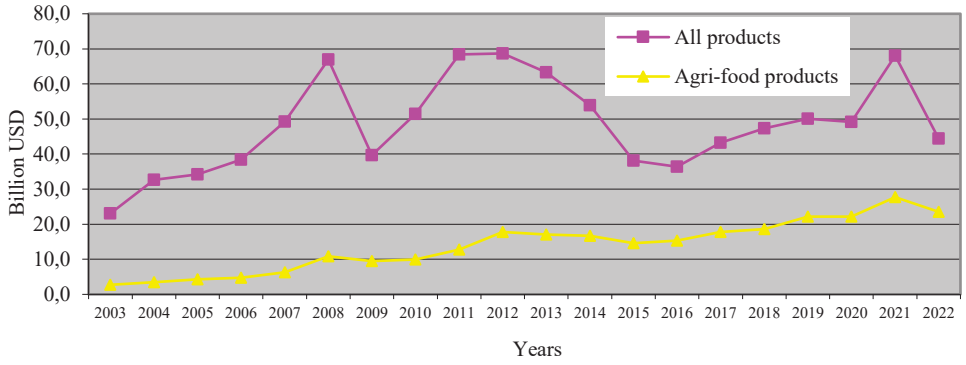

Fig. 1. Total and agri-food exports of Ukraine, 2003-2022

Source: calculations of author based on the International Trade Centre database.

Exports of agri-food products are characterised by more stable growth than total exports. In addition, the share of agri-food products in total exports increased from 11.8% to 53.0%.

Due to a significant part of Ukraine's exports being raw materials, there is a problem with processing products; therefore, it is necessary to involve new technologies and foreign direct investment.

In addition, according to the calculations of the Commodity Pattern of Foreign Trade of Ukraine [Commodity Pattern of Foreign Trade of Ukraine] in 2022, II. Plant products accounted for 30% of Ukraine's total exports, XV. Base metals and preparations thereof – 13.6%, III.15 Animal or plant fats and oils – 13.5%, and in 2010, XV. Base metals and preparations thereof – 33.7%. This is explained by the continuation of hostilities in the East of Ukraine, the lack of necessary conditions for the operation of enterprises and the loss of communication between enterprises – which, according to base metals and preparations thereof, are predominantly concentrated there.

Poland's total exports increased from $52.8 to $342.8 billion, and agri-food exports from $4.4 to $49.8 billion (Fig. 2) – i.e., 6.5 and 11.3 times, respectively; it was more than in Ukraine.

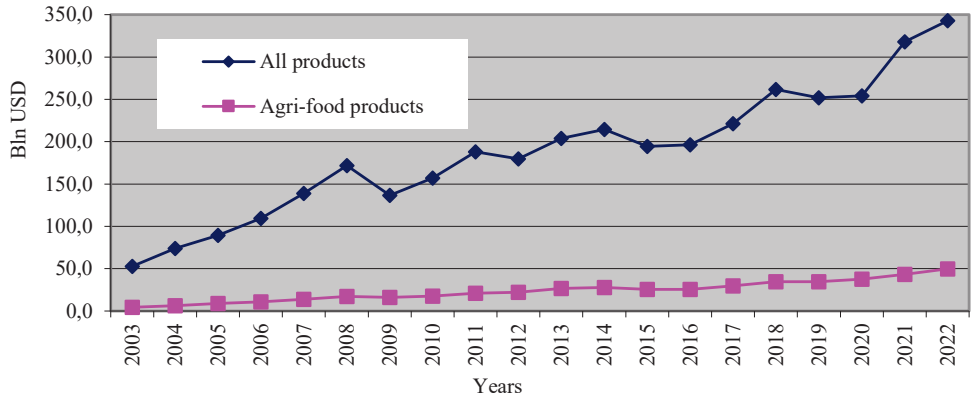

Fig. 2. Total and agri-food exports of Poland, 2003-2022

Source: calculations of author based on the International Trade Centre database.

The share of agri-food products in total exports increased from 8.4% to 14.5%, a rise of 1.7 times. That is, in both Poland and Ukraine during 2003-2022, there was an increase in the export of all agricultural and food products and the share of the latter in total exports. However, while the increase in total and agri-food exports was greater in Poland, the share of agri-food products grew more and was significantly larger in Ukraine. Additionally, export growth in Poland was stable.

This is due to the greater stability of the Polish economy, effective marketing systems, compliance of product quality with European quality standards, Poland's membership in the EU, greater adaptability of Polish manufacturers to new export opportunities, etc.

The growth of Ukrainian agri-food exports can also be explained by the harmonisation of quality standards in Ukraine with European ones.

In total, of the Polish exports to Ukraine, agri-food products accounted for 10% in 2022; this was more than 1% only for meat and edible offal, milk and dairy products, poultry eggs, natural honey and vegetables (Table 3).

Table 3. Value and share of agri-food products in total exports of Poland and Ukraine in trade between them, bln USD, %

Products	Export from Poland to Ukraine						Export from Ukraine to Poland					
	2003	2010	2015	2020	2021	2022	2003	2010	2015	2020	2021	2022
All goods, bln USD	1.5	3.9	3.3	5.7	7.1	9.7	0.8	1.8	2.0	3.3	5.2	6.7
Agro-food products, bln USD	0.2	0.5	0.3	0.8	0.9	1.0	0.0	0.2	0.4	0.8	1.0	2.6
Share of agri-food products in total exports, %	10.3	11.9	10.0	14.6	13.1	10.0	6.1	13.5	21.4	23.2	18.8	39.5

Source: calculations of author based on the International Trade Centre database.

The share of agri-food products in Ukraine's total exports to Poland amounted to 39.5%. For Poland, this indicator in 2003-2022 fluctuated between 5.5% and 14.6%, and for Ukraine – between 6.1% and 39.5%, although by 2022 it did not exceed 24.2%. The calculations show: 1) the share of agri-food products in total exports in bilateral trade is higher for Ukraine than for Poland; 2) the share of agri-food products has rather increased in Ukraine than in Poland in mutual trade; 3) from 2003 to 2022, Poland's total and agri-food exports to Ukraine increased (6.4 and 6.2 times, respectively) less than from Ukraine to Poland (8.8 and 56.7 times, respectively); 4) in bilateral trade, Ukraine is characterised by a significantly greater increase in agri-food exports than in total, unlike Poland. The share of Polish agri-food exports to Ukraine was 10% (2022), and in its world exports – 14.5%. For Ukraine, these figures were 39.5% and 53.0%, respectively. Thus, the share of agri-food products in the total exports of bilateral trade of these countries and in their world trade are close, and for Poland, they are less than for Ukraine.

By the way, on September 1, 2017, the Association Agreement between Ukraine and the EU came into force in full (Agreement, 2021). After this, Ukraine's total and agri-food exports to Poland (a member of the EU) increased noticeably. In 2017, total exports ($2.7 billion) were higher than in 2003-2016, except for 2011 ($2.8 billion), and since 2018, they have not fallen below $3 billion and have grown steadily. There is a similar trend in the export of agri-food products, which in 2017 ($0.52 billion) was lower than in 2012 ($0.62 billion) and slightly lower in 2013-2014 ($0.53 and $0.54 billion), and since 2018, it has not fallen below $0.6 billion and has grown steadily. Although until 2017, exports fluctuated. Poland's exports to Ukraine have not fallen below $4.8 billion since 2017 and were higher than in 2003-2016, except for 2007-2008 and 2012-2013 (when they were $5.5 billion, $6.4 billion, $5.3 billion and $5.7 billion). If they fluctuated before 2017, then after 2017, they grew steadily and reached their maximum value in 2022 – $9.7 billion. A similar trend is observed for agri-food products. In 2017, exports of agri-food products were higher than in 2003-2016, except for 2008 and 2010-2014, and since 2017, they have grown steadily in contrast to the previous period, exceeding the highest values prior to 2017, and in 2022 amounted to $1 billion. It can be concluded that the agreement between Ukraine and the EU has contributed to a steady increase in trade between the countries.

According to the calculations for 2003-2022 (Table 4), it can be seen that the average absolute increase, the average growth rate and the average rate of increase of agri-food exports from Poland to Ukraine are less than from Ukraine to Poland.

Table 4. Average indicators of the time series of agri-food exports of Poland and Ukraine, 2003-2022

Specification	The average level of exports	The average absolute increase	The average growth rate	The average rate of increase
	bln USD	bln USD	%	%
Poland's exports to Ukraine	0.50	0.04	1.10	10
Ukraine's exports to Poland	0.52	0.14	1.24	24

Source: calculations of author based on the International Trade Centre database.

At the same time, the average level of exports of countries differs slightly, but from 2003 to 2022, Poland's exports increased annually by 1.10 times, while Ukraine's increased by 1.24 times. It is expected that this trend will continue and that foreign trade between the countries will develop, which may contribute to their further integration.

For a more detailed analysis, indicators of the development of international trade between Poland and Ukraine were calculated (Table 5).

Table 5. Indicators of the development of foreign trade between Poland and Ukraine, 2003-2022

Years	All types of products			Agri-food products		
	Turnover, bln USD	Trade balance, bln USD	Exports to imports ratio (goods), %	Turnover, bln USD	Trade balance, bln USD	Exports to imports ratio (goods), %
2003	2.3	0.8	207.5	0.2	0.1	382.2
2004	3.1	1.0	194.8	0.2	0.1	295.9
2005	3.6	1.6	253.5	0.3	0.1	288.4
2006	5.3	2.6	300.7	0.4	0.1	166.4
2007	7.2	3.8	325.4	0.5	0.2	206.6
2008	8.8	4.1	273.7	0.9	0.3	192.9
2009	4.6	2.3	297.7	0.7	0.2	204.3
2010	5.7	2.1	215.6	0.7	0.2	169.8
2011	7.5	1.9	168.0	1.0	0.0	96.9
2012	7.8	2.7	207.1	1.3	0.0	97.7
2013	7.9	3.5	257.5	1.1	0.1	130.4
2014	6.5	1.9	184.0	1.0	0.0	99.2
2015	5.0	1.6	194.4	0.8	-0.1	78.0
2016	5.8	1.8	190.5	0.8	-0.1	74.2
2017	7.2	2.4	199.8	1.0	-0.1	78.4
2018	8.3	2.2	173.8	1.3	-0.1	82.6
2019	8.2	2.4	182.4	1.4	-0.1	81.3
2020	8.6	2.7	192.6	1.7	0.0	99.5
2021	12.1	2.0	139.9	2.0	-0.2	83.8
2022	15.9	3.5	155.9	3.8	-1.9	34.1

Source: calculations of author based on the International Trade Centre database.

Table 5 shows that from 2003 to 2022, the turnover of goods between Poland and Ukraine for all goods increased by 7.1 times, and for agri-food products even more – by 19.4 times, with the minimum values observed in 2003 and the maximum in 2022. The trade balance between Poland and Ukraine for all goods was constantly positive; that is, the trade balance was active. Poland's exports to Ukraine exceeded its imports from Ukraine by

1.4 (2021) to 3.3 (2007) times, and this difference has noticeably decreased since 2014, when it no longer exceeded 2 times (2017). Before that, it was less only in 2004 and 2011 – 1.9 and 1.7 times, respectively.

Exports to imports ratio (goods) constantly exceeded 100%; its values have been lower since 2014, except for 2011. From 2003 to 2022, Polish exports to Ukraine increased 6.5 times, but imports to Poland from Ukraine increased even more – 8.5 times. If we compare 2022 with 2016, the year before the Association Agreement between Ukraine and the EU came into force, Poland's exports to Ukraine increased by 2.5 times, and imports from Ukraine to Poland by 3.1 times. The trade balance for agri-food products for Poland in trade with Ukraine was positive by 2010, and later – except for 2013 – it became negative. Similarly, the exports to imports ratio has not exceeded 99.5% (2020) since 2011, except for 2013. But if in 2013 it was 130.4%, then by 2011 it did not fall below 166.4% (2006) and reached 382.5% in 2003. Exports of agri-food products from Poland from 2003 to 2022 increased by 6.2 times, almost the same as the total export, and imports from Ukraine increased by 69.8 times, which was significantly more than the average. Compared to 2016, for Polish exports the indicator was 2.7 times, and for imports from Ukraine to Poland – 5.9 times.

So, from the analysis, it is clear that the total export and export of agri-food products of Poland and Ukraine in their bilateral trade is increasing. Poland's exports to Ukraine grew less than imports from Ukraine to Poland and the growth of Polish agri-food exports to Ukraine is almost the same as the growth of total exports, while the increase in imports from Ukraine to Poland of agri-food products is noticeably higher than total imports. This trend continued in 2022 compared to 2003 and 2016; the trade balance was constantly positive for Poland in trade with Ukraine, while the trade balance for agri-food products was positive only before 2011 and in 2013. The exports-to-imports ratio decreased compared to the period before 2011, although fluctuations were observed (i.e., there is a greater effect for Ukraine). However, the trade balance for all types of products remains consistently positive for Poland. The greater growth of Ukraine's exports to Poland compared to Poland's exports to Ukraine is also due to the fact that Poland's exports to Ukraine were already significantly higher – even before the signing of the Association Agreement between Ukraine and the EU – and its high product quality standards as an EU member. Among the agri-food products most exported by the countries, a significant part coincides (Table 6).

Table 6. Selected agri-food products most exported by Poland and Ukraine, 2022

Product	Poland		Product	Ukraine	
	Share of total country exports, %	Share of exports of agri-food products of the country, %		Share of total country exports, %	Share of exports of agri-food products of the country, %
Meat and edible meat offal	2.3	15.9	Cereals	20.6	38.9
Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere and others	1.2	8.2	Animal, vegetable or microbial fats and oils and their cleavage products; prepared edible fats and others	13.5	25.4
Preparations of cereals, flour, starch or milk; pastrycooks' products	1.2	8.1	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal and others	8.5	16.0
Cereals	1.0	6.6	Residues and waste from the food industries; prepared animal fodder	2.5	4.6
Miscellaneous edible preparations	0.9	6.4	Meat and edible meat offal	2.1	4.0
Preparations of meat, of fish, of crustaceans, molluscs or other aquatic invertebrates, and others	0.8	5.6	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere and others	1.0	1.9
Residues and waste from the food industries; prepared animal fodder	0.8	5.6	Edible fruit and nuts; peel of citrus fruit or melons	0.7	1.3
Cocoa and cocoa preparations	0.7	4.9	Sugars and sugar confectionery	0.7	1.3
Fish and others	0.7	4.6	Preparations of cereals, flour, starch or milk; pastrycooks' products	0.6	1.1
Preparations of vegetables, fruit, nuts or other parts of plants	0.6	4.1	Preparations of vegetables, fruit, nuts or other parts of plants	0.5	1.0
Animal, vegetable or microbial fats and oils and their cleavage products; prepared edible fats and others	0.5	3.2	Cocoa and cocoa preparations	0.3	0.6

Source: calculations of author based on the International Trade Centre database.

