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## Vegetable production under the influence of food insecurity, environmental factors, and international integration processes

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**Abstract.** The significance of vegetable production is driven by the need of the population for vitamin products, processing enterprises for raw materials, especially in wartime, in the face of food and environmental hazards, and the need to increase export opportunities, considering international integration processes. The purpose of this study was to investigate the impact of war on the economic availability and environmental safety of food, to identify and assess the components and vectors of

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food and environmental safety management, and to evaluate and promote exports in the context of international economic integration. The study employed the methods of analysis and synthesis, generalisation and specification, mathematical and graphical methods. Sources of information: data from the Food and Agriculture Organization of the United Nations (FAO), the International Trade Centre (ITC), and the State Statistics Service of Ukraine. The study analysed the current state of vegetable production, identified the key problems under the influence of food hazards, environmental factors, and integration processes. The study examined the impact of the war on the economic availability and environmental safety of food, estimated the volume of deficit in vegetable production, identified the principal economic and environmental problems and areas for improving the efficiency of the industry in the future. The volume of the deficit in vegetable production was found and the size of the lost sowing areas was determined; the reasons for the unsatisfactory state of vegetable production were identified. It was established that in recent years the country has experienced a temporary famine, which is unacceptable in the European space. It was found that, to minimise the agri-food crisis and environmental threats, it is necessary to focus on the implementation of the proposed measures to support production efficiency, the implementation of which will allow solving the issues of independence and food security of territorial communities, especially in times of war, and improve the functionality of governing bodies, economic entities, investors, scientists, and producers based on sustainable development. The practicality of the study findings is confirmed by the effectiveness of the developed proposals that can be used in the implementation of measures to increase vegetable production and exports

**Keywords:** food; ecology; vegetable growing; production; consumption; innovative development; export; international economic integration

## INTRODUCTION

Ukraine is among the leaders in global food security matters. Considering that the world's population is constantly growing, with projections suggesting that it will increase to 10 billion people in 2050, the number of hungry people could increase noticeably. According to N. Palapa *et al.* (2022), Ukraine can provide food for about ½ billion people. According to FAO (2023), the number of hungry people in the world has reached 811 million. The war in Ukraine is exacerbating food issues not only within the country, but also on foreign markets, the African continent and the Middle East. It was found that, despite their relatively low energy value, vegetables have valuable phytonutrients that serve as an essential source of antioxidants that neutralise the effects of reactive oxygen species and products of their interaction with organic molecules and nitrogen oxides (Recommendations for a healthy diet for adults, 2017). However, to this day, Ukraine still has an extremely insufficient range and variety of high-vitamin products. Furthermore, as a result of the hostilities, there is a shortage of vegetable and melon products, which affects the country's food and environmental security, and the food problem needs to be addressed with due regard to the possibilities of domestic production.

The participation of countries in integration processes plays a special role in the economic development of countries, their trade, production, and food security. Thus, the EU Treaty of Rome states that the objectives of the Common Agricultural Policy are to increase the productivity of the agricultural sector; stabilise markets; ensure the availability of supplies; guarantee that supplies reach consumers at reasonable prices, etc.

O. Mogylna *et al.* (2018), N. Kalyuzhna and L. Kudyko (2023) note that trade integration stays a relevant form of cooperation between countries and

a driver of their innovative and technological development, despite the intensifying trend of neo-protectionism and the aggravation of imbalances in national economies. Notably, the food security strategy should consider the forecast of supply and demand for food and agricultural raw materials, while their forecasting is based on the annual formation of the supply and demand balance, including changes in stocks, domestic production, internal consumption, exports, and imports. Therefore, international economic integration plays a special role in the development of trade and food security, especially in the current environment.

Many researchers are interested in food supply issues. However, modern reality and new environmental threats require systematisation and further research to reduce food threats, especially in the context of military, anthropogenic, and climate challenges. Moreover, during the occupation of the south of Ukraine, a considerable territory suitable for intensive vegetable production has been lost, equipment, logistics facilities, warehouses were looted, entire workshops of vegetable processing plants (PJSC Chumak) were taken out, crops were flooded, and unique environmental sites were destroyed (Mudrak, 2022; Blahopoluchna, 2022). As a result, the enterprises for shock freezing of berries, vegetables, and fruits located in the adjacent Ukrainian territories lack raw materials to fully utilise them (Sobkevich *et al.*, 2023).

The problem of food security, according to V. Boyko and L. Boyko (2021), lies in the plane of almost all institutional aspects of the state: political, economic, and social, and requires the acquisition of skills in dealing with emergencies, rapid response to environmental hazards, considering the prospects for the long-term development and functioning of communities where

over 8 million people living in their territories are currently internally displaced.

The established market institutions already need to be adjusted in the current environment. Thus, 13 concepts of regional and national state targeted programmes for the development of the vegetable industry created in 2010-2022 were not funded. However, at the same time, as a result of the performance of the main forecast indicators of these programmes, the normative consumption would be ensured not only within the internal agricultural market, but also the country's export level would be reached (Khareba & Rybak, 2018). Considering this, N. Markovych (2019) notes that vegetables and their processed products represent a considerable foreign economic reserve for increasing revenues and diversifying Ukraine's agricultural exports. As the global demand for vegetables is quite high and the culture of healthy eating encourages the population of many countries to increase their consumption of fresh or processed vegetables, Ukrainian agribusiness has a considerable potential to increase its exports. Therewith, it is worth considering the removal of trade barriers in trade with countries with which regional trade agreements (RTAs) have been concluded, which should help to increase exports and, accordingly, vegetable production.