Thus, among the goods that occupy the largest share in the agri-food exports of Poland and Ukraine are: meat and edible meat offal; dairy produce; birds' eggs; natural honey; edible products of animal origin; preparations of cereals, flour, starch or milk; pastrycooks' products; cereals; residues and waste from the food industries; prepared animal fodder; preparations of vegetables, fruit, nuts or other parts of plants; and animal, vegetable or microbial fats and oils and their cleavage products. To improve the quality and trade of

these products, it is advisable to create joint ventures across countries. For Poland, these are significant livestock products, in particular: meat and edible meat offal; dairy produce; birds' eggs; natural honey; and edible products of animal origin (24.1% of the country's agri-food exports). For Ukraine, significant products are crop products: cereals; animal, vegetable or microbial fats and oils and their cleavage products; prepared edible fats; oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; and industrial or medicinal products (80.3%). The commodity structure of Poland's agri-food exports is more diversified – the maximum share is meat and edible meat offal at 15.9%, with the share of other listed goods varying from 3.2% to 8.2%. In contrast, in Ukraine, the share of cereals is 38.9%, and the share of other listed products ranges from 0.6% to 25.4%. In addition, while 38.8% in Poland is occupied by four product groups, in Ukraine, only cereals account for 38.9%. This indicates the feasibility of commodity diversification of Ukraine's agricultural exports.

Calculating the intensity of intra-industry trade (3) will help predict the most promising directions for the integration of countries in trade (Table 7).

Table 7. Index of intra-industry trade of agricultural products of Ukraine with Poland, 2018-2022

Products	Years					
	2018	2019	2020	2021	2022	average value
Edible vegetables and certain roots and tubers	0.76	0.88	0.60	0.50	0.30	0.61
Products of the milling industry; malt; starches; inulin; wheat gluten	0.39	0.30	0.29	0.56	0.24	0.35
Preparations of cereals, flour, starch or milk; pastrycooks' products	0.27	0.27	0.25	0.29	0.41	0.30
Preparations of vegetables, fruit, nuts or other parts of plants	0.87	0.96	0.93	0.87	0.97	0.92
Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere and others	0.85	0.63	0.45	0.50	0.91	0.67
Sugars and sugar confectionery	0.94	1.00	0.90	0.76	0.43	0.81
Edible fruit and nuts; peel of citrus fruit or melons	0.27	0.52	0.40	0.21	0.10	0.30
Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal and others	0.11	0.10	0.17	0.08	0.05	0.10
Cereals	0.02	0.03	0.30	0.04	0.01	0,08

Source: calculations of author based on the International Trade Centre database.

The above calculations show that Grubel and Lloyd's Indicator values are highest for edible vegetables and certain roots and tubers, preparations of vegetables, fruit, nuts or other parts of plants, edible products of animal origin not elsewhere specified, sugars and

sugar confectionery. This indicates the greatest prospects for integration between Poland and Ukraine in these areas. Moreover, among these goods, there are those that have the largest share in the bilateral trade of the countries – in particular, dairy produce, birds' eggs, natural honey and preparations of vegetables, fruit, nuts or other parts of plants.

The types of agri-food products which countries export most in mutual trade and predominantly import are determined (Table 8).

Table 8. Agri-food products occupying the largest share in the exports of Poland and Ukraine in their mutual trade and imports of these countries, 2022

Export from Poland to Ukraine	% of agri-food exports to Ukraine	Ukraine's import	% of Ukraine's agri-food imports	Export from Ukraine to Poland	% of agri-food exports to Poland	Poland's import	% of Poland's agri-food imports
Meat and edible meat offal	11.3	Edible fruit and nuts; peel of citrus fruit or melons	11.1	Animal, vegetable or microbial fats and oils and their cleavage products; prepared edible fats	30.0	Residues and waste from the food industries; prepared animal fodder	10.3
Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere and others	11.2	Fish and others	10.5	Cereals	24.4	Fish and others	9.1
Edible vegetables and certain roots and tubers	10.2	Miscellaneous edible preparations	7.0	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal and others	18.3	Animal, vegetable or microbial fats and oils and their cleavage products; prepared edible fats and others	8.3
Residues and waste from the food industries; prepared animal fodder	8.8	Residues and waste from the food industries; prepared animal fodder	6.1	Residues and waste from the food industries; prepared animal fodder	9.9	Edible fruit and nuts; peel of citrus fruit or melons	7.5
Preparations of cereals, flour, starch or milk; pastrycooks' products	8.1	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal and others	6.0	Edible fruit and nuts; peel of citrus fruit or melons	4.1	Meat and edible meat offal	6.2
Coffee, tea, maté and spices	7.2	Edible vegetables and certain roots and tubers	5.9	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere and others	3.4	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere and others	5.2

Miscellaneous edible preparations	7.1	Animal, vegetable or microbial fats and oils and their cleavage products; prepared edible fats and others	4.9	Preparations of vegetables, fruit, nuts or other parts of plants	2.1	Miscellaneous edible preparations	5.2
Edible fruit and nuts; peel of citrus fruit or melons	6.8	Coffee, tea, maté and spices	4.6	Sugars and sugar confectionery	1.7	Cocoa and cocoa preparations	4.9
Preparations of vegetables, fruit, nuts or other parts of plants	6.3	Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere	4.2	Vegetable plaiting materials; vegetable products not elsewhere specified or included	1.1	Preparations of cereals, flour, starch or milk; pastrycooks' products	4.5
Cocoa and cocoa preparations	5.6	Cocoa and cocoa preparations	4.1	Meat and edible meat offal	1.0	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal and others	4.4

Source: calculations of author based on the International Trade Centre database.

Poland exports the most meat and edible offal to Ukraine, but this group is not among those that Ukraine imports the most. The opposite situation applies to dairy produce, birds' eggs, natural honey, edible vegetables and certain roots and tubers, residues and waste from the food industries, miscellaneous edible preparations, edible fruit and nuts the peel of citrus fruit, etc. Among the products that Ukraine imports more of, exports from Poland do not occupy the largest share; for example, fish, oil seeds and oleaginous fruits, miscellaneous grains, seeds and fruit and industrial or medicinal products.

Among the agri-food products that Ukraine exports to Poland are: animal, vegetable or microbial fats and oils and their cleavage products; oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruits; residues and waste from the food industries; edible fruit and nuts; citrus fruit peel; dairy produce; birds' eggs; natural honey; edible products of animal origin; and meat and edible meat offal. However, this is not typical for the majority of imported goods from Poland, which include fish; miscellaneous edible preparations; cocoa and cocoa preparations; preparations of cereals, flour, starch or milk; and pastrycooks' products. Therefore, as one of the largest suppliers of cereals, Ukraine should prioritise the export of preparations of cereals, flour, starch or milk, as well as pastrycooks' products to Poland. Generally, the goods that Poland exports most to Ukraine are those that Ukraine predominantly imports, and the situation is similar in Ukraine.

A noticeable increase in Poland's exports to Ukraine and a positive balance indicate the importance of the Ukrainian market for Poland and the prospects for further development of trade. Skwirowski (2024) also notes that the trade balance with Ukraine is very favourable for Poland, and since the beginning of the war, Polish exports have grown rapidly. It is important to pay attention to the Polish-Ukrainian call to develop cooperation with the EU. The Leviatan Confederation, the Polish-Ukrainian Chamber of Commerce and Industry and the Association of Ukrainian Entrepreneurs have asked the governments of Poland and Ukraine to develop, in cooperation with the European Commission, a real

programme to eliminate the main economic reasons leading to agricultural protests. They argue that it is in strategic interests to stop further destruction of mutual economic, social and other relations.

Also, Vlasyuk (2024) notes that Ukraine is a profitable trade partner for Poland, as it ranks seventh among partner countries in terms of Polish exports, and Polish exports to Ukraine exceed exports to China. It includes jobs and added cost in the country.

It was substantiated that the harmonisation of product quality standards with European ones contributed to an increase in the export of agri-food products to Poland.

Platonova (2019) notes that Ukraine has taken actions to gradually achieve compliance with EU technical regulations and the EU systems of standardisation, metrology, accreditation, conformity assessment work and market surveillance and undertakes to adhere to the principles and practices presented in existing decisions and regulations of the EU. It is important to acknowledge that the quality development of exports is impeded by challenges related to financing the innovative development needs of Ukrainian enterprises and the existence of a significant number of underutilised production capacities, among other factors. Nevertheless, the establishment of joint ventures between countries, particularly in the processing of agricultural products, could serve as a potential solution to these issues.

Conclusions

Taking into account the trends in the development of exports between Poland and Ukraine, even in the context of hostilities, it is assumed that trade between the countries will develop – and the Free Trade Agreement between Ukraine and the EU will facilitate this. Following the conclusion of the Association Agreement, there has been a significant increase in trade between Ukraine and the EU – particularly with Poland. To enhance the position of Poland and Ukraine in the global market, the same product groups that have the largest share in the exports of both countries were identified, including grains, milk and dairy products, poultry eggs, natural honey, ready-made grain products, vegetable processing products, etc. It is proposed to create joint enterprises to improve the quality of these products, increase their production and export and stimulate the export of processed products. For Poland, this primarily concerns livestock products, while for Ukraine, it relates to crop production. This initiative should provide benefits to the population, enabling consistent access to high-quality products at affordable prices, while also expanding markets for producers. Furthermore, the establishment of joint ventures should help increase revenues for the state budgets of both countries, create new jobs (as a result of establishing joint processing enterprises) and improve product quality by attracting new technologies and investments.

At the same time, it is advisable to deepen research on production, quality standards and demand in the world market for selected types of agri-food products in order to increase their exports by Poland and Ukraine. It would also be beneficial to further the study by analysing how the well-being of the populations of these countries influences the exports and imports of Poland and Ukraine.

From 2003 to 2022, the total and agri-food exports of Poland and Ukraine increased, with Polish exports rising more than Ukrainian ones. The share of agri-food products also

increased, more significantly in Ukraine, where it was higher. A similar pattern is observed in mutual trade between the two countries; agri-food products account for 10% of Polish exports and 39.5% of Ukrainian exports. The growth of total and agri-food exports from Poland to Ukraine did not differ significantly, but exports of agri-food products from Ukraine to Poland increased at a faster rate. The shares of agri-food products in each country's exports are almost the same as in their bilateral trade. The influence of the International Economic Integration (IEI) has become significant; after the conclusion of the Association Agreement between Ukraine and the EU, trade between Ukraine and the EU – particularly with Poland – increased noticeably. Exports from Poland became more stable, while exports from Ukraine to Poland grew more than those from Poland to Ukraine. Foreign trade turnover between Poland and Ukraine saw a greater increase in agricultural and food products.

Poland's trade balance with Ukraine has always been positive, although the difference between exports and imports is decreasing, and the exports-to-imports ratio has generally begun to decline. Regarding agri-food products, the trade balance for Poland was positive before 2010 and in 2013. The same product groups have the largest share in the exports of both Ukraine and Poland, particularly cereals, dairy produce, birds' eggs, natural honey, edible products of animal origin not elsewhere classified, preparations of cereals, flour, starch or milk, pastrycooks' products and preparations of vegetables, fruit, nuts or other parts of plants, among others.

Therefore, it is advisable to create joint ventures in order to improve quality, increase production and export of products. For Poland, these primarily consist of livestock products, while for Ukraine, they focus on crop production. The commodity structure of Polish agri-food exports is more diversified than that of Ukraine. Considering the commodity structure of exports and imports between the countries in mutual trade, it is advisable for Ukraine to stimulate the export of preparations of cereals, flour, starch or milk and pastrycooks' products to Poland. In the context of integration with the EU, Poland's exports to the Union are growing, particularly in agri-food products. A similar trend is evident for Ukraine. The largest importers of these countries, especially Poland, are EU countries, indicating the impact of integration on trade.

Product groups with the greatest prospects for integration between Poland and Ukraine have been determined, namely in the trade of: edible vegetables and certain roots and tubers; preparations of vegetables, fruit, nuts or other parts of plants; dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere classified, as well as sugars and sugar confectionery.

A peculiarity has been established that, depending on the trade policy of the integration group, IEI may not reduce, but increase trade with third countries.

Taking into account the types of products that countries import the most can help manufacturers increase their production and exports; however, it is essential to pay attention to compliance with product quality standards and the preferences of consumers in those countries. The growth of high-quality exports in the bilateral trade between Poland and Ukraine should enhance the competitiveness of products and satisfy the demands of consumers with diverse preferences. Ukraine and Poland should encourage increased and expanded product diversification of exports to their largest importing countries, as they already have positions in these markets. According to calculations of export statistics, it is assumed that the trend of increasing trade will continue, which may contribute to further integration of countries, including Ukraine, into the EU. Consequently, foreign trade

between Ukraine and Poland is developing. Since the conclusion of the Association Agreement between Ukraine and the EU, there has been a significant increase in trade between Ukraine and the EU – particularly with Poland.

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For citation:

Kryvenko N. (2024). Foreign Trade in Agricultural Products between Poland and Ukraine in the Context of the Development of International Economic Integration. *Problems of World Agriculture*, 24(3), 4-25; DOI: 10.22630/PRS.2024.24.3.9

Scientific Journal Warsaw University of Life Sciences – SGGW
Problems of World Agriculture volume 24(XXXIX), number 3, 2024: 26-36
DOI: 10.22630/PRS.2024.24.3.10

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Sustainable Development Goals Related to Agriculture and the EU's Main Development Strategies

Abstract. The paper deals with the United Nations Sustainable Development Goals (SDGs) of 2015 and their relation to agricultural and rural activities. Over the years, many strategic documents have been created, especially within the European Union. The aim of this paper is to analyse the most important ones, to highlight the outlined objectives related to agriculture and rural areas and to compare them with the SDGs. A review of major EU CAP documents published in recent years, as well as the EU economic, agricultural and environmental strategies, has been undertaken. The analysis is set against the background of the UN declarations and agendas. Research shows that of the 17 Sustainable Development Goals (SDGs) promoted by the United Nations, 16 are directly or indirectly linked to agriculture and are implemented through the activities of the Common Agricultural Policy (CAP). It could also be said that the SDGs served as a kind of starting point for many important documents, shaping, among other things, the future of the CAP.

Keywords: United Nations, sustainable development goals, agriculture, European Union, economic strategies, Common Agricultural Policy

JEL Classification: A10, E00, F10

Introduction

The main research problem is whether current EU economic and agricultural strategies, along with the related documents, reflect the UN Sustainable Development Goals (SDGs). The 2030 Agenda for Sustainable Development of 2015 (United Nations, 2015) applies to our entire planet, including the economies of individual countries, and – thus – also to agriculture. The list of Sustainable Development Goals (SDGs) promoted by the United Nations contains 17 items (Table 1). It would be interesting to see how many of these objectives relate to agriculture and rural areas; this constitutes the second research problem.

The aim of the paper is to determine how these goals interact with the strategies of sustainable development in economies, including agriculture, as well as with strategic documents created in recent years. Both document analysis (Bowen, 2009) and comparative methods are employed.

Document analysis involves skimming (superficial examination), reading (thorough examination) and interpretation. A literature review as a research methodology (Snyder, 2019) was also used when examining links between SSGs and agriculture. The majority of the strategic documents have been created in the European Union. The author intends to look at the list of objectives contained in the most important ones and use them as the basis for comparison with SDGs. In this case, a literature review is employed. For instance, Scown et al. (2020, p. 1) partly attempt to solve the two research problems and even the

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precondition – why we examine precisely the EU documents. In the quoted article, it is stated that agriculture is essential to meeting the SDGs. According to other sources (European, 2017, p. 8) and confirmed by Scown, the EU is a "world leader" in reaching the SDGs. The authors state that there are many connections between the CAP and the SDGs and that the CAP has the potential to contribute to most of the SDGs. In the EU report (Lafortune, 2024), it was clearly explained that meeting the SDGs is an important part of the current EU political programme, which is expressed in the documents. However, the employed methodology is different from the one used in this article. The quoted authors (Scown, 2020; Pe'er, 2019; Lafortune, 2024) concentrate on CAP indicators aligned with SDG indices, whereas in this study, strategic goals indicated in the documents are compared with the SDGs. However, one method is common, namely applying keywords to analyse CAP objectives and SDG targets.

Matthews (2020, p. 2) states that "agricultural production has potential relevance for a majority of the SDGs". In his study, "the Green Deal" and "Farm to Fork Strategy" are also mentioned (p. 3) as important documents pursuing SDGs. In the 2017 Communication: The Future of Food and Farming, it is clearly shown that the CAP contributes to at least 13 SDGs (p. 8). In the Commission's impact assessment accompanying its CAP legislative proposal (European Commission, 2018a, Part 3/3, p. 73), one can find that there are clear links between the CAP and nine SDGs (1, 2, 3, 6, 8, 9, 10, 13 & 15) as well as indirect links with Objectives 4 and 5.

The author does not intend to evaluate or criticise the quoted documents. The aim is to indicate whether the objectives and actions analysed in the documents align with the SDGs. The new approach used in this article attempts to demonstrate that agriculture and rural areas are central to the sustainable development of nations, especially developing ones.

United Nations Sustainable Development Goals (SDGs)

The SDGs are contained in Table 1. Document analysis and literature review enabled the creation of a list of important documents containing policy objectives starting from 2015 – the year of the SDGs' introduction. These will be addressed in this paragraph. Jean-Claude Juncker based his work programme on 10 priorities covering, among others, jobs and the Energy Union (European Commission, 2015). Juncker also set out the priorities for the Common Agricultural Policy (European Commission, 2017, p. 7). These are:

- Enhancing quality employment and boosting growth and investment (8);
- Exploiting the potential of the Energy Union, circular economy and bioeconomy, while enhancing environmental care, combating and adapting to climate change (7,13,15);
- Transferring research and innovation from laboratories to fields and markets (4, 9);
- Fully connecting farmers and rural areas to the digital economy (9);
- Contributing to the implementation of the European Commission's Agenda on Migration (3,4,8,10,17).

Table 1. SDG goals and its links with agriculture

SDG Goals	Agricultural feedback
1: No Poverty	**End poverty in all its forms everywhere** The poverty gains from growth in agriculture are large (Christiaensen, 2006, p. 34). Poverty could be diminished through growth which in agriculture has a much bigger effect than in other sectors (Gunnarson, 2018, p. 8).
2: Zero Hunger	**End hunger, achieve food security and improved nutrition and promote sustainable agriculture** SDG2 goals are especially oriented towards agriculture and food sciences. For example, Goal 2.3 is about increasing the income of small farmers. Goal 2.4 is about securing sustainable food production systems and appropriate agricultural practices that help in adaptation to climate change. Goal 2.5 is to sustain biodiversity in food production in order to ensure sufficient food (McConnell, 2023, p. 13165)
3: Good Health and Well-being	**Ensure healthy lives and promote well-being for all at all ages** For populations with limited access to large amounts of food, even consuming smaller portions of these nutrient-dense indigenous foods can help combat undernutrition and decrease the number of preventable deaths in children under 5 (Ansah et al., 2017, p. 1). Agriculture is fundamental for good health; for the poor, it is also the only way of securing basic needs (Hawkes, 2006, p. 984).
4: Quality Education	**Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all** In villages, insufficient education is one of the chief constraints that curtails the acquisition of knowledge and the adoption of technologies. Spreading knowledge and technology may change this situation, improving the conditions of rural areas and stimulating sustainable rural development (Costa, 2020, p. 43). In many of the developing countries, agricultural education and training have failed to adapt and respond to the realities of rural societies (Gazi, 2019, p. 7).
5: Gender Equality	**Achieve gender equality and empower all women and girls** Women are powerful agents of change and continue to make increasing and significant contributions to sustainable development, despite existing structural and socio-cultural barriers (Overview, 2016, p. 6). Women play important roles at different nodes of both agricultural and off-farm value chains, but in many countries their contributions are either underestimated or limited by prevailing societal norms or gender-specific barriers (Quisumbing, 2021 p. 1).
6: Clean Water and Sanitation	**Ensure access to water and sanitation for all** There should be a new attitude towards water management for better health and nutrition (Gerber, 2019 p.5). This is especially important in developing countries, where water is often extremely scarce. There is a collective relevance of water, sanitation and hygiene (WASH) and biosecurity interventions to the antimicrobial-resistance agenda in agricultural settings and they appraised their reported effects on infection burden, antibiotic use and antibiotic resistance in livestock production and aquaculture (Jimenez, 2023, p. e419).
7: Affordable and Clean Energy	**Ensure access to affordable, reliable, sustainable and modern energy for all** This study provides a high-level overview of alternative energy sources that can be harnessed to power agricultural operations, focusing on renewable energy technologies. When thinking about the overall economy around the globe, agriculture is vital. Energy is required at each step of production, from fertiliser production to fuelling tractors for planting and harvesting (Majeed, 2023, p. 344).
8: Decent Work and Economic Growth	**Promote sustained, inclusive and sustainable economic growth, as well as full and productive employment and decent work for all** The integrated crop-livestock-forestry system (ICLFS), is a solution that links efficiency improvement with nature protection and implements SDG8 (Decent, 2020, p. 16).
9: Industry, Innovation and Infrastructure	**Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation** Regulatory barriers constrain investments in the development of storage and processing, which hampers the development of effective market institutions and lowers the capacity of agricultural producers to be internationally competitive (Kohli, 2021, p. 691).
10: Reduced Inequalities	**Reduce inequality within and among countries** Agricultural growth is found to reduce the accentuation of inequality or accelerate inequality reduction (Imai, 2016, p. 26). Agricultural growth reduces poverty – both headcount ratios and poverty gaps – in both middle-income and low-income countries (p. 27).

11: Sustainable Cities and Communities	**Make cities and human settlements inclusive, safe, resilient, and sustainable** Aside from the economic functions, urban agriculture is known to perform social and environmental functions. The environmental functions are in the forms of air and water quality enhancement. The social functions are evident in its support for political activism and volunteerism in cities (Azunre, 2019, p. 104). Ensuring food security, improving sustainability, and, at the same time, demonstrating the widely perceived economic value are challenges presented by commercial urban agriculture (Oliveira de, 2022, p. 1).
12: Responsible Consumption and Production	**Ensure sustainable consumption and production patterns** Unsustainable consumption and production patterns have been among the greatest challenges over the past few years. They are the main drivers of the triple planetary crises of climate change, biodiversity loss and pollution, threatening human lives, the environment and the targets of the SDGs (Arora, 2023, p. 1)
13: Climate Action	**Take urgent action to combat climate change and its impacts** Agriculture is a significant contributor to anthropogenic global warming, and reducing agricultural emissions—largely methane and nitrous oxide—could play a significant role in climate change mitigation (Lynch 2021, p.1).
14: Life Below Water	**Conserve and sustainably use the oceans, seas and marine resources for sustainable development** There is some overlap between SDGs 14 and 15. For example, there is a need to reduce, control and eradicate invasive species (Kerton, 2023, p. 401).
15: Life on Land	**Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss** It is necessary to create a new SDG, "Life Below Land". This goal is on biodiversity and includes microfauna, mesofauna, macrofauna, photosynthetic organisms and fungi. All these organisms have an impact on soil, and research outcomes are crucial to attaining SDGs (Arora, 2023b, p. 1).
16: Peace Justice and Strong Institutions	**Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels** Collaboration in agriculture helps in training farmers and achieving development goals. A better social environment forms the base for adapting agricultural technologies (Stuchi, 2020, p. 18).
17: Partnerships for the Goals	**Strengthen the means of implementation and revitalise the global partnership for sustainable development** It is generally agreed that agricultural cooperation through partnerships helps to attain Sustainable Development Goals. This is especially true in the area of agricultural services (Alotaibi, 2022, p. 1).

Source: Author's own work.

These priorities are related to the SDGs (the numbers in parentheses next to the priorities indicate the relevant SDG number. This procedure applies to all quoted documents).

In February 2017, the Maltese Presidency prepared a document linking proposals developed during various meetings and presenting priorities for future work (Council, 2017, pp 2-3). The following are the objectives and priorities:

i. Building resilience: it includes risk management, gaining capital and financial tools, securing incomes, managing income and price changes, increasing competitiveness, research and innovation, specialised assistance to less favoured areas, emphasis on food security, including the necessities of family farms, and improving consumer consciousness (1, 2, 8 & 13);
ii. Responding to environmental challenges by: improving the sustainability of agriculture, mitigating climate fluctuations, supplying environmental public goods and adhering to the United Nations Framework Convention on Climate Change COP 21 (United Nations, N. D. a), as well as the goals outlined in the 2030 Agenda for Sustainable Development (6, 7, 13 & 15);
iii. Investing in rural viability and vitality: enhancing the creation of new jobs and supplying services in rural areas, improving village administration, assisting the

heterogeneity of agriculture and benefiting from the multi-functionality of agriculture (8, 11 & 15);

iv. Ensuring generational renewal through: easier access to capital and land, the proliferation of learning, increased professional qualifications and a diminished administrative burden (3, 5 & 16);
v. Maintaining market orientation: promoting both domestic and export competition, striving for viable agriculture, ensuring a proper balance between opening new markets, defending vulnerable sectors and retaining high European standards (12);
vi. Strengthening farmers' position by: striving for clarity in contract arrangements, fighting unjust commercial practices, encouraging collaboration among farmers and improving consumer consciousness (12).

In its Communication (European Commission, 2017, p.11), the European Commission indicates which way the CAP should evolve. It also points out the general aspects of the new CAP. These are:

- supporting a smart and resilient agricultural sector;
- enhancing environmental care and climate action to contribute to the Union's environmental and climate change objectives;
- strengthening the socio-economic structure of rural areas.

In subsequent documents, the general objectives were then split into 10 specific objectives, stemming from the general objectives (European Commission, N.D.).

The objectives of the new CAP are:

1. support for the income and resilience of farms throughout the EU to support food security (1, 8, 9, 13, 15);
2. increasing competitiveness and market orientation (12);
3. improving the position of farmers in the value chain (12);
4. contributing to climate change mitigation and adaptation (13);
5. promoting sustainable development and efficient management of natural resources (15);
6. nature and landscape protection (15);
7. attracting new farmers and facilitating their activities and generational renewal (3,5,16);
8. promoting employment, growth, social inclusion and local development in rural areas, including the bioeconomy (11);
9. taking into account societal expectations in terms of food and health (3,12);
10. fostering knowledge and innovation (all SDG's).

The European Union has its own sustainable development strategies, either comprehensive or focused on various areas of the economy. A similar situation exists in many countries, both developed and developing. This is due to management needs and the importance of sustainability issues, among other factors. The creation and implementation of these strategies is a commitment arising from the membership of individual states and groupings in international organisations, and it already has a history.

The significant document in which one can find references to the need to create a sustainable development strategy is the United Nations Millennium Declaration issued on 8 September 2000 (United Nations, 2000). The Millennium Declaration included the so-called "Millennium Development Goals" (MDGs) (eight goals) (United Nations, N.D. b),

which were to be implemented by 2015. Despite the undoubted successes in achieving the Millennium Goals, it was decided to extend the 2015 deadline until 2030 and introduce the Sustainable Development Goals – hence the initiative 'Transforming Our World: The 2030 Agenda for Sustainable Development' (United Nations, 2015), which includes sustainable goals.

Defining development strategies is generally a formal process, often failing to reflect the specificity of the problem. The term is most commonly dominated by the approach to strategy as the classic content of the plan, that is, in the form of goals, methods and means (Chandler, 1962). R. L. Ackoff (1974) believes that strategy pertains to long-term goals and the means to achieve them, affecting the whole system. T. Markowski (2015), in turn, argues that strategy is a composition of reflections, decisions and actions aimed at defining general objectives, setting directions for action, choosing the means of implementation and, consequently, conducting specific activities and controlling the tasks performed.

Who is creating the sustainable development strategy at the European Union level? The strategy is endorsed by the experts and services of the European Commission, as well as new ideas and draft solutions concerning the EU's Common Agricultural Policy. If the same centres formulate goals, create sustainable development strategies and establish objectives for the CAP, it is difficult to discuss contradictions. Of course, there may be different emphases in different documents, and often – not only in the EU – agricultural matters can be part of the overall strategy, regardless of the creation of a document solely for the needs of agriculture.