The development of foreign trade is of particular significance for increasing production volumes, which is facilitated by the development of integration processes. B. Matkovski *et al.* (2022) emphasise the need to revise trade agreements with the EU and the Free Trade Agreement. Trade intensification and a partial change in the regional and commodity structure of trade occurred in all Western Balkan countries. It is proposed as a prerequisite that all countries try to secure the best possible position for agri-food products during pre-accession negotiations with the EU. However, according to the study, most Western Balkan countries have comparative advantages in exporting agri-food products. This is also worth considering for Ukraine, which also has regional trade agreements with the EU, as well as Canada, Turkey, the UK, and other countries.

Considering the above, the purpose of this study was to assess internal production and foreign trade in vegetables in Ukraine and the world, identify the principal economic and environmental problems and areas for improving the efficiency of the industry in the future in the context of the impact of environmental factors and integration processes.

## MATERIALS AND METHODS

The study was conducted using methodological approaches that reveal the theoretical and practical content of the research object. To accomplish this task, conventional methods of economic analysis (methods of scientific intuition, abstract logical, and graphical methods), analysis (comparison, grouping), and generally accepted methods (mathematical and statistical, calculation and design, balance sheet, etc.) were used.

The methods of analysis and synthesis were employed to investigate foreign trade in vegetables; economic and statistical – to analyse the world vegetable market; abstract and logical – to form conclusions; graphical – to display trends in foreign trade; and the method of generalisation – to formulate proposals. The study investigated the change in the geographical structure of Ukraine's vegetable exports over 20 years (from 2004 to 2023), considering the development of international economic integration, identified the largest trading partners in the world market, considering their share in world exports and imports and the level of economic development. To expand the analysis, the period from 2004 to 2023 was used, considering changes at the global level and those specific to Ukraine.

The application of the methods of comparison, grouping, and index method helped to assess the normative and factual consumption indicators and analyse the degree of coverage of annual consumption norms for various food products in Ukraine in different periods. This made it possible to analyse pre-war and current levels of production of major crops, compare indicators, determine the degree of change, discuss the main reasons for these deviations, analyse possible consequences for the industries, identify reserves for increasing the competitiveness of enterprises in the vegetable market, and propose possible scenarios for replacing regional production of certain types of vegetable crops in Ukraine by 2025. The method of classification and grouping of the collected data helped to systematise the structure of vegetable seed producers in Ukraine, to determine the share of Ukrainian varieties and hybrids of vegetable and melon plants in the State Register as of 1 January 2024 (State register of plant varieties suitable for distribution in Ukraine, 2024).

The statistical methods allowed for the systematisation, processing, and further monitoring of numerical data to analyse the price situation in the agricultural market, to establish the regional variation in prices of agricultural enterprises in Ukraine and the relationship between them using coefficients of variation and correlation coefficients of prices in 2000 with prices in 2024. The method helped to structure the price situation in the agricultural market by product type and substantiate the need for government intervention in the vegetable sector to create equally competitive conditions for the distribution of income among all participants in the producer-processor-consumer and distribution infrastructure.

Using the questionnaire survey method, the study managed to collect data on 51 district markets in Ukraine, determine the structure of retail average prices for vegetable products in 2024, and calculate the cost of a "borshch set". Subsequently, by establishing a correlation based on the price comparison method and the normative cost limits "price formed based on supply and demand" and "minimum price", the study substantiated the amount of lost income that would allow the

producer to secure the economic interest necessary for expanded reproduction.

The sources of information included statistical data of the Food and Agriculture Organisation of the United Nations (FAO, 2023) and the International Trade Centre (ITC, 2023), regulatory and legislative acts of Ukraine related to the agro-industrial complex (Law of Ukraine No. 2145-IX, 2022; Law of Ukraine No. 3116-XII, 1993); data of the State Statistics Service of Ukraine (n.d.), Ministry of Agrarian Policy and Food of Ukraine (n.d.).

## RESULTS

The vegetable industry is a complex system of institutions, methods, and resources, including commodity production, seed production, processing, logistics, trade, and other essential components, which plays a significant role at the global and national level and has been

developing dynamically, especially in the last 30 years. In the early 1990s, the world produced 88 kg per capita, while in 2022 – 235 kg. China produced the most vegetables per capita (over 400 kg), followed by Greece (296 kg) and Spain (273 kg).

Today, global production is 903.4 mn t. Leaders: China (451.6 mn t), India (77.2 mn t), the United States (38.9 mn t), Italy (13.6 mn t), Spain (12.7 mn t), Ukraine (9.4 mn t), and France (5.7 mn t) (FAO, 2023). According to the ITC (2023), Ukraine exported vegetables to almost 90 countries in 2023, while in 2004 it exported to less than 50 countries, which suggests a geographical diversification of exports. In 2023, Ukraine exported 72.1% of its top 10 importers, while in 2004 it exported 86.2% (Table 1). Notably, during the period under study, exports increased by 3.4 times, which means that geographical diversification of exports contributes to its growth.

**Table 1.** Share of Ukraine's vegetable exports to its largest importers in 2004-2023, %

No. seq.	2004		No. seq.	2023	
	Importer	Share, %		Importer	Share, %
1	Hungary	26.0	1	Turkey	18.2
2	India	15.1	2	Poland	10.6
3	Spain	14.3	3	Italy	9.9
4	Italy	7.2	4	Moldova	7.9
5	Belarus	5.5	5	Malaysia	7.4
6	Pakistan	5.4	6	Bangladesh	6.4
7	Poland	3.8	7	Germany	4.4
8	Russia	3.2	8	Pakistan	2.6
9	Lithuania	3.1	9	United Kingdom	2.5
10	Germany	2.6	10	Sri Lanka	2.3

**Source:** calculated based on ITC data (2023)

Another noteworthy fact is that in 2023, exports to Asian markets grew: while in 2003, only India, Pakistan, and Russia were among the largest importers, in 2023, Turkey, Malaysia, Bangladesh, Pakistan, and Sri Lanka were among the largest importers, and the share of exports to the latter countries was 36.8%. In 2004, the situation was analogous among the country's largest importers, except for India and Pakistan, with which regional trade agreements were concluded before and afterwards, and in 2022, except for Malaysia, Bangladesh, Pakistan, and Sri Lanka, as presented in Table 1 (ITC, 2023).

This suggests that the development of foreign trade contributes to integration, and the latter contributes to the former, specifically through the removal of trade barriers. Therewith, one should consider the harmonisation of product quality standards, improve-

ment of product quality, country demand, and a series of other factors. As for the world's largest exporters and importers of vegetables, they are mainly developed countries (Table 2), and often they are included in both groups. These are, for instance, the USA, Canada, Italy, and France. China, Japan, and the US are not among Ukraine's largest importers, which is worth paying attention to, considering the feasibility of increasing vegetable exports, the size, and solvency of the population of these countries. Furthermore, Ukraine has regional trade agreements with Canada and the EU, which are the world's largest importers of vegetables, and Canada is a member of one of the most developed integration groups, the North American Free Trade Agreement, which may help to increase exports of Ukrainian products to this continent.

**Table 2.** The share of major exporters, importers, and Ukraine in the global vegetable market in 2022, %

No. seq.	Largest exporters	Share in global exports, %	No. seq.	Largest importers	Share in global imports, %
1	China	12.2	1	USA	17.0
2	Mexico	10.9	2	Germany	8.8
3	Netherlands	9.9	3	United Kingdom	5.0

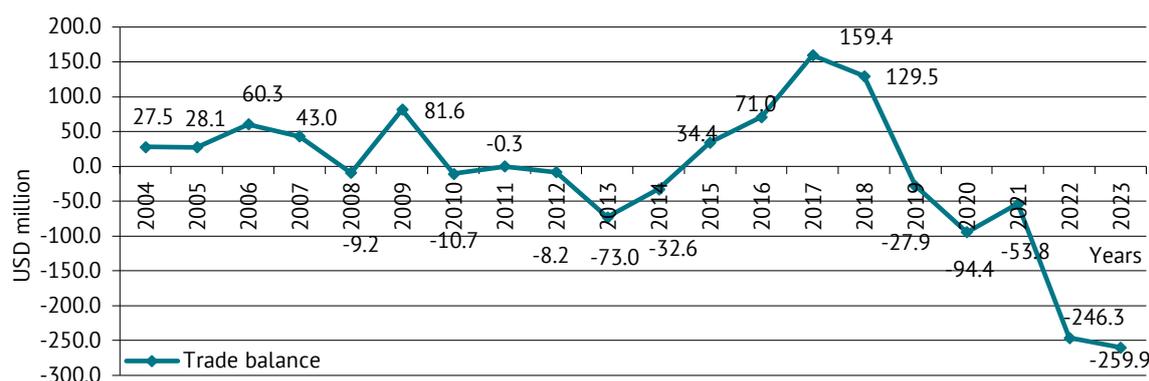
Table 2. Continued

No. seq.	Largest exporters	Share in global exports, %	No. seq.	Largest importers	Share in global imports, %
4	Spain	9.8	4	France	4.6
5	Canada	7.4	5	China	4.5
6	USA	6.1	6	Canada	4.3
7	France	3.4	7	Netherlands	3.5
8	Belgium	3.1	8	Japan	3.0
9	Turkey	2.5	9	Italy	2.8
10	Italy	2.4	10	Belgium	2.8
11	Ukraine	0.1	11	Ukraine	0.4

**Source:** calculated based on ITC data (2023)

According to FAO (2023), the largest vegetable producers are China, India, and the United States, accounting for 52.5%, 12.4%, and 2.3% of global production, respectively. Ukraine's share was only 0.9%, ranking 20<sup>th</sup> among producers and behind such countries as Nigeria, Uzbekistan, and Japan. Considering the natural and cli-

matic conditions and resource endowment, it is advisable to promote the production and export of vegetables in Ukraine. Notably, Ukraine's trade balance in vegetables has been active and passive, but in recent years the periods of negative balance have become longer, and the value of the indicator has increased (Fig. 1).



**Figure 1.** Ukraine's trade balance in vegetables for 2004-2023

**Source:** calculated based on ITC data (2023)

As for the countries of Ukraine's largest importers with which regional trade agreements have been concluded, according to ITC (2023), since 2004, the trade balance with Turkey was positive only in 2005 and 2017, with Poland – in 2004, 2006, 2016-2018, and with Italy – constantly, except for 2013, 2015-2016, 2018, 2022, and 2023. Generally, the values of the indicator in trade with major importers were both positive and negative, but the trade balance has been consistently positive since 2004 in trade with Pakistan, the United Kingdom, and since 2015 – Malaysia, Bangladesh, Sri Lanka, the United Arab Emirates, and Hungary. This suggests the presence and prospects of Ukraine's exports to the EU and Asian markets, the need to increase vegetable production, and the need to effectively use the free trade agreements concluded.

In terms of the commodity structure of Ukraine's vegetable exports, the largest exports were in 2023 (ITC, 2023). Dried leguminous vegetables, shelled,

whether or not skinned or split (0713); Vegetables, uncooked or cooked by steaming or boiling in water, frozen (0710); Potatoes, fresh or chilled (0701); Other vegetables, fresh or chilled (excl. potatoes, tomatoes, alliaceous vegetables, edible brassicas [...], and leguminous vegetables) (0709). The largest imports are Tomatoes, fresh or chilled (0702); Onions, shallots, garlic, leeks and other bulbous vegetables, fresh or chilled (0703); Other vegetables, fresh or chilled (excl. potatoes, tomatoes, alliaceous vegetables, edible brassicas [...], and leguminous vegetables) (0709); Cucumbers and gherkins, fresh or chilled (0707), etc. In other words, Ukraine largely imports vegetables that it may well grow itself, although in this case, the seasonality of production must be considered, and therefore the focus should be on increasing internal production rather than reducing imports. It is worth considering which types of vegetables are most traded in Ukraine (Table 3).