The EU Biodiversity Strategy to 2020 (European Environment, 2011, p 4) included six mutually reinforcing and interdependent targets: the protection and restoration of biodiversity and related ecosystem services (Targets 1 and 2); strengthening the positive contribution of agriculture and forestry and reducing key threats to biodiversity in the EU (Targets 3, 4 and 5); as well as increasing the EU's contribution to global biodiversity (Target 6). Those targets align with SDGs 12, 13, 14 and 15. By calling for the above actions, the Commission announces in the strategy the introduction of "greening", which has become the main element of new CAP solutions implemented since 2014.

A subsequent important document published in December 2019 was 'The European Green Deal'. The Green Deal is integral to the Commission's strategy for implementing the United Nations' 2030 Agenda and sustainable development goals (European Commission, 2019, p. 3). Thus, in this case, the European Commission itself ensures that the objectives of the European Green Deal (EGD) and the SDGs are compatible. At the same time, the Commission is promoting other documents, namely the Farm to Fork and Biodiversity Strategies (European Commission, 2020a; European Commission, 2020b), as supporting documents for the creation of a National Strategic Plan (European Commission, 2018), the basic CAP act of law for the coming years.

The EC places a great emphasis on ensuring sustainable food production while pointing out that in order to achieve this, farmers will have to change their production methods by using solutions that least interfere with nature and based on new technologies, including digital ones. Manufacturers will be required to ensure better environmental performance, make the system more resilient to climate change and reduce the use of chemicals (e.g., pesticides and fertilisers). The downward trend in genetic diversity should also be reversed, facilitating the use of traditional crop varieties and animal breeds.

On 14 July 2021, the European Commission accepted the 'Fit for 55' package (European, 2021), which adjusts existing climate and energy legislation to meet the new EU

objective of a minimum 55% reduction in greenhouse gas (GHG) emissions by 2030. The 'Fit for 55' package is part of the European Green Deal, which aims to achieve EU climate neutrality by 2050. The package includes a revision of the Renewable Energy Directive (RED II) (A New Energy, 2023). Consequently, the documents address almost all SDGs directly or indirectly, as climate and environmental issues are now central to solving global problems.

Recently, international interest in the SDGs issue intensified. It is reflected in the Europe Sustainable Development Report (2022), as well as in the EU Voluntary Review on the Implementation of the 2030 Agenda for Sustainable Development (2023). The Europe Sustainable Development Report 2022 (4th edition) includes the SDG Index and Dashboards. In 2022, Heads of State agreed that a number of countries (40) should present reports on their progress towards the SDGs in so-called "voluntary national reviews" (VNRs) each year. The report contains a substantial list of references, including both recent scientific publications and government reports.

The first Voluntary Review of the European Union on the implementation of the 2030 Agenda for Sustainable Development shows that the EU is fully committed to delivering the 17 Sustainable Development Goals (SDGs). The 2030 Agenda should be examined alongside two other documents published in the same year: the Paris Agreement on Climate Change (The Paris, 2015) and the Addis Ababa Action Agenda on Financing for Development (Financing 2015). The European Union (EU) seeks to promote the 2030 Agenda both internally and externally. The Voluntary Review states (p. 8) that the European Green Deal is in line with the following SDGs: 2, 3, 6-9 & 10-15.

Since 2020, the SDGs have been included in every Commission work programme. The Joint Declaration of the European Parliament, the Council of the European Union and the European Commission on EU legislative priorities for 2023 and 2024 (EU Legislative, 2022) includes a commitment to expedite the implementation of the European Green Deal and, at the same time, the 2030 Agenda. The SDGs have become a main element of EU policies and a beacon for EU law-making. New legislation must include a reference to its relation to the SDGs (Better, 2021, p. 21).

The Voluntary Review shows advancements in the implementation of the Sustainable Development Goals. The EU's progress in implementing one of the most important goals (also significant from the CAP perspective) – SDG 2, as a result of sustainable agriculture measures – was moderate. Better results are expected for SDG 13 on climate action and SDG 15 on biodiversity.

Conclusions

Of the 17 Sustainable Development Goals (SDGs) promoted by the United Nations, 16 are directly or indirectly linked to agriculture and implemented through the activities of the Common Agricultural Policy. These include goals 1-9, 11-13 and even 10, 15, 16, and 17. This fact is supported by an analysis of the literature. According to an Indian project, 178 research articles indicated links between SDGs and agriculture (Rao, 2018).

The second part of this research dealt with the analysis of major EU CAP documents published in recent years, as well as those incorporated in the EU economic and agricultural strategies. Nine important documents, including four strategies and related papers, were

examined. The analysis was set against the background of the UN declarations and agendas. Thus, it can be said that the SDGs were a kind of "seed corn" or starting point for many significant documents, shaping – inter alia – the future of the CAP. It must be stressed that the SDGs properly reflect the problems facing modern agriculture and rural areas. This is true for almost all SDGs.

The relevance of this research is also demonstrated by the most recent OECD report (Measuring, 2023, p. 8), in which a new METRO-PEM model is recommended: "to ensure a better alignment between current policy objectives, their estimated impacts, and the UN Sustainable Development Goals". Such alignment helps to repurpose agricultural support in the EU.

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For citation:

Krzyżanowski J.T. (2024). Sustainable Development Goals Related to Agriculture and the EU's Main Development Strategies. *Problems of World Agriculture*, 24(3), 26-36;
DOI: 10.22630/PRS.2024.24.3.10

Scientific Journal Warsaw University of Life Sciences – SGGW
Problems of World Agriculture volume 24(XXXIX), number 3, 2024: 37-53
DOI: 10.22630/PRS.2024.24.3.11

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Effects of Information Providers, Channels and Types on the Adoption of Climate – Resilient Practices in Lesotho

Abstract. This study examined the effects of information providers, channels and types on the adoption of climate-resilient practices in Lesotho, deviating from the usual separate analysis of the relationships between information provider, channels and types. Previous studies have generated only partial insights into the influence of different information variables on adoption behaviour, neglecting a holistic representation of the interactive effects of all dimensions of information and adoption. Using a sample of 1,659 farmers from the Bureau of Statistics (BOS) database on the 2019/2020 agricultural production survey, the data was analysed using frequency counts, percentages and Probit regression. The results show that the majority of the farmers are male (53%), less than 30 years of age (59%), possess an education level between High School form 1 to 5 (59%), have between 5 and 10 persons per household (50%) and rely on subsistence farming as their main source of income (36%). The extension services provided, as indicated by at least 90% of the farmers, include information on farm management, crop selection, input use, credit, farm machinery, livestock, crop protection, conservation, marketing, irrigation and nutrition. In contrast, the information received is more focused on marketing, livestock production, agronomic practices, irrigation and fisheries production. The major extension service providers and sources of information are public service providers and radio. Agricultural extension information providers, channels and types influence the adoption of climate-resilient practices. The study recommends that extension information providers, channels and types be matched to specific contexts for improved effectiveness.

Keywords: information providers, channels, information types, adoption, climate, resilience, information sources, extension services

JEL Classification: Q10, Q16

Introduction

Climate change poses threats and exacerbates high vulnerability to agricultural livelihoods due to low adaptive capacity, human development, political resolve, infrastructure/technology and inadequate resources, which require crucial actions by individuals and governments (IPCC, 2021). The concern becomes more existential due to the need to meet the food needs of a rapidly growing population and changing diets. Fadairo et al. (2020) and IPCC (2021) stated that adaptation practices are crucial to reducing the impacts of climate change on food systems and agriculture. Antwi-Agyei et al. (2023) and Dougill et al. (2021) have reported that the adoption of climate-smart agriculture enhances food security and livelihoods, increases farmer adaptation, mitigates greenhouse gas (GHG) emissions and increases resilience. Climate resilience, as a basic concept of climate risk management, is the ability of an agricultural system to anticipate and prepare for, as well as adapt to, absorb and

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recover from the impacts of changes in climate and extreme weather. The adoption and improvement of agricultural practices increase the propensity for climate resilience. These practices are often depicted as sustainable agriculture, regenerative agriculture, nature-based solutions, environmentally friendly agriculture and agricultural clean production technologies. The characteristics of value-chain actors would influence the eco-efficiency and cleaner production decisions regarding the use of farm equipment and machinery. Climate-smart agriculture practices promote integrated cleaner production approaches through the minimisation of resource extraction, increased use efficiency, recycling waste residue and energy savings (Athira et al., 2019). Farmers' adaptation to the challenges of climate change and improving societal well-being is enhanced through the framework of climate-smart agriculture (Zilberman et al., 2018). Climate information services have led to an increase in adaptation strategies for climate change, specifically weather variability (Djido et al., 2021), productivity enhancement and livelihood protection (Yegbemey et al., 2021; Alidu et al., 2022). Agricultural production is enhanced through information by creating awareness, knowledge and skills (Anmol and Mohammed, 2021), facilitating all activities across the value chain for efficient management through changing operational contexts. The utility of information is often correlated to its influence on profitability; thus, limited access to information and technical knowledge constitutes a major barrier to the effective management of agricultural risks (Duong et al., 2019; Skaalsveen et al., 2020). Information is crucial to the effective management of agricultural risks (McKune et al., 2018), making adoption decisions (Mulwa et al., 2017), increasing resilience (Chaudhuri and Kendall, 2021; Blazquez-Soriano, 2022), adaptation and mitigation (Ponce, 2020), improved capacity (IPCC, 2021) and decision-making (Antwi-Agyei and Stringer, 2021).

Farmers are simultaneously exposed to multiple risks and, thus, need access to diverse information throughout the production cycles of their enterprises (Korell et al., 2020). The diversity of farmers' information needs extends to the content (Amah et al., 2021), typologies and message adequacy (Kumar et al., 2020), alignment to users' needs (Kumar et al., 2020) and preferred sources and channels of information (Mottaleb et al., 2017). The majority of research on information needs has focused on production and market risks (Komarek et al., 2020), neglecting the adequacy of measures required by end-users (Nwafor et al., 2020), specific information for different stages of the value chain (Diemer et al., 2020) and emerging needs (Chen and Lu, 2019). Harvey et al. (2014) stated that farmers' vulnerability is related to agricultural risks, resilience capacity (Heeks and Ospina, 2018) and perceived consistency of meteorological data (Rapholo and Makia, 2020; Simelton et al., 2013).

This study is anchored in the Diffusion of Innovation Theory, which – according to Rogers (2003) – posits that innovation passes through the process of knowledge about the innovation, persuasion, the decision to adopt or not, implementation of the innovation and confirmation of adoption to determine adoption. This process is often evaluated through the indicators of perceived relative advantage, compatibility with existing cultural norms, attitudes and beliefs, complexity and the ease of understanding and use by end-users, trialability and observability. Diffusion theories focus on how innovative technologies are introduced to prospective adopters at different temporal scales and are used to explain the transfer and adoption of agricultural technologies between farmers. The diffusion of innovation theory was applied to explore the adoption of various technologies due to its generalisability and applicability covering a wide range of potentially influential variables and constructs across many sectors and contexts, such as small-scale irrigation pumps among

farmers in Malawi (Kamwamba-Mtethiwa et al., 2021) and improved cassava varieties in Ghana. Kondo et al. (2020) used the theory to examine the various dissemination strategies and factors determining farmers' adoption.

Magesa et al. (2024) noted that farmers' misperceptions of agricultural information sources and messages exist and, thus, explore multiple information sources. Naveed & Hassan (2021) reported that farmers relied overwhelmingly on their prior experience and fellow farmers or friends, as well as progressive farmers, for agricultural information. Lv et al. (2024) noted that different information sources affect farmers' adoption behaviour differently, with formal and informal personal information sources having significant positive effects on intentions; informal information sources being the strongest determinant of adoption behaviour, while impersonal information sources had no significant influence. Masephula & Olorunfemi (2023) reported that farmers' access to extension visits was a significant correlate of their extension and marketing information needs. Fidelugwuowo & Omekwu (2023) found that factors relating to the propensity to adopt include access to extension services and the cost of innovation. Naveed & Hassan (2021) stated that farm size, education and income predict information needs and sources and that information acquisition by farmers was hindered by poor timely access, inaccessibility, unawareness, bad timing of television programmes, poor economic conditions, infrequent visits from extension staff, low levels of education and language barriers.

The novelty of this study is to show the combined effects of information providers, channels and types on the adoption behaviour of farmers with respect to climate-resilient practices. This is predicated on the fact that several studies and authors have separately examined the relationship between information providers, channels, types and socio-demographic characteristics and adoption behaviour, which has generated a partial understanding of the different information variables' influence on adoption behaviour, neglecting the holistic representation of the interactive effects of all dimensions of information and adoption. This study changes the existing narrative of singling out information dimensions rather than considering the collective impacts of the information variables. This study, therefore, fills the knowledge gap concerning how the interactive effects of information variables address the vacuum created by the unidimensional analysis of the impact of information on adoption behaviour. The objective of this study is to determine the effects of information providers, channels and types on the adoption of climate-resilient practices in Lesotho.

Methodology

The study was carried out in Lesotho, a country enclosed and landlocked by South Africa, featuring a high-altitude terrain that comprises lowlands, foothills and the Sengu River Valley as agro-ecological zones. These zones range from 1,400 to 2,000 m for the valleys and from 2,000 to 3,400 m above sea level for the highlands. Lesotho covers ten administrative districts, with a total land area of 30,355 km^2. The rainy season lasts from October to April, while the dry-cold season extends from May to September. The administrative districts are Mokhotlong, Butha-Buthe, Quthing, Qacha's Nek, Thaba-Tseka, Mafeteng, Mohale's Hoek, Berea and Maseru (Lepheana et al., 2018).

Fig. 1. Map showing the study area

Source: Nthapeliseng Nthama & O. I. Oladele (26 Mar 2024): Effects of Radio-Based Extension Services on farmers' Adoption of Organo-Mineral Fertilizers, Biofertilizers, and Manure in Lesotho, Journal of Radio & Audio Media, DOI: 10.1080/19376529.2024.2332714.

The data used in this study was obtained through permission from the Lesotho Bureau of Statistics (BOS) for the 2019/2020 Agricultural Production Survey, which included 8,000 agricultural households from rural areas across all four ecological zones. This encompassed 500 sample Primary Sampling Units (PSUs) stratified according to the ten administrative districts and later clustered into the four agro-ecological zones. The criteria for determining the sample size included levels of production of key cereal crops, the number of small and large ruminant livestock and districts as the lowest domain of estimation, with a minimum of 400 agricultural households based on a 7.5% Coefficient of Variation. The data covered agricultural practices, extension services received, service providers, extension information, sources of information, types of services received, demographics and social characteristics. A sample of 1,659 farmers was extracted from the survey database as they are linked to the adoption of climate-resilient practices. The extracted data was analysed using SPSS IBM version 29, with frequencies, percentages, Probit regression and summarised with tables and graphs.