**Table 3.** Share of certain types of vegetables exported and imported by Ukraine, 2023

Vegetables with the largest share in Ukraine's exports, %			Vegetables with the largest share in Ukraine's imports, %		
Code	name	%	Code	name	%
0713	Dried leguminous vegetables, shelled, whether or not skinned or split	75.8	0702	Tomatoes, fresh or chilled	31.3
0710	Vegetables, uncooked or cooked by steaming or boiling in water, frozen	8.6	0703	Onions, shallots, garlic, leeks and other alliaceous vegetables, fresh or chilled	16.9
0701	Potatoes, fresh or chilled	5.1	0709	Other vegetables, fresh or chilled (excl. potatoes, tomatoes, alliaceous vegetables, edible brassicas, lettuce "Lactuca sativa" and chicory "Cichorium spp.", carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots, cucumbers and gherkins, and leguminous vegetables)	15.2
0709	Other vegetables, fresh or chilled (excl. potatoes, tomatoes, alliaceous vegetables, edible brassicas, lettuce "Lactuca sativa" and chicory "Cichorium spp.", carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots, cucumbers and gherkins, and leguminous vegetables)	4.4	0707	Cucumbers and gherkins, fresh or chilled	9.1
0707	Cucumbers and gherkins, fresh or chilled	2.2	0704	Cabbages, cauliflowers, kohlrabi, kale and similar edible brassicas, fresh or chilled	7.9
	Other	3.9		Other	19.6

**Source:** calculated based on ITC data (2023)

Since vegetables are imported, which have all the conditions for growing in Ukraine, it is advisable to increase their production independently. We believe that the development of exports should help increase vegetable production in Ukraine. To increase exports, it is necessary to focus on the country's natural and climatic conditions, land availability, population, export prospects, considering the presence of importers of products where products are already exported, and regional trade agreements. It is worth considering that not only tariff, but also non-tariff barriers block trade, and therefore it is advisable to promote product quality and harmonise Ukrainian quality standards with European ones, which will allow Ukraine to expand its position not only in the EU market but also in other developed countries.

Considering the development of integration processes, it is worth emphasising that the EU-Ukraine Association Agreement addresses the issue of geographical indications, including recognised ones, supplementing them with new ones, the scope of their protection, the right to use, etc. It is also worth mentioning the regional trade agreements concluded by Ukraine and their impact on the development of foreign trade and, accordingly, production of products, including vegetables. Therewith, one of the key tasks is to meet internal demand with high-quality products. The analysis of the consumption balances of basic foodstuffs helped to identify three groups of products by the degree of availability: sufficient, low, and critical. The first group with sufficient consumption, provided that the consumption index is greater than 1, includes potatoes, vegetables, and bread (Table 4).

**Table 4.** Coverage of annual consumption norms for various food products in Ukraine, 2022, kg/person

Indicators	Group I (sufficient)					Group II (low)				Group III (critical)
	Potatoes	Vegetables	Bread and bread products	Oil	Eggs, pcs.	Sugar	Meat and meat products	Milk and dairy products	Fruits and berries	Fish and fish products
	Standard, kg/person									
Minimum	96	105	94	8	231	32	52	341	68	12
Rational	124	161	101	13	290	38	80	380	90	20
	Consumed, kg/person									
Factually, kg/person	144	163	101	12.4	265	33	51	211	48	9.7
	Ratio index: consumed/norm									
to the minimum standard	1.50	1.55	1.07	1.55	1.15	1.03	0.98	0.62	0.71	0.81
to the rational standard	1.16	1.01	1.00	0.95	0.91	0.87	0.64	0.55	0.53	0.49

**Source:** calculated by the authors of this study based on data from the State Statistics Service of Ukraine (2023)

If one analyses the state of the crop production sector during the military operations, according to 2022, almost 26% of the sunflower market was lost, 28.3% of the grain and legume market, and about 6% of the fruit and berry market. In 2022, 7.5 million tonnes of vegetables were produced. The deficit was 24.4%, or 2.4 mn t (Table 5). However, overall, if one analyses the pre-war period, i.e., compares 2021 with 2000, the vegetable market developed quite dynamically. Thus, even though the area under crops decreased by 16% during this period, due to a 1.9-fold increase in yields from 11.2 t/ha in 2000 to 21.4 t/ha in 2021, i.e., by 10.2 t/ha, gross vegetable harvest increased by 1.7 times and amounted to 9.7 mn t. In 2022, compared to 2021, production decreased by 2.4 mn t, and 85.9 thsd ha, or 18.6%, were lost. In 2023, it became possible to stabilise the situation and even increase

gross vegetable production by 785.1 thsd t, or 10.5%. The sown area in 2023 increased by 21.8 thsd ha, or 5.8%. Private households played a key, stabilising role in these processes.

The retail sector is the main supplier of vegetables to Ukrainian markets and will continue to supply local markets. However, the negative aspects of their activities include a low level of mechanisation of production processes, high labour costs, low marketability, and the inability to form the required volumes of batches of products for wholesale. During the war period, in 2022, the share of households increased to 94.1%, while the share of melons increased to 97.6%. In 2023, the share of large-scale agricultural enterprises increased to 11.5%. Thus, private households will continue to supply local markets and play a leading role in providing the population with vegetables.