A Probit regression analysis was applied to determine the effects of information providers, channels and types on the adoption of climate-resilient practices in Lesotho. For the Probit models, it is assumed that farmers have two alternatives: to adopt climate-resilient practices or not, as expressed by Nagler (1994). Binary outcome variables were considered dependent variables with two possibilities, such as yes or no. The model is appropriate as it can overcome heteroscedasticity and satisfies the assumption of a cumulative normal probability distribution (Gujarati, 2004).

Table 1. Independent variables of the Probit model and their expected signs

Variables	Description	Measurement	Expected sign
infomainsource	Main source of information	Dummy (0 = no, 1 = yes)	+/-
infoagrono	Information on agronomy	Dummy (0 = no, 1 = yes)	+
infodiesepest	Information on diseases and pest	Dummy (0 = no, 1 = yes)	+
infocredit	Information on credit	Dummy (0 = no, 1 = yes)	+
infovarieties	Information on varieties	Dummy (0 = no, 1 = yes)	+/-
infoweather	Information on weather	Dummy (0 = no, 1 = yes)	+/-
infonewpractice	Information on new practice	Dummy (0 = no, 1 = yes)	-
EXTPFU	Farmers Union as extension provider	Dummy (0 = no, 1 = yes)	+
EXTPMAFSAEO	Ministry of Agriculture as Extension provider	Dummy (0 = no, 1 = yes)	+
EXT1cropprotection	Extension services on crop protection	Dummy (0 = no, 1 = yes)	+
EXT1conserva	Extension services on soil conservation	Dummy (0 = no, 1 = yes)	+
EXT1credit	Extension on credit	Dummy (0 = no, 1 = yes)	+
EXTAgrodealers	Extension services by agro-dealers	Dummy (0 = no, 1 = yes)	+/-
inforsource1	Information sources	Dummy (0 = no, 1 = yes)	+/-

Source: Authors' compilation.

It is assumed that Y can be specified as follows:

$$Y = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots + \beta_{ki} X_{ki} + U_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

And that:

$$Y_i = 1 \text{ if } Y > 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$$Y_i = 0$$

Otherwise, Where X_1, X_2,……X_n represents a vector of random variables, β represents a vector of unknown parameters and U represents random disturbance terms (Nagler, 1994).

Results and Discussion

The results and discussions are organised into sections on personal characteristics, farm characteristics, extension service providers and information sources, information types received and Probit regression analysis of the effects of information providers, channels and types on the adoption of climate-resilient practices in Lesotho. Figure 2 presents the results of the personal characteristics of farmers and reveals that the majority of the farmers are male (53%), less than 30 years of age (59%), never married (57%), had an education level between form 1-5 (59%), make complete decisions on their farming enterprises (74%), did not receive formal agricultural training (89%), have between 5 to 10 persons per household (50%), rely on subsistence farming as their main source of income (36%) and derive their entire income from agriculture (34%). Rantso et al. (2019) reported that although agriculture is a male-dominated activity, more female farmers participated in block farming than male farmers in Lesotho. Seko and Jongrungrot (2022) reported that over two-thirds of farming households were male and were either separated or widowed, deriving most of their income from pensions, with an average household size of five members. Rantso et al. (2019) found that the majority of farmers in Lesotho are married, have primary education and have household sizes ranging between five and nine members. This may be attributed to the use of family

labour in agricultural chores such as weeding, ploughing and harvesting, among others. The agricultural sector in Lesotho is dominated by small-scale farmers who produce mainly for consumption (Rantso et al., 2019).

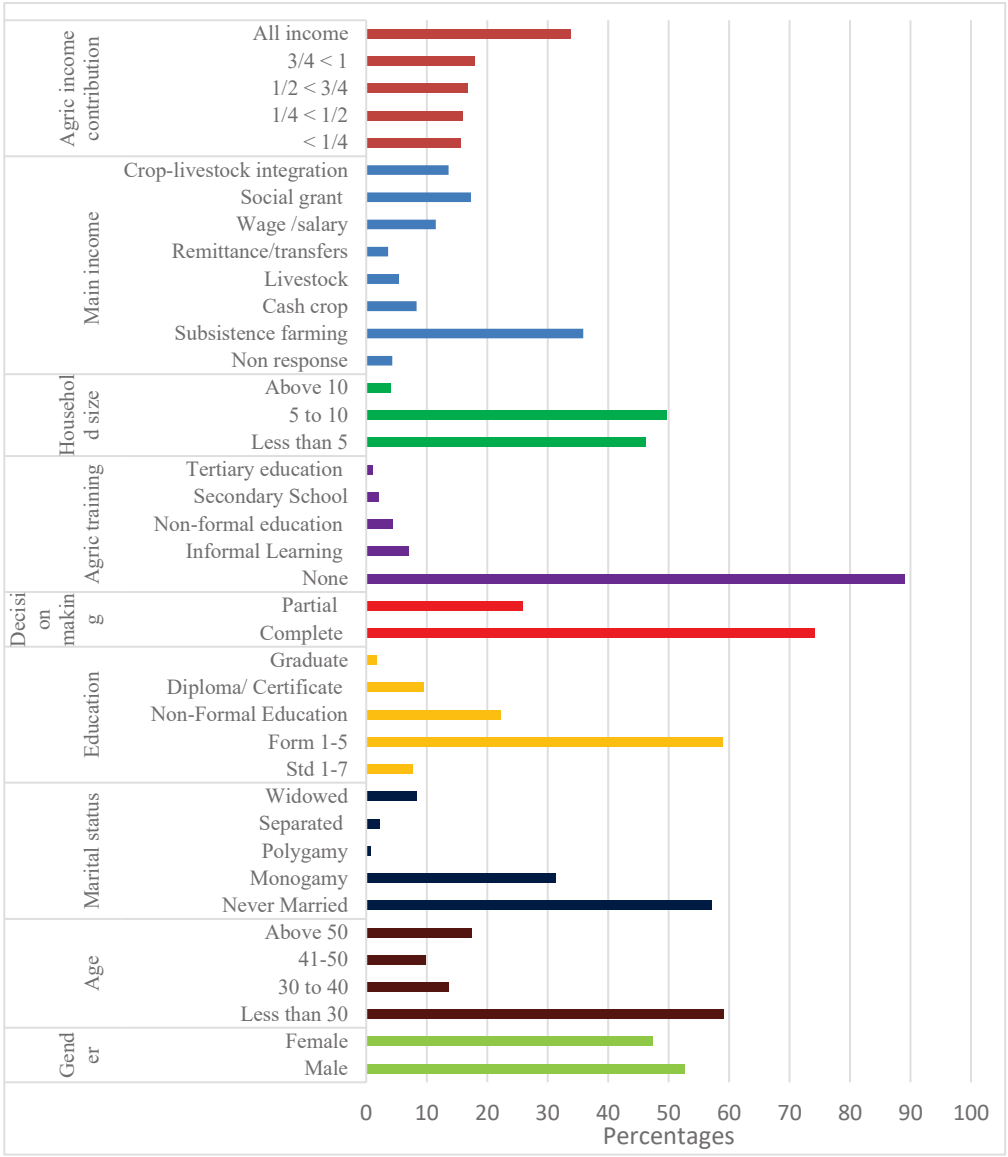

Fig. 2. Distribution of respondents based on personal characteristics

Source: Authors' compilation.

Table 2. Distribution of respondents based on farm characteristics

Variables	Options	Frequency	Percentages
Percentage loss	less than 2	1 483	89.4
	2–10	88	5.3
	above 10	88	5.3
Loss location	on the field	1 100	66.3
	during storage	260	15.7
	during transport	86	5.2
	loss during processing	116	7.0
	loss during packaging	78	4.7
	loss during sales	20	1.2
Proportion planted temporary crops	less than ¼	71	4.3
	¼	123	7.4
	½	241	14.5
	¾	86	5.2
	whole field	1 138	68.6
Proportion harvested	less than ¼	244	14.7
	¼	111	6.7
	½	158	9.5
	¾	75	4.5
	whole field	1 073	64.7
Area fertilized	all	911	54.9
	not all	748	45.1
Types of fertiliser	mineral fertilisers (inorganic fertiliser)	703	42.4
	organo-mineral fertilisers	111	6.7
	organic fertilisers	181	10.9
	bio fertilisers	20	1.2
	manure	644	38.8
Product purpose	producing only for sale	85	5.1
	producing for sale with some own consumption	166	10.0
	producing for own consumption with some sale	491	29.6
	producing mainly for own consumption	987	59.5
Land use type	unclassified land	71	4.3
	land under temporary crops	1 546	93.2
	land under temporary and permanent crops	41	2.5
Land tenure	inherited	1 030	62.1
	purchased	93	5.6
	community land / use right from local Authority	224	13.5
	sharecropping	108	6.5
	borrowed / rented	133	8.0

Source: Authors' compilation.

Ogundeji et al. (2018) found that savings, scale of production, membership of farmer associations and financial record keeping exert significant positive effects on access to credit for farmers in Lesotho. Farmers did not achieve the required yields (Seko & Jongrungrot 2022). Social capital influences participation in the informal markets, while market information, membership in farmer organisations, farming experience and access to transport influence participation in the formal markets by farmers in Lesotho (Rantlo et al. 2021).

The results of the farm characteristics of farmers are presented in Table 2 and show that the majority of farmers had less than 2 per cent crop loss (89%) (crop loss is operationalised as crop failure), with crop loss occurring on the field (66%), planting the whole field (66%), harvesting the whole field (65%), applying fertiliser on the whole field (55%), using inorganic fertilisers (42%), producing crops mainly for their own consumption (60%), with a land use type of temporary crops (93%) and inheritance as land tenure (62%). The crop loss could be due to a combination of the effects of climate change and access to and utility of information on climate-resilient practices. The results may further be attributed to the fact that the majority of the farmers are small-scale and their level of production is subject to associated inefficiencies. Seko & Jongrungrot (2022) found that crop management strategies, such as seeding rate – which was found to be lower than recommendations by the Ministry of Agriculture and Food Security (MAFS) – seed type and soil fertility, are significant factors. According to Rantso & Seboka (2019) and Seko & Jongrungrot (2022), inheritance is the most predominant method of land tenure among farmers in Lesotho and is closely related to the customary land tenure practiced in the country.

Figure 3 presents the results of the extension service providers and information sources, revealing that the majority of farmers – between 73 and 99% – indicated that extension service providers include private fisheries, forestry, farmers' unions, the Ministry of Agriculture and Food Security, extension and veterinary officers, agro-input dealers and local and international non-governmental organisations. This may be related to the prevalence of the pluralistic extension system, where several role players provide extension services to farmers along the value chain. The pluralistic extension system is considered to be the co-occurrence of several service providers with not-for-profit, profit-based, public, private and mixed extension systems, based on numerous sources of funding, coverage and specialisations (Davis & Terblanché, 2016). Odongo et al. (2023) stated that the management style of extension agents and participatory monitoring and evaluation of smallholder farmer extension activities had positive and significant effects on socioeconomic resilience. Loki et al. (2020) noted that farmers who are dissatisfied with the frequency of extension visits and poor technical advice on agriculture use multiple sources of extension services.

The results on information show radio as the main source of information among farmers (73%), followed by television (14%) and farmers' associations (6%). These results agree with findings that farmers explored and established preferences for various risk management information sources (Rejesus et al., 2020): radio as a preferred information source (Rahman et al., 2016), the main source of information for the adoption of sustainable agricultural intensification practices in East Africa (Kansiime et al., 2021), a determinant of the adoption of agro-weather information sources in Kenya and Ethiopia (Oladele et al., 2019) and perceived as a sufficient source of information (Brhane et al., 2017). In Rwanda, the use of radio broadcasts, call-in shows and radio listening clubs extended climate services and scaled up participatory integrated climate services for agriculture. Radio-based dissemination overcomes literacy issues and enables mass coverage, while the use of call-in options and

call centres provides two-way communication. Nthama and Oladele (2024) found that radio-based extension services in Lesotho covered information such as agronomy, pests/diseases, credit, new practices, varieties, weather, land tenure, soil conservation and crop protection, while technologies promoted by radio include soil conservation, terraces, cover cropping, crop rotation, organo-mineral fertiliser, organic fertiliser, biofertilisers, manure and improved seeds. Radio continues to play a major role in the dissemination of agricultural information and influences adoption behaviour, despite the multimedia approach to agricultural communication.

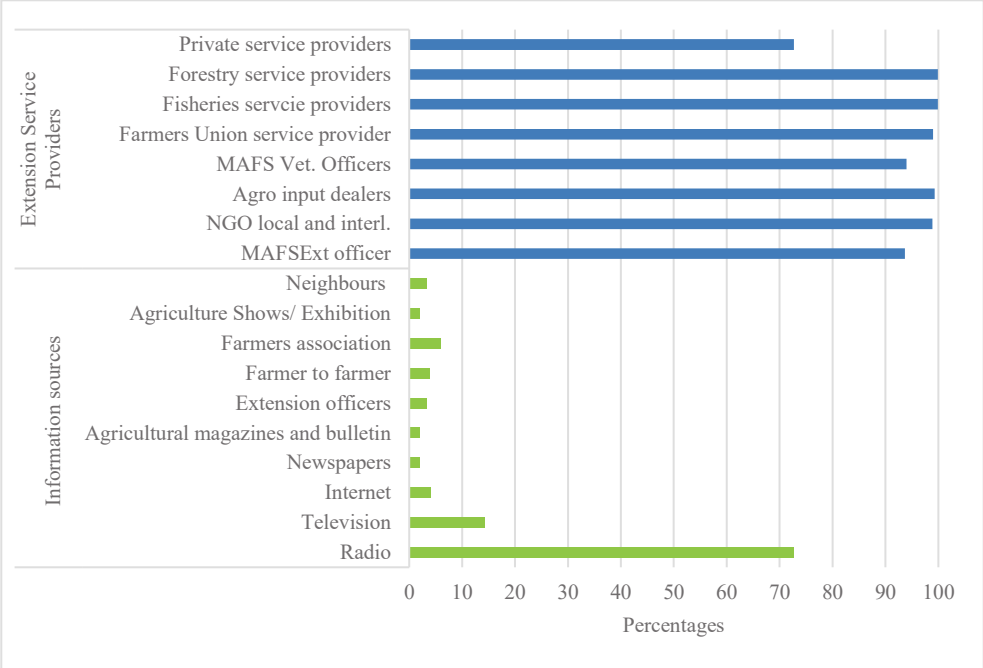

Fig. 3. Extension Service Providers and Information sources

Source: Authors' compilation.