**Table 5.** Gross harvest, sown areas, and yields of major crops, 2000-2023

Crops	Years				2021/2000		2022/2021		2023/2022	
	2000	2021	2022	2023	(+, -)	%	(+, -)	%	(+, -)	%
Gross harvest, thsd t										
Outdoor vegetables in the open field	5,821	9,935	7,512	8,297.1	4,114	170.7	-2,423	75.6	785.1	110.5
Sunflower	3,457	15,254	11,329	12,759	11,797	441.2	-3,925	74.3	1,430	112.6
Cereal and leguminous crops	24,459	75,143	53,864	59,772	50,684	307.2	-21,279	71.7	5,908	111.0
Fruits and berries	1,453	2,119	1,995	1,996	666	145.8	-124	94.1	1	100.1
Factory sugar beet	13,199	10,205	9,942	13,129	-2,994	77.3	-263	97.4	3,187	132.1
Potatoes	19,838	20,269	20,899	21,359	431	102.2	630	103.1	460	102.2
Sown area, thsd ha										
Outdoor vegetables in the open field	541	460.8	374.9	396.7	-80.2	85.2	-85.9	81.4	21.8	105.8
Sunflower	2,943	5,928	5,238	5,202	2,985	201.4	-690	88.4	-36	99.3
Cereal and leguminous crops	13,646	15,318	11,773	10,836	1,672	112.3	-3,545	76.9	-937	92.0
Fruits and berries	425	225	171	167	-200	52.9	-54	76.0	-4	97.7
Factory sugar beet	856	222	184	250	-634	25.9	-38	82.9	66	135.9
Potatoes	1,629	1,309	1,204	1,210	-320	80.4	-105	92.0	6	100.5
Yield, t/ha										
Outdoor vegetables in the open field	11.2	20	21.5	20.9	8.8	178.6	1.5	107.5	-0.6	97.2
Sunflower	1.22	2.56	2.16	2.45	1.34	209.8	-0.4	84.4	0.29	113.4
Cereal and leguminous crops	1.94	4.91	4.58	5.5	2.97	253.1	-0.33	93.3	0.92	120.1
Fruits and berries	3.84	10.8	11.6	11.9	6.96	281.3	0.8	107.4	0.3	102.6
Factory sugar beet	17.7	46.1	54.1	52.5	28.4	260.5	8	117.4	-1.6	97.0
Potatoes	12.2	15.5	17.4	17.7	3.3	127.0	1.9	112.3	0.3	101.7

**Source:** calculated by the authors of this study based on data from the State Statistics Service of Ukraine (2024)

The significance of full-scale agricultural production is growing, especially in the context of military operations, anthropogenic disasters, and the climate crisis. The situation is acutely complicated by the explosion of the Kakhovka HPP, which has adverse consequences primarily for internal and external consumers. In 2022, the company produced 272.3 thsd t of melons, which is 230.8 thsd t less than in the previous year (in 2021 –

503.1 thsd t). Analysing the pre-war production of melons in Ukraine, the southern region of the country was the leader, with a share of over 50% in total production. Kherson Oblast was the largest producer with 168 thousand tonnes, accounting for almost 70% of production in the south and 33% of the total. Next were Poltava and Zaporizhzhia Oblasts with 48.1 thsd t and 27.5 thsd t, respectively. Next, Dnipro Oblast produced

37 thsd t, followed by Mykolaiv and Odesa Oblasts with 31.4 thsd t and 26 thsd t, respectively. In 2022, the leaders were Poltava (46.4 thsd t), Dnipro (35.1 thsd t), Vinnytsia (29.5 thsd t), Odesa (22.6 thsd t), and Kirovohrad (20.7 thsd t) Oblasts.

In 2023, a more significant decline in vegetable production was explained by the regional affiliation with the

oblasts where hostilities are ongoing. However, the overall decline in production was partially mitigated by the reorientation of farmers who switched to vegetable production in the face of a shortage in the internal market. As for the possibilities of regional substitution of the deficit supply of 2 mn t, Table 6 shows the forecasted production of vegetables by type.

**Table 6.** Forecast of regional substitution of vegetable production in Ukraine for 2025

Consumer oblast	Supply deficit, thsd t	Factually sown, thsd ha		Factual yield, t/ha		Additional sowing required, thsd ha 2022	Forecast for 2025		
		2022	2023	2022	2023		Supplier oblast 2023	Probable supply volumes, thsd t	Economic effect of the event, UAH mn,
<i>Cabbage</i>									
Kherson, Kharkiv, Donetsk, Zaporizhzhia, Luhansk	-1,698.5	60.1	61.8	22.0	26.2	8.3-9.0	Vinnytsia, Khmelnytskyi, Ternopil, Volyn Rivne, Zakarpattia, Chernihiv, Odesa, Poltava, etc.	1,904.4	294.9
<i>Carrot</i>									
Kherson, Kharkiv, Donetsk, Zaporizhzhia, Luhansk	-1,149.2	38.2	39.6	18.0	18.4	5.2-5.5	Volyn, Poltava, Khmelnytskyi, Rivne, Odesa, Chernihiv, etc.	1,154.9	203.9
<i>Beetroot</i>									
Kherson, Kharkiv, Donetsk, Zaporizhzhia, Luhansk	-864.9	34.8	35.6	19.0	20.3	4.8-5.5	Zakarpattia, Chernihiv, Lviv, Sumy, Poltava, Khmelnytskyi, Cherkasy, Volyn, Ternopil, etc.	1,074.7	187.3
<i>Onions</i>									
Kherson, Kharkiv, Donetsk, Zaporizhzhia, Luhansk	-2,145.9	44.2	45.3	15.0	23.6	11.4-12.5	Kirovohrad, Cherkasy, Sumy, Poltava, Odesa, Dnipro, etc.	2,149.9	388.6
<i>Tomato, pepper, aubergine</i>									
Kherson, Kharkiv, Donetsk, Zaporizhzhia, Luhansk,	-12,906.0	51.5	52.4	35.0	45.4	25.8-26.5	Dnipro, Odesa, Mykolaiv, Kirovohrad, Cherkasy	12,587.0	947.1
<i>Gourds and melons</i>									
Kherson, Kharkiv, Donetsk, Zaporizhzhia, Luhansk,	-2,308.2	33.9	34.6	8.1	10.1	25.0-30.0	Dnipro, Mykolaiv, Vinnytsia, Odesa, Kirovohrad, Poltava	2,340.5	256.5
Total	-21,072.7	262.7	269.3	–	–	80.5-89.0	–	21,211.4	2,278.3

**Source:** calculated by the authors of this study based on data from the State Statistics Service of Ukraine (2024)

Thus, by 2025, it is planned to increase the area under cultivation:

- vegetables (borshch set), less common and green vegetables in Vinnytsia, Khmelnytskyi, Ternopil, Volyn, Rivne, Zakarpattia, Chernihiv, Odesa, Poltava, and other oblasts to 37-40 thsd ha (including cabbage – 8.28-9.0 thsd ha, carrots – 5.2-9.5 thsd ha, red beetroot – 4.8-5.5 thsd ha, onions – 11.4-12.5 thsd ha);

- warm-weather crops (peppers, aubergines, tomatoes, watermelons, melons) in Dnipro, Odesa, Mykolaiv, Kirovohrad, Cherkasy oblasts to 25.0-26.5 thsd ha.

Under severe stressful conditions, it is important to provide the country's population with the necessary amount of products with a high content of biologically active substances, vitamins, and microelements with a minimum level of contamination. This task can be most

effectively achieved through the introduction of organic and energy-saving technologies for growing vegetable and melon crops, which are aimed at preserving the environment. The introduction of adaptive technologies

for growing vegetable plants with biological crop rotations provides considerable resource savings, increased profitability of vegetable production (by 24%), and organic quality products (Table 7).

**Table 7.** Comparison of costs of cultivation under intensive (standard) and adaptive systems in terms of UAH thsd per crop rotation

Expenditure item	Crop rotation		Biologised to intensive, (+/-), %
	Intensive	Biologised	
Salary with accruals	46,720	51,870	+ 10
Fuels and lubricants	9,220	8,610	-7
Mineral and organic fertilisers	19,370	8,580	-126
Agrochemicals (plant protection products)	5,120	960	-433
Depreciation and amortisation expenses	13,580	10,810	-26
Repairs of fixed assets	9,050	7,210	-26
Expenses, total	162,050	136,990	-18
Profit	196,400	219,050	+10
Profitability level, %	115	151	+24

**Source:** calculated by the authors of this study based on data from O. Vitanov et al. (2022)

The key aspect of such technologies is the introduction of varieties and hybrids with high adaptive potential for cultivation in various agroclimatic zones; adapted to the requirements of alternative and organic cultivation technologies; with high compliance with technological regulations for processing and long-term storage; with a high content of biologically valuable components and high therapeutic and prophylactic properties; immune to major pathogens; genetically aligned, with a friendly yield, high marketable quality of vegetable products.

The existing network of research stations at the Institute of Vegetable and Melon fully covers the full range of soil and climatic conditions, which allows not only to create competitive varieties and hybrids for a particular zone, but also to establish highly efficient seed production. Breeding, production, and marketing need to be integrated into a single complex, with the mandatory introduction of a system of certification, licensing of seed production and sales, which will ensure quality assurance at all stages of its passage.

The internal market of vegetable seeds is represented by virtually all well-known international companies, as well as a series of Ukrainian producers; according to the conclusions of the Agricultural Marketing Project experts, approximately 60% of the vegetable seed market is controlled by the top 20 foreign companies, the remaining 40% of the seed market is represented by Ukrainian agricultural enterprises that have a passport for growing and selling seeds (22%) and illegal producers of vegetable seeds (18%).

According to analytical studies, the capacity of the imported seed market in Ukraine today is about

EUR 16 mn, while the total vegetable seed market in Ukraine today reaches EUR 25 mn (Rud et al., 2023). In recent years, Ukraine's seed industry has been in near decline. The propagation of seeds of low reproductions continues with insufficient varietal control and violations of agricultural practices, processing, cleaning, and storage of vegetable seeds. An entire series of seed farms do not have permission to grow and sell seeds. Often, seed production is carried out by farms that have not been certified and have no idea about the specifics of this industry. As a result, the Ukrainian market receives seeds with low sowing qualities and low reproductions.

Despite the general trend of decline in Ukrainian seed production, the achievements of scientists at the Institute of Vegetable and Melon of the National Academy of Agrarian Sciences of Ukraine have created a sufficient number of cultivars of vegetable and melon crops that can meet the most demanding consumer needs, but the demand for selection achievements is determined not only by the recommendation of new cultivars and heterotic  $F_1$  hybrids, but also by the availability of sufficient high-quality seeds. Therefore, the creation of new varieties and hybrids should be accompanied by their rapid reproduction and active introduction into production.

In Ukraine, selection work is carried out with 59 vegetable, melon, and 43 rare plants. Every year, the Institute of Vegetable and Melon Growing of the National Academy of Agrarian Sciences of Ukraine, its network, and coordinated institutions submit an average of 23-25 cultivars and hybrids to the State Service for Plant Variety Rights Protection (Protection documents for plant varieties, n.d.) (Table 8).

**Table 8.** The number of cultivars and hybrids of vegetable and melon plants transferred to the State Service for Plant Variety Rights Protection in 2000-2023

Originating institution	2000	2020	2021	2022	2023	Total
Institute of Vegetable and Melon of NAAS	6	14	6	10	8	44
Dnipro RS	0	2	0	2	6	10
Donetsk RS	0	7	0	0	2	9
Kyiv RS	4	6	3	3	4	20
RS Maiak	6	2	4	0	2	14
Coordinated agencies	7	9	3	7	10	36
Total	23	40	16	22	32	133

**Source:** calculated based on data from the State register of plant varieties suitable for distribution in Ukraine (2024)

As of 1 January 2024, 321 cultivars and hybrids developed by the Institute, research stations, and coordinated institutions are in the State Register suitable for distribution in Ukraine (Table 9).