Table 3 presents the distribution of extension services provided and shows that at least 90% of farmers indicated that they received information on farm management, crop selection, input use, credit, farm machinery, livestock, crop protection, conservation, marketing, irrigation and nutrition. The trend of this result can be attributed to the prevalence of pluralistic extension services, where several extension service providers with different specialisations and scopes reached farmers with various extension messages. Mbatha (2024) reported that extension services received by farmers in South Africa include seed supply, manure preparation, implementation of irrigation schemes, farm fencing, training and assistance with vaccinating crops and livestock, while Sahu et al. (2024) found that inputs (seeds, fertilisers, plant protection) were the most sought-after information. Agwu et al. (2023) recommended strengthening, coordination and elimination of gaps and duplications among role players in agricultural innovation systems for effective linkage mechanisms. Sahu et al. (2024) stated that due to the era of changing needs, farmers strive to acquire

additional information on aspects such as marketing, climate change and post-harvest functions.

Table 3. Distribution of extension services provided the respondents

Extension services provided	No	Yes
Farm management	37 (2.2)	1622 (97.8)
Crop selection	87 (5.2)	1572 (94.8)
Input use	22 (1.3)	1637 (98.7)
Credit	2 (0.1)	1657 (99.9)
Farm machinery	9 (0.5)	1650 (99.5)
Livestock	53 (3.1)	1606 (96.9)
Crop protection	55 (3.3)	1604 (96.7)
Conservation	19 (1.1)	1640 (98.9)
Marketing	9 (0.5)	1650 (99.5)
Irrigation	9 (0.5)	1650 (99.5)
Nutrition	9 (0.5)	1650 (99.5)

Source: Authors' compilation.

Table 4 presents the distribution of farmers according to the types of information received and shows that the proportion of farmers ranged from 86% for weather information to 99% for disease and pest management, among others. The extension services covered various types of information due to the generalist approach of extension service providers and their response to demand-driven information aimed at enhancing the livelihoods of farmers. The demand-driven services imply making extension more responsive to the needs of all farmers, including women, the poor and the marginalised, as well as being accountable to them. According to Sahu et al. (2024), the type of information sought influences farmers' preferred sources of extension services. Kwapong et al. (2020) found that information received by farmers from both farmer-to-farmer exchanges and agricultural extension agents focused on motivation towards farming businesses, financial resources for the production season, willingness to reinvest profits, access to farmland for future expansion, group formation, marketing challenges, diversification of farm operations and good agricultural practices. Abu Harb et al. (2024) stated that information received by farmers includes farm productivity, adopted technology, environmental challenges, livelihood improvement, livestock production and crop production.

Table 5 presents the results of the Probit regression analysis of the effects of information providers, channels and types on the adoption of climate-resilient practices in Lesotho. All the models are well-fitted, as confirmed by the Chi-Square values and a significance level of 0.01. All indicators of variables on different information providers, channels and types across various climate-resilient practices are significant, although at different significance levels (Table 5).

Table 4. Distribution of respondents according to Information received

Information types	No	Yes
Info-general agriculture	139 (8.4)	1520 (91.6)
Info-weather	219 (13.2)	1440 (86.8)
Info-varieties	158 (9.5)	1501 (90.5)
Info-new practice	22 (1.3)	1637 (98.7)
Info-machinery	9 (0.5)	1650 (99.5)
Info-credit	94 (5.6)	1565 (94.4)
Info-disease & pest	14 (0.8)	1645 (99.2)
Info-market	167 (10.0)	1492 (90.0)
Info-livestock	15 (0.8)	1644 (99.2)
Info-agronomy	17 (1.0)	1642 (99.0)
Info-irrigation	3 (0.1)	1656 (99.9)
Info-fisheries	26 (1.5)	1633 (98.5)
Info-HIV/AIDS	29 (1.7)	1630 (98.3)

Source: Authors' compilation.

The extension factors and variables influencing the adoption of soil conservation, cover cropping, terracing, crop rotation and improved seeds as climate-resilient practices are the main channels of information: agronomy information, disease and pest information, credit information, information on varieties, weather information, information on new practices, farmers' unions as extension providers, the Ministry of Agriculture as an extension provider, crop protection extension services received, conservation extension services received, credit extension services received, agro-dealers as extension providers and multiple information channels. Smallholder farmers source climate information through radio because it is believed to be accessible, credible, timely and location-specific, eliminating mismatches of services and users' needs (Yegbemey et al., 2021; Kumar et al., 2020). Agro-dealers facilitate the distribution of improved farm inputs, extension information and post-harvest handling services to smallholder farmers (AGRA, 2016; Das et al., 2019). Several authors have reported that factors influencing farmers' adoption of climate-resilient practices include the availability and accessibility of inputs (Mulema et al., 2020), access to information (Kassie et al., 2021; Mofya et al., 2021) and that contact with extension agents positively predicts the intensity of joint adoption of climate-smart agriculture practices. Serote et al. (2023) reported that contact with extension services removes barriers to the adoption of climate-smart agriculture. Kelil et al. (2020) noted that extension services improve access to and use of climate-smart agricultural information. Elia (2017) indicated that extension services increased farmers' awareness and understanding of climate change and variability in central semi-arid Tanzania, thus facilitating the adaptive response to climate change. Colussi et al. (2022) stated that communication affects the adoption of technologies and that extension services are a major source of communication with farmers.

Table 5. Probit regression analysis of the effects of information providers, channels and types on the adoption of climate –resilient practices in Lesotho

Parameter	Soil Conservation Coefficient (Std err)	Cover cropping Coefficient (Std err)	Terrace Coefficient (Std err)	Crop rotation Coefficient (Std err)	Improved seeds Coefficient (Std err)
infomainsource	.124 (.017)***	.126 (.020)***	.128 (.016)***	.128 (.017)***	.121 (.017)***
infoagrono	-.214 (.020) ***	-.200 (.023) ***	-.232 (.019) ***	-.222 (.020) ***	-.195 (.020) ***
infodiesepest	.345 (.032) ***	.310 (.037) ***	.347 (.031) ***	.348 (.032) ***	.340 (.032) ***
Infocredit	.061 (.011) ***	.050 (.013) ***	.065 (.011) ***	.062 (.011) ***	.057 (.011) ***
infovarieties	-.010 (.008)	-.010 (.009)	-.011 (.007)	-.010 (.008)	-.011 (.008)
infoweather	.014 (.007) **	.012 (.008)	.014 (.006) **	.014 (.007) **	.013 (.007) **
infonewpractice	.051 (.021) **	.063 (.025) **	.070 (.021) ***	.058 (.021) ***	.032 (.022)
EXTPFU	-.035 (.019) *	.010 (.023)	-.036 (.019) **	-.032 (.019) *	-.030 (.020)
EXTPMAFSAEO	.217 (.020) ***	.218 (.024) ***	.234 (.020) ***	.226 (.020) ***	.204 (.020) ***
EXT1cropprotection	.005 (.011)	.000 (.013) **	.005 (.011)	.004 (.011)	.004 (.011)
EXT1conserva	-.173 (.019) ***	-.168 (.022) ***	-.186 (.018) ***	-.176 (.019) ***	-.160 (.019) ***
EXT1credit	.414 (.102) ***	.063 (.094)	.345 (.094) ***	.268 (.091) **	.401 (.104) ***
EXTAgrodealers	-1.148 (.073) ***	-.933 (.083) ***	-1.094 (.073) ***	-1.028 (.075) ***	-1.132 (.074) ***
inforsource1	.023 (.001) ***	.020 (.001) ***	.023 (.001) ***	.023 (.001) ***	.022 (.001) ***
Intercept	-.971 (.249) ***	-.979 (.250) ***	-.936 (.237) ***	-.947 (.235) ***	-.995 (.255) ***
Chi-Square	83189.585	46879.643	89086.666	82171.704	75501.072
Df	1644	1644	1644	1644	1644
Sig	.000	.000	.000	0.000	0.000

* significant < 10%, ** significant < 5%, *** significant < 1%
Source: Authors' compilation.

It is noteworthy that information on varieties does not significantly influence any of the climate-resilient practices. This may be due to the fact that extension services did not cover specialised information on varieties, as many extension agents might lack competence in this area. Walsh et al. (2015) found that community seed production improves links between formal and farmer seed systems, sustains the transition into commercial entities and fosters connections with publicly funded programmes. Ayenan et al. (2021) reported that available seed varieties are predominantly open-pollinated and that private sector-mediated seed systems offer a higher potential for seed quality and profitability, with community-based seed systems showing the greatest potential for ensuring access to seeds. Kimenye and McEwan (2014) stated that foundation seeds are critical for promoting better access to high-quality seeds, which can be achieved through farmer-led seed production models, contract models, research models and quality declared seed models for acquiring skills in establishing and managing seed production and marketing. Ncube et al. (2023) found that local seed systems contribute to household seed security through timely and effective distribution networks that offer several choices and alternatives. CIMMYT (2023) stated that last-mile delivery of stress-tolerant and nutritious seeds addresses the impacts of climate change, pests and diseases and shocks on food systems by enhancing access to a diverse range of seeds. This

allows farmers to choose the best varieties to suit their needs and local environment. Myeni and Moeletsi (2023) stated that the adoption of improved seed varieties was driven mainly by factors such as easy and stable access to seeds. Branca et al. (2022) found that access to extension services, land, credit and input and output markets impacts the adoption of improved seeds.

Similarly, the extension services received on crop protection were not significantly related to the adoption of soil conservation. Weather information, farmers' unions as extension providers and the extension services received did not influence the adoption of cover cropping. This may be attributed to the fact that the provision of information without the supply of associated inputs could have hindered the utility of the extension services provided. The adoption of terraces due to the topography of the farms in the study area, crop rotation and improved seeds were not influenced by the extension services received on crop protection. This may be because of the peculiarities and disease/pest-specific needs of crop protection, as opposed to the generalised information provided. Jena et al. (2023) stated that the adoption of crop rotation was found to be influenced by access to extension services, access to credit and subsidies for seed. The adoption of climate-resilient practices is influenced by climate and ecological zoning, access to extension services and farming system diversity (Nyang'au et al., 2021), information (García-Jiménez 2022) and improved access to extension programmes (Dhehibi, 2022).

Conclusions

This paper provides large-scale evidence of the effects of information providers, channels and types on the adoption of climate-resilient practices in Lesotho using the combined effects of these factors on the adoption behaviour of farmers regarding climate-resilient practices. This is based on the fact that several studies and authors have separately examined the relationship between information providers, channels, types and socio-demographic characteristics and the adoption behaviour, generating partial insights into the influence of the different information variables on adoption behaviour while neglecting a holistic representation of the interactive effects of all dimensions of information and adoption. This study, therefore, fills the knowledge gap concerning how the interactive effects of information variables address the vacuum created by the unidimensional analysis of the impact of information on adoption behaviour. The results indicate that extension service providers include private entities, fisheries, forestry, farmers' unions, the Ministry of Agriculture and Food Security, extension and veterinary officers, agro-input dealers and local and international non-governmental organisations. Similarly, the information received ranged from general agricultural advice to specific information on weather, varieties, machinery, credit, diseases/pests and irrigation, with the finding that information providers, channels and types significantly influenced the adoption of climate-resilient practices in terms of scope and intensity.

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For citation:

Oladele O.I., Nthama N. (2024). Effects of Information Providers, Channels and Types on the Adoption of Climate – Resilient Practices in Lesotho. *Problems of World Agriculture*, 24(3), 37-53; DOI: 10.22630/PRS.2024.24.3.11

Scientific Journal Warsaw University of Life Sciences – SGGW
Problems of World Agriculture volume 24(XXXIX), number 3, 2024: 54-65
DOI: 10.22630/PRS.2024.24.3.12

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Polish-Ukrainian Trade in Selected Fruits and Vegetables in the Face of the War in Ukraine

Abstract. Poland is among the top five largest producers of horticultural products in the European Union. A characteristic feature of Polish horticultural production is the great diversity in terms of scale and scope of activity. In Ukraine, the agricultural sector is also one of the key pillars of the economy; in 2021, about 14% of the country's population found employment in agricultural production. The analyses carried out indicate that Poland and Ukraine have different directions of change in the fruit and vegetable sector; namely, Poland shows a tendency to reduce the area of crops, while Ukraine, despite some declines, maintains a more stable production structure. The results of this research indicate significant variability in the import of selected fresh or frozen fruits and vegetables from Ukraine and the export from Poland in 2022. The most noticeable increase in imports in 2022 was recorded in the case of frozen blackcurrants and frozen raspberries. In terms of exports of Polish agricultural products to Ukraine, 2022 was characterised by significant increases in almost all analysed categories.

Keywords: fruit market, vegetable market, impact of war on horticultural sector, war in Ukraine, Polish trade with Ukraine

JEL Classification: Q02, Q11, Q17

Introduction

As noted by Drejerska and Fiore (2022), the agri-food sector plays a crucial role in the global economy – it is directly related to the livelihoods of almost eight billion people. Poland is one of the leading agricultural economies in Europe, with land designated for cultivation covering more than half of the country's area. It is worth emphasising that Polish agriculture shows significant diversity in terms of both the scale and scope of production. Additionally, Poland is among the top five largest producers of horticultural goods in the European Union. A characteristic feature of Polish horticultural production is the great diversity in terms of scale and scope of activity (Sobczak 2021). It should be noted that the fruit and vegetable market, although part of the agricultural market, is distinguished by the existence of independent local markets, distinct seasonality, significant participation of small informal entities and a wide range of products of varied quality (Filipiak 2014, Gołębiewski, Sobczak 2017). Horticultural products are characterised by great diversity in durability, transportability, qualitative heterogeneity and varied standards of preparation for sale. These features contribute to the instability of the horticultural market, which is further intensified by changes in supply resulting from weather conditions and incorrect decisions made by economic entities such as producers, processors and distributors. Fluctuations in trade relations between exporting and importing countries also affect the variability of the horticultural market (Trębacz 1994). Horticultural product markets and their mechanisms

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function in a manner similar to other product markets while maintaining their specificity. Among the factors distinguishing agricultural markets, one can mention a high level of competitiveness resulting from a large number of producers, a large group of end recipients, spatial character, cyclicality and seasonality, low price elasticity of supply and demand, as well as high price risk (Rembeza 2010).