**Table 9.** The number of cultivars and hybrids of vegetable and melon plants in the State Register suitable for distribution in Ukraine as of 1 January 2024

Originating institution	Variety	Hybrid	Total
Institute of Vegetable and Melon of the NAAS of Ukraine	104	14	118
Dnipro RS	43	3	46
RS Maiak	63	2	65
Institute of Horticulture of the NAAS	19	7	26
Institute of Climate-Smart Agriculture of the NAAS	49	2	51
Zakarpattia State Agricultural Research Station of NAAS	12	–	12
Cherkasy State Agricultural Research Station of the National Research Centre Institute of Agriculture of NAAS	3	–	–
Total	293	28	321

**Source:** calculated based on data from the State register of plant varieties suitable for distribution in Ukraine (2024)

In recent years, a decline in vegetable seed production has been observed in Ukraine. This decline was primarily conditioned by the collapse of the seed production system, fierce competition from foreign firms, high material costs of seed production, the difficult political

situation related to the military operations, and other factors. In total, the Register contains 1,581 cultivars and hybrids of vegetable, melon, and rare plants, of which 1,261 are vegetable cultivars. Out of the total number of varieties and hybrids, only 53% are Ukrainian (Fig. 2).

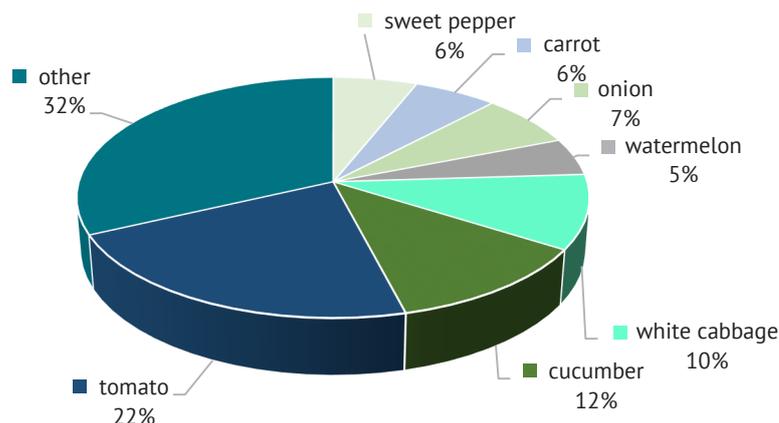


**Figure 2.** Share of Ukrainian and foreign cultivars/hybrids in the Register of Plant Varieties of Ukraine (2023), %

**Source:** calculated based on data from the State register of plant varieties suitable for distribution in Ukraine (2024)

The wide range of the 7 plant species (68% of the total) is conditioned by both their wide consumption and rich genetic diversity, which provides a diverse range of cultivars and hybrids with a series of economically valuable and morphological and biological traits. Thus, a tomato has over 20 shades of fruit colour alone,

each of which deserves attention. According to statistics, today the varieties and hybrids of Ukrainian breeding occupy only about 45% of the sown area. In the species composition, the largest percentage is occupied by cultivars and hybrids – tomato (22%), cucumber (12%), white cabbage (10%), and onion (7%) (Fig. 3).



**Figure 3.** The structure of the most common plant species in the Register of Plant Varieties of Ukraine (2023), %  
**Source:** calculated based on data from the State register of plant varieties suitable for distribution in Ukraine (2024)

The Institute of Vegetable and Melon of the NAAS and its network are engaged in the cultivation of seeds of higher reproductions and can provide the full volume of seeds needed for Ukraine (Table 10).

**Table 10.** The need for original, elite, and reproductive seeds of main vegetable plants for all categories of farms in Ukraine

Crop	Commercial crop area, thsd ha	Seeding rate, kg/ha	Need for seeds		
			Certified, t	Baseline, t	Prebaseline, kg
White cabbage	29	1/0.3*	29.0/9.6	0.25/0.08	3/1
Tomato	38	1/0.3*	38.0/11.4	0.6/0.2	10/3
Cucumber	21	4	84	1.6	140
Carrot	15	3	45	1.1	15
Red beetroot	14	10	14	1.0	20
Onion	20	7	140	1.3	50
Radish	7	20	140	5.5	250
Sweet pepper	2.4	1	2.4	0.02	2
Aubergine	2.4	1	2.4	0.02	2
Zucchini	10	4	40	0.7	20
Watermelon	22	3	66	0.8	60
Melon	5.4	4	21.6	1.2	80
TOTAL	186.2	-	622.4	14.1	672

**Note:** \* in the numerator – seed consumption for direct sowing method; in the denominator – seedling method

**Source:** calculated based on data from the State register of plant varieties suitable for distribution in Ukraine (2024)

However, to meet the need for such a large quantity of original and elite seeds, it is necessary to have a clear order from certified seed producers (Table 11).