Risk and uncertainty are integral components of economic activity, as well as the functioning of the entire economy, with a particular emphasis on agriculture. This sector is strongly dependent not only on economic dynamics, but also on changing climatic and weather conditions. The most dangerous events are unexpected and difficult to predict, affecting the physical parameters of production or price relations (Sadowski 2023). As the authors of this study point out, this risk is particularly noticeable in the fruit and vegetable production sector, which is characterised by a short shelf life and cannot be stored for a longer period (unlike cereals, which have a much longer storage period). A significant factor intensifying uncertainty in the agricultural market has turned out to be the war in the East, which has influenced changes in the level of supply and demand and contributed to the increase in the prices of means of production (Sadowski 2023).

The agricultural sector is one of the key pillars of the Ukrainian economy (Zolotnytska, Kowalczyk, 2022). In 2021, about 14% of the country's population found employment in agricultural production (Negrei and Taranenko, 2022). The year 2022 brought the outbreak of war in Ukraine, which initially had a regional character (covering the Donetsk Coal Basin) but, in the following months, spread to almost the entire country. This conflict caused far-reaching geopolitical and geoeconomic consequences, affecting both the main parties involved – Ukraine and Russia/Belarus – as well as Europe and the rest of the world (Sadowski 2023, Walkowski 2024). This war has become, after the COVID-19 pandemic, another serious shock to the global economy; although the warfare is regional in nature, its multidimensional effects have a global dimension (Banse et al. 2022, Walkowski 2024) – especially in the context of food security (Câmpeanu, 2022). This conflict has exacerbated the pressure on food supply chains, particularly disrupting exports from the Black Sea region (Glauben et al. 2022). As a result, Ukraine's foreign trade – especially exports – has collapsed, forcing the country to seek alternative trade routes. Consequently, there have been significant changes in the geographical structure of Ukrainian exports and imports. The launch of the grain corridor in mid-2022 was of key importance for the transport of goods from Ukraine, allowing ports to regain a dominant role in the export of agri-food products (Matuszczak et al., 2023).

This situation also had an impact on the policy of the European Union (Celi et al., 2022). The suspension of import duties and quotas on Ukrainian exports to the EU in mid-2022, along with the establishment of EU solidarity corridors, facilitated the export of Ukrainian products to the EU. However, it also caused serious disruptions in the agricultural markets of the region. Rapidly growing imports from Ukraine led to oversupply of agricultural products (mainly cereals), resulting in downward pressure on prices and the saturation of logistics chains in some EU regions, including Poland. There were also concerns about the quality of imported products, particularly regarding the issue of so-called "technical grain" (Kacprzak and Zawadka, 2023). Until February 24, 2022, Ukraine was a moderately important sales market for Polish agri-food products. The Russian invasion of Ukraine resulted in record sales returns in Polish agri-food trade with Ukraine in 2022, particularly in terms of imports (Bułkowska, Bazhenova 2023). The increase in exports of many products occurred despite the challenges and problems related to the

development of agriculture during the war (Cherevko 2024), such as the destruction of crops and temporary restrictions on grain exports from Ukraine to world markets (Gołębiewski and Stefańczyk 2023). Ultimately, Ukraine managed to maintain agricultural production and remain a significant supplier of agricultural products in the global market, as emphasised by Cherevko (2024). The large production and trade potential of Ukraine, alongside the growing import of agri-food products by land within the EU solidarity corridors, necessitates an assessment of the effects of the war on trade in agri-food products in EU countries bordering Ukraine, including Poland, which plays a key role in this process (Bułkowska, Bazhenova 2023).

Taking into account the importance of the horticultural sector in Polish agricultural production and its specific conditions, as well as the significant potential of Ukraine in agricultural production, including horticultural, it seems important to attempt to characterise changes in the fruit and vegetable market in the context of trade between Poland and Ukraine. Despite the growing interest in the impact of the war in Ukraine on economic relations in Eastern Europe, there is a lack of detailed research on Polish-Ukrainian trade in selected fruits and vegetables. Analyses conducted so far have focused mainly on general aspects of international trade, including trade in grains, without a thorough exploration of the fruit and vegetable sector – which is particularly sensitive to changes in logistics. This study fills the research gap in the literature on the subject, including changes in trade in the fruit and vegetable sector during the conflict in Ukraine. The paper analyses a specific agricultural sector, namely the fruit and vegetable market in the context of war perturbations, which will allow for a better understanding of the mechanisms occurring in this market segment.

Material and methods

The aim of this article was to characterise changes in the fruit and vegetable market in the context of trade between Poland and Ukraine. Attention was focused on the transformation of the market under the influence of the war in Ukraine. The assessment was made by analysing changes in trade during 2022-2023 compared to previous years. These changes were evaluated based on annual data for selected periods. Data from the FAOSTAT Database for 2017-2022 was used to present the general situation in the fruit and vegetable market in Poland and Ukraine. Data from the EUROSTAT database was utilised to assess the impact of the war in Ukraine on the situation in Polish markets from 2017 to 2022. Annual data on the level of imports of selected species of fresh and frozen fruits and vegetables between Ukraine and Poland, as well as exports from Poland to Ukraine, was employed to illustrate these changes. The selection of species was intentional, focusing on those of significant importance to both Poland and Ukraine.

The data analysis process in this study involves using annual data for selected periods to assess the changes in the market for selected fruits and vegetables. The following steps were taken to conduct the analysis:

1. Data collection: Annual data on the area of crops and harvests of selected fruit and vegetable species in Poland and Ukraine was collected, along with data on the import of selected products from Ukraine by Poland and the export of these products from Poland to Ukraine. This data came from the above-mentioned databases.

2. Data cleaning and preparation: The collected data were checked for missing values. Necessary corrections and adjustments were made to ensure data integrity and accuracy.

3. Data Transformation: Collected data was organized and transformed into a format suitable for analysis.

4. Descriptive analysis: Descriptive statistics, including trend measures, were calculated to summarize the data..

5. Interpretation of results and conclusions: Analysed data and statistical findings were interpreted to understand the observed changes in the market. Results were examined in the context of the war in Ukraine, considering its potential impact on market instability.

Results

The potential of horticultural cultivation in Poland and Ukraine

Analysis of data on the area of crops of selected fruit and vegetable species in Poland and Ukraine from 2017 to 2022 indicated changes in the structure of agricultural production in both countries (Table 1). In Poland, a significant decrease in the area of crops for many key species was observed. The largest change can be seen in the case of tomatoes, with a reduction of almost 41%. A similar trend is evident for strawberries, the area of which decreased by 37%, and for raspberries, where the decrease was about 26%. In Ukraine, changes in the area of crops were much less dynamic. A comparison of Poland and Ukraine indicates different trajectories of change in the studied sector; namely, Poland shows a tendency to reduce the area of crops, while Ukraine, despite some decreases, maintains a more stable production structure.

Table 1. Area of selected horticultural crops in Poland and Ukraine, in thousand ha

Specification	Poland							Ukraine						
	2017	2018	2019	2020	2021	2022	2022 to 20217	2017	2018	2019	2020	2021	2022	2022 to 20217
Apples	176.4	166.2	155.6	152.6	161.9	151.9	86%	91.2	91.8	87.7	85.0	84.4	76.9	84%
Blueberries	7.1	8.1	8.5	9.7	10.7	11.4	161%	0.4	0.5	0.5	0.1	0.1	0.1	25%
Cabbages	24.4	26.4	25.8	16.1	16.5	16.4	67%	64.6	62.4	65.9	69.1	67.8	59.3	92%
Carrots and turnips	22.1	22.7	22.5	17.7	17.5	16.8	76%	42.7	43.1	43	43.5	43.2	38.2	89%
Cauliflowers and broccoli	14.3	15.2	15.8	10.3	10.7	10.8	76%	3.3	1.3	1.4	1.5	1.4	0.8	24%
Cherries	9.6	8.9	9.0	10.4	9.7	9.9	103%	10.2	9.8	10.0	10.0	10.3	7.0	69%
Cucumbers and gherkins	15.0	16.5	17.1	8.8	9.2	6.7	45%	50.4	49.5	52.1	54.1	53.3	45.1	89%
Currants	44.0	43.7	43.4	42.5	43.4	44.8	102%	4.8	4.7	4.2	3.9	3.7	3.5	73%
Onions and shallots, dry	26.0	25.5	25.2	23.2	23.4	22.8	88%	54.8	52.5	53.9	55.1	53.8	44.2	81%
Other berries and fruits of the genus vaccinium n.e.c.	12.6	14.2	14.3	22.3	21.6	21.2	168%	1.4	1.7	1.5	1.6	1.8	2.2	157%
Plums and sloes	14.3	13.5	13.6	18.7	16.5	16.5	115%	18.0	18.2	17.3	17.6	17.9	16.7	93%
Raspberries	29.3	29.6	29.5	17.9	19.8	21.7	74%	5.0	4.9	5.2	5.3	5.4	4.8	96%
Sour cherries	29.5	28.0	28.3	24.8	25.3	26.0	88%	19.7	19.8	20.0	19.9	20.2	18.7	95%
Strawberries	49.6	49.2	49.9	33.0	33.9	31.3	63%	7.8	7.9	7.9	8.1	8.0	7.0	90%
Tomatoes	11.4	13.1	13.5	7.8	7.7	6.7	59%	74.4	73.1	72.9	74.9	75.8	51.5	69%

Source: Own study based on FAOSTAT Database data (accessed 16/06/2024).

The analysis of the harvest of selected products in Poland and Ukraine from 2017 to 2022, as well as the area of crops, reveals differences in the dynamics of production in both countries (Table 2). In Poland, significant changes were observed in the production of various crops; notably, the production of apples increased substantially, nearly doubling to reach 4.26 million tonnes in 2022. This indicates an intensification of production and the absence of unfavourable production conditions. When comparing both countries, Poland demonstrates a greater dynamism in changes to horticultural production, with clear increases in some sectors and decreases in others, while Ukraine is characterised by more stable production.

Table 2. Harvests of selected fruits and vegetables in Poland and Ukraine, in thousand tonnes

Specification	Poland							Ukraine						
	2017	2018	2019	2020	2021	2022	2022 to 20217	2017	2018	2019	2020	2021	2022	2022 to 20217
Apples	2,441.4	3,999.5	3,080.6	3,555.2	4,067.4	4,264.7	175%	1.076.2	1.462.4	1.154.0	1.114.6	1.278.9	1.129.1	105%
Blueberries	16.3	25.3	34.8	55.3	55.3	64.0	393%	1.4	1.2	2.4	0.6	0.1	0.2	14%
Cabbages	1,083.6	985.4	899.1	767.5	726.4	687.5	63%	1,673.4	1,650.8	1,732.9	1,759.2	1,722.6	1,533.5	92%
Carrots and turnips	827.1	726.4	678.3	681.0	638.4	619.6	75%	839.0	841.8	869.5	862.5	863.3	748.9	89%
Cauliflowers and broccoli	317.0	292.8	282.5	244.1	225.9	208.0	66%	59.9	21.2	22.6	20.2	17.9	9.1	15%
Cherries	19.7	60.0	44.4	51.3	59.1	76.6	389%	70.9	84.6	68.6	63.6	61.9	58.2	82%
Cucumbers and gherkins	543.7	538.7	519.4	526.5	473.0	472.2	87%	896.3	985.1	1,034.2	1,012.5	1,080.0	825.6	92%
Currants	128.8	164.6	126.2	145.9	152.0	145.8	113%	27.1	29.6	26.6	25.8	27.0	24.7	91%
Onions and shallots. dry (excluding dehydrated)	667.4	562.9	535.4	667.8	618.1	651.1	98%	976.7	883.9	998.1	1,033.7	1,024.4	809.8	83%
Other berries and fruits of the genus vaccinium n.e.c.	53.4	66.0	54.0	88.1	87.6	85.2	160%	1.3	1.8	1.4	2.3	4.1	3.0	231%
Plums and sloes	58.4	121.1	95.0	117.4	117.4	133.2	228%	200.5	198.1	181.1	173.2	188.3	168.6	84%
Raspberries	104.5	115.6	75.7	123.2	103.9	104.9	257%	34.2	35.2	35.5	35.3	36.3	33.6	105%
Sour cherries	71.6	200.6	151.9	155.5	166.6	183.8	112%	172.3	218.7	167.5	174.6	193.7	180.2	99%
Strawberries	177.9	205.2	185.4	157.6	162.9	199.4	175%	55.0	62.3	62.6	55.2	62.3	54.7	55%
Tomatoes	898.0	928.8	917.8	766.6	815.8	787.2	88%	2,267.5	2,324.1	2,224.4	2,250.3	2,444.9	1,257.5	14%

Source: Own study based on FAOSTAT Database data (accessed 16/06/2024).

As already indicated, in the years 2017-2022, the analysis of data on the area of crops and harvests of selected fruit and vegetable species in Poland and Ukraine indicates that these countries followed slightly different trajectories. These changes may be the result of

several factors. First, rising production costs, such as the prices of fertilisers, fuel or plant protection products, made some crops less profitable for farmers, which prompted them to reduce acreage or completely abandon certain crops. Second, changes in consumer preferences and competitive pressure from international markets could have influenced decisions to limit production. Additionally, climate change is a significant factor influencing changes in the structure of crops. Rising temperatures, increasingly frequent droughts and irregular rainfall have had a negative impact on crops, especially the more sensitive ones, such as strawberries and raspberries. In the case of Poland, attention should also be paid to the need to adapt production to the requirements of the Common Agricultural Policy and EU standards. At the same time, the increase in harvests in the cases indicated above may result from production intensification and investment in modern cultivation technologies, such as more efficient varieties and advanced plant protection methods.

Export structure in the fruit and vegetable sector in Poland and Ukraine

In Poland, the dominant export category in the fruit and vegetable sector is apples (status as of 2022), with exports reaching 732.73 thousand tonnes, indicating Poland's significant position as a key exporter of apples in the international market. Apple production in Poland is concentrated and intensive, which allows for a large scale of exports. The second important category is tomatoes (82.46 thousand tonnes), followed by the export of cabbage (487.53 thousand tonnes) and pears (6% share) (Figure 1).