**Table 11.** Production of baseline and certified seeds at the Institute of Vegetable and Melon of NAAS of Ukraine and at research stations in 2023

Crops	Production volumes, kg	
	Baseline	Certified
White cabbage	23.9	141
Onion	40	278
Carrot	17	227
Red beetroot	112	468
Tomato	7.6	91.5
Other nightshade crops	2.5	18.9

Table 11. Continued

Crops	Production volumes, kg	
	Baseline	Certified
Cucumber	18.1	966
Watermelon	100	224
Other melons and gourds	10	1375
Other types of vegetable plants	360.4	46
	691.5	3835.4

**Source:** calculated according to data from the State Statistics Service of Ukraine (2024)

Only certified seeds were produced to cover an area of 5.7-7.6 thsd ha. The Institute's scientists are actively transitioning to heterotic breeding, specifically, the percentage of hybrids created, and hybrid seeds of pumpkin crops (cucumber, watermelon, melon) grown has increased significantly. Currently, the State Register of Plant Varieties contains 18 hybrids of internally sourced selection (24 together with research stations) (State register of plant varieties suitable for distribution in Ukraine, 2024). The production of hybrid seeds was substantially increased. In 2023, over 600 kg of hybrid cucumber seeds were produced, which will allow sowing over 1,500 ha of land and producing about 70,000 t

of marketable products to ensure food security. A selection base was also developed for creating hybrids of nightshade crops (tomato, sweet pepper, aubergine), carrots, red beetroot, late-ripening cabbage, onions, and other crops. Despite the high labour intensity of hybrid seed production, the volume of hybrid seeds produced annually is growing. It is also necessary to consider the volume of seeds grown by commercial entities under licence agreements (Table 12). Considering the two-year cycle for some vegetable plants, in 2023, vegetable seeds were grown to cover the area of 55,313 ha, which is 13% of the total area under vegetable and melon plants in Ukraine (426.5 thsd ha) (Table 13).

Table 12. Production of seeds of biennial vegetable plants in 2023 under licence agreements

Crops	Sales volume of baseline seeds, kg (autumn 2021 – spring 2022)	Area under mother plantations, ha	Area under seed breeding plots, ha	Seed yield, kg/ha	Gross harvest of SS-1 seeds, t	Area sown with grown seeds, ha
Onions	91	16	160	400	64.0	8,000
Red beetroot	408	51	153	1,300	206.7	20,670
Carrot	27	7	42	400	12.6	2,100
Radish	30	2.5	20	600	10.0	1,250
Other root vegetables	92	19	76	500	38.0	9,500
Total					331.3	40,520

**Source:** calculated according to data from the State Statistics Service of Ukraine (2024)

Table 13. Production of seeds of annual vegetable plants in 2023 under licence agreements

Crops	Sales volume of baseline seeds, kg (2022)	Area sown with baseline seeds, ha	Seed yield, kg/ha	Gross harvest of SS-1 seeds, t	Area sown with grown seeds, ha
Tomato	5.9	11.8	100	1.18	2,360
Sweet pepper	2.7	2.7	100	0.27	270
Cucumber	2	0.4	200	0.08	13
Other melons and gourds	67	33.5	200	6.7	3,350
Dill	7.1	3	500	1.5	500
Salad	8	8	350	2.8	700
Total				12.53	7,193

**Source:** calculated according to data from the State Statistics Service of Ukraine (2024)

According to theoretical provisions, the completion of the process of forming a single market environment should be associated with minimal price fluctuations. In fact, the situation is quite different, indicating that the

formation of a single market space is incomplete, and that supply and demand are spontaneous and sporadic. The reason for this situation is the general economic instability and high fuel prices and transport costs,

which have had a negative impact on the collective farm vegetable market in general. The data in Table 14 suggest that the formation of a single market compet-

itive environment is incomplete, as the coefficient of variation of regional prices (the range of variation) for vegetables is increasing.

**Table 14.** Regional variation of farm prices in Ukraine and the relationship between them

Product name	Price variation coefficients, %		Correlation coefficient between 2000 prices and 2023 prices
	2000	2023	
Fruits and berries	32.6	45.3	0.49
Outdoor vegetables in the open field	11.5	43.6	0.17
Potatoes	22.8	18.8	0.29
Cattle meat	9.2	12.8	0.14
Sunflower	30.4	12.8	-0.29
Eggs	12.7	9.2	0.18
Cereals	7.9	8.8	-0.26
Whole milk	8.5	6.8	0.03
Sugar beet (factory)	10.5	6.2	-0.08
Pig meat	8.4	5.9	0.45

**Source:** calculated according to data from the State Statistics Service of Ukraine (2024)

The range of variation was calculated as the ratio of the average monthly market price for 2023 to 2000. It was found that in 2000, this deviation was 11.5%, and in 2023 it reached 43.6% and was the highest among the main agricultural products, second only to fruits and berries. One can assume that the situation on the fruit and vegetable market will stay challenging in the near future. While a high territorial variation in prices for a particular product indicates localised exchange processes, the presence of moderate (up to 0.5) and significant (over 0.5) price correlation demonstrates stable differentiation of regional prices. In other words, Ukraine has a low level of formation of a single trading space in the fruit and vegetable market.

It is known that there is a monopolistic practice whereby large agricultural producers, including fruit and vegetable producers, determine the pricing policy and specialisation of production, which allows them to ensure the level of profit that will ensure survival in a hyper-competitive environment. However, today, considering that the lion's share of the vegetable market is held by small private households (about 90%), large-scale enterprises do not have a substantial impact on pricing policy. In other words, pricing policy is currently "dictated" by the private sector, which is also a feature of the vegetable market. All this led to a distortion (deformation) of the cost structure. Thus, in 1990, the share of material costs was 42%, labour costs – 30%,

and net income – 28%. The profitability level of agricultural enterprises is slightly higher than that of private ones, at 11.1%.

In the context of commodity relations, the price ensures a balance between supply and demand. In 2022, grain and vegetable producers faced the phenomenon of price and cost incompatibility. Thus, in 2022, the price of onions, late cabbage, carrots, and beetroot was marginal, while the price of onions was even lower than the cost of production.

It was found that in 2015-2023, the cost of growing vegetables increased 3.1 times from UAH 56.3 thsd in 2015 to UAH 184.6 thsd in 2023 (State Statistics Service