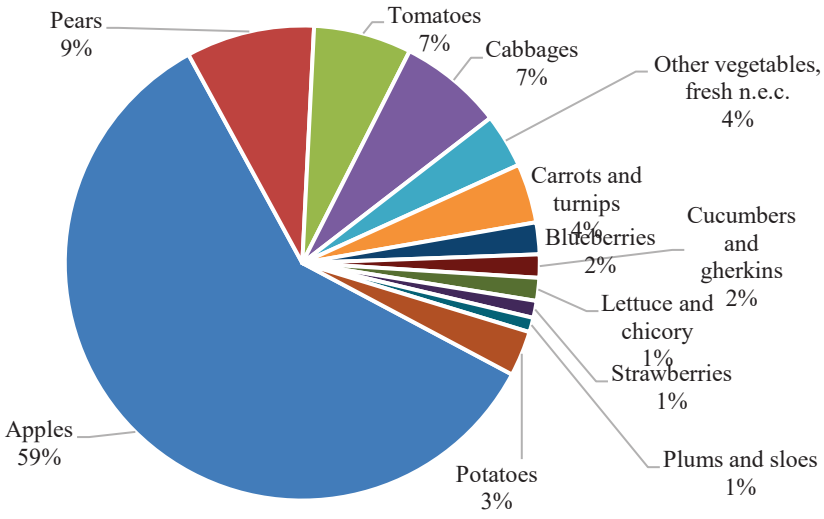

Fig. 1. Structure of Polish exports of selected fruit and vegetable species in 2022

Source: Own study based on FAOSTAT Database data (accessed 16/06/2024).

As in Poland, apples also play a significant role in the export of fruits and vegetables in Ukraine. However, it should be noted that although they are important, their export reached 20.28 thousand tonnes in 2022 – which is a much smaller value compared to

Poland. A significant export category werewas potatoes (30.08 thousand tonnes) and cabbage (1.15 thousand tonnes) (Figure 2).

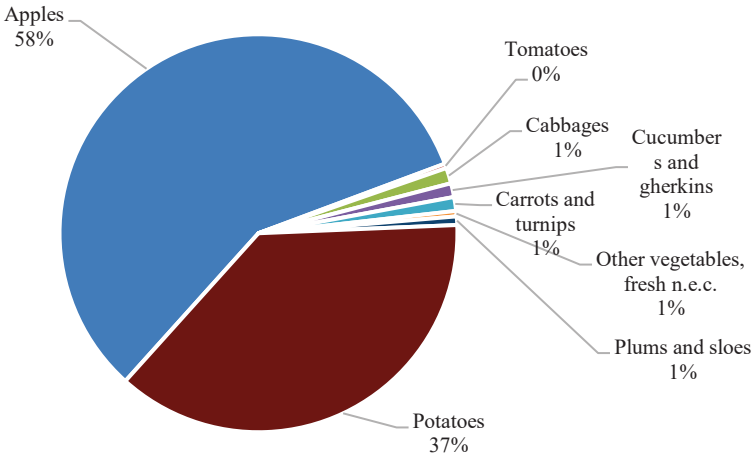

Fig. 2. The structure of Ukrainian exports of selected fruit and vegetable species in 2022

Source: Own study based on FAOSTAT Database data (accessed 16/06/2024).

Comparing the general export structure of both countries, it is evident that Poland dominates the production and export of apples and vegetables such as tomatoes and cabbage. Ukraine, on the other hand, despite having smaller export volumes, focuses on other categories.

Changes in the export and import of selected fruits and vegetables

In the analysed period from 2017 to 2021, there was a noticeable increase in the import of fruits and vegetables (fresh or processed) from Ukraine to Poland. As the data indicate, the import of frozen raspberries increased from 7,173.2 tonnes in 2017 to 17,146.5 tonnes in 2021, representing a significant, almost 140% increase. A similar situation occurred in the case of the import of edible vegetables and roots/tubers, which showed an increase from 5,902.7 tonnes to 11,821.6 tonnes (the largest jump was recorded in 2018, reaching 29,863.7 tonnes) (Table 3). In the case of other products, such as fresh raspberries, strawberries, tomatoes and plums, changing trends are observed – which may result from various factors, including weather conditions or changes in demand. The year 2022 brought significant changes in the structure of imports of the analysed products, which can be linked to the escalation of the armed conflict in Ukraine and the resulting disruptions in supply chains, as well as changes in trade policy. The most noticeable increase in imports in 2022 was recorded for frozen blackcurrants, where imports increased from just 22.1 tonnes in 2021 to 1,255.9 tonnes in 2022, an increase of over 5,600%. Similarly, imports of frozen raspberries increased from 17,146.5 tonnes in 2021 to 22,089.4 tonnes in 2022, a rise of 28.8%. Also, in the case of edible vegetables and roots and tubers, imports increased from

11,821.6 tonnes to 21,078.5 tonnes. However, not all products saw an increase in imports in 2022; the import of fresh raspberries and fresh tomatoes dropped significantly, which may indicate problems with the production and logistics of these fresh products in Ukraine – especially under wartime conditions.

Analysis of data from subsequent years showed that in 2023 the growth in imports of frozen raspberries continued, reaching 24,286.6 tonnes. However, compared to 2022, the growth rate was lower, while imports of edible vegetables and roots fell to 14,322.7 tonnes, which may indicate normalisation after a sharp increase in 2022. A significant decline in imports in 2023 was also noticeable in the case of plums (a drop to 812.4 tonnes) and apples (a drop to 359.5 tonnes).

Table 3. Import of selected fruits and vegetables from Ukraine to Poland, in tons

Specification	2017	2018	2019	2020	2021	2022	change 2022 to 2021	2023
Black currants, uncooked or cooked by steaming or boiling in water, frozen, unsweetened	0.0	42.9	183.8	69.1	22.1	1,255.90	5683%	126.3
Cucumbers, fresh or chilled	1,698.5	2,118.0	2,318.4	2,183.9	2,065.8	727.9	35%	940.6
Dried prunes	542.7	3.2	20	42	272.4	188.2	69%	65
Dried, shelled lentils, whether or not skinned or split	4.0	34.0	127.3	544.7	376.5	140.2	37%	572.5
Edible vegetables and certain roots and tubers	5,902.7	29,863.7	37,131.1	20,377.4	11,821.6	21,078.5	178%	14,322.7
Fresh apples	39.5	514.6	18.6	20.3	0.0	59.0		359.5
Fresh or chilled horse-radish "Cochlearia armoracia"	0.0	196.0	808.7	295.5	55.8	169.0	303%	43.8
Fresh plums	6,637.1	0.0	136.2	79.7	329.2	79.3	24%	812.4
Fresh raspberries	929.3	879.6	860.3	534.6	397.3	408.4	103%	383.7
Fresh strawberries	51.9	48.0	367.9	222.8	410.1	209.7	51%	100.6
Frozen strawberries. uncooked or cooked by steaming or boiling in water, whether or not sweetened	2,032.6	2,437.8	2,393.1	1,475.7	2,740.0	3,316.6	121%	1,488.6
Raspberries, uncooked or cooked by steaming or boiling in water, frozen, unsweetened	7,173.2	7,782.3	6,893.9	11,440.0	17,146.5	22,089.4	129%	24,286.6
Tomatoes, fresh or chilled	1,816.1	1,193.3	1,438.1	829.5	879.8	247.6	28%	352.6

Source: Own study based on EUROSTAT data (read on 27/07/2024).

Table 4. Export of selected fruits and vegetables from Poland to Ukraine, in tons

Specification	2017	2018	2019	2020	2021	2022	change 2022 to 2021 (in %)	2023
Cabbages. cauliflowers. kohlrabi. kale and similar edible brassicas. fresh or chilled	575.08	706.97	1,780.44	1,741.29	1,780.79	24,208.66	1359%	8,691.54
Cucumbers. fresh or chilled	28.25	90.46	908.79	317.95	107.42	2,262.38	2106%	1,927.67
Edible vegetables and certain roots and tubers	17,300.89	18,248.48	36,355.65	62,142.53	119,020.50	170,826.44	144%	96,084.13
Fresh apples	40,094.22	1,837.71	24,147.19	12,163.30	15,924.65	793.64	5%	5,983.33
Fresh or chilled aubergines "eggplants"	298.29	213.38	855.06	740.95	963.05	1,002.41	104%	1,285.66
Fresh or chilled cabbage	811.56	1,258.47	3,019.73	3,055.34	4,254.28	2,433.77	57%	4,557.07
Fresh or chilled carrots and turnips	1,964.68	938.58	339.21	94.12	57.85	26,032.86	45001%	14,691.89
Fresh or chilled cauliflowers and headed broccoli	317.22	324.51	1,423.45	1,575.52	1,560.19	1,747.59	112%	1,553.11
Fresh or chilled celeriac "rooted celery or German celery"	82.99	46.33	176.98	101.4	116.72	974.6	835%	1,540.66
Fresh or chilled sweet peppers	2,069.88	2,173.40	5,316.93	5,538.20	4,622.24	5,207.29	113%	4,973.63
Fresh or chilled vegetables n.e.s.	188.38	212.15	136.72	232.43	374.35	1,008.14	269%	554.63
Mixtures of vegetables. uncooked or cooked by steaming or by boiling in water. frozen	1,335.56	2,005.39	2,789.34	3,887.46	5,077.69	4,860.48	96%	4,892.58
Onions. shallots. garlic. leeks and other alliaceous vegetables. fresh or chilled	4,089.46	1,061.57	2,903.87	9,978.15	2,564.68	56,756.18	2213%	28,292.67
Tomatoes. fresh or chilled	877.82	939.42	5,878.11	12,764.61	4,687.09	22,202.17	474%	12,324.79
White and red cabbages. fresh or chilled	123.61	303.57	20.25	32.27	51.61	20,858.86	40416%	5,750.29

Source: Own study based on EUROSTAT data (read on 27/07/2024).

In the case of fruit and vegetable exports from Poland to Ukraine between 2017 and 2021, there were variable but generally upward trends (Table 4). It is worth emphasising particularly significant increases in some categories; for example, the export of edible vegetables and certain roots and tubers increased from 17,300.89 tonnes in 2017 to 119,020.50 tonnes in 2021. The export of fresh apples, one of Poland's key export commodities, was characterised by greater variability. After an impressive export level of 40,094.22 tonnes in 2017, there was a decrease to 1,837.71 tonnes in 2018. This may be the result of the low harvest of these fruits in Poland in 2017. From 2019 to 2021, apple exports did not reach the level of 2017, although some increases were recorded during 2019-2021.

The year 2022 was a turning point in the export of Polish agricultural products to Ukraine, with record increases in almost all analysed categories. Total exports of edible vegetables and roots and tubers increased to 170,826.44 tonnes, representing an increase of 43.6% compared to 2021. This is the highest export value in the analysed period. A similar situation occurred in the case of onion group exports, which increased from 2,564.68 tonnes in 2021 to 56,756.18 tonnes in 2022. Similarly dynamic increases were recorded in the case of carrots and turnips; exports increased from 57.85 tonnes in 2021 to 26,032.86 tonnes in 2022, indicating an urgent need for supplies of these products in the Ukrainian market. Comparable increases were also observed in other categories, such as cabbages (up from 51.61 tonnes to 20,858.86 tonnes) and tomatoes (up from 4,687.09 tonnes to 22,202.17 tonnes). The only category that did not record such dynamic growth was fresh apples, whose exports fell from 15,924.65 tonnes in 2021 to just 793.64 tonnes in 2022. The year 2023 brought some stabilisation and even declines in exports compared to the record year 2022. Total exports of edible vegetables and roots and tubers amounted to 96,084.13 tonnes, which represents a decrease of 43.8% compared to 2022. Nevertheless, the level of exports in 2023 remained higher than before 2022.

In summary, the analysed data indicates that 2022 was an exceptional year for the growth of Polish agricultural exports to Ukraine, likely in response to sudden changes in the supply of products related to the war crisis. However, the following year saw a stabilisation of the export level. Differences in the level of production and specialisation within the fruit and vegetable sector are also evident in the export of these products. Although apples play a significant role in exports for both countries, their importance is much greater in Poland. The year 2023 brought a decline in exports of selected fruits and vegetables from Poland to Ukraine.

Conclusion

The analyses carried out indicate that Poland and Ukraine have different directions of change in the fruit and vegetable sector. Specifically, Poland shows a tendency to reduce the area of crops, while Ukraine, despite some decreases, maintains a more stable production structure. On the other hand, when comparing the levels of fruit and vegetable harvests in both countries, Poland demonstrates greater dynamics of change in horticultural production, whereas Ukraine is characterised by more stable production.

The war in Ukraine has become, after the COVID-19 pandemic, another serious shock to the global economy. Despite the fact that the military operations are regional in nature, their multidimensional effects are global. As suggested by Franc-Dąbrowska and Drejerska (2022), considering the recent shocks in the agricultural products market – namely COVID-19, the war in Ukraine and rising inflation – one can expect a problematic situation in the food market in the near future, particularly concerning products for which Ukraine is a significant producer on the international stage.

The analyses carried out indicate significant variability in the import of selected fresh or frozen fruits and vegetables from Ukraine and exports from Poland. 2022 was exceptional in terms of changes in their levels, which were related to extraordinary geopolitical circumstances. It should be noted that in 2023, the pace of change slowed down. The most noticeable increase in imports in 2022 was recorded for frozen blackcurrants, where imports rose from only 22.1 tonnes in 2021 to 1,255.9 tonnes in 2022,

and frozen raspberries saw an increase of 28.8%. On the other hand, the import of fresh raspberries and fresh tomatoes decreased significantly. Analysis of data from subsequent years indicated that in 2023, the increase in the import of frozen raspberries continued, reaching 24,286.6 tonnes. However, compared to 2022, the growth rate was lower.

In the case of Polish agricultural exports to Ukraine, 2022 was characterised by significant increases in almost all analysed categories. Total exports of edible vegetables, roots and tubers increased by 43.6% compared to 2021. This was the highest export value in the analysed period. A similar situation occurred with onion exports, which increased from 2,564.68 tonnes in 2021 to 56,756.18 tonnes in 2022, and with carrots and turnips, which rose from 57.85 tonnes in 2021 to 26,032.86 tonnes in 2022.

The main limitations of this paper include the lack of access to up-to-date data from the Ukrainian State Statistical Office, limited representativeness of the results and a short time frame. In addition, the instability of markets caused by the war and unpredictable changes in trade policy may distort the conclusions drawn. To deepen the analysis in future research, it is worth focusing on the long-term impact of war on trade and changes in trade structure after the end of the conflict. An analysis of Polish-Ukrainian trade in selected fruits and vegetables in the context of the war in Ukraine may suggest that changes in production directions in both countries are necessary in the future. It is also worth noting the need for logistical support and infrastructure investments to minimise disruptions in supply chains under difficult conditions.

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For citation:

Sobczak-Malitka W., Sobczak E. (2024). Polish-Ukrainian Trade in Selected Fruits and Vegetables in the Face of the War in Ukraine. *Problems of World Agriculture*, 24(3), 54-65; DOI: 10.22630/PRS.2024.24.3.12

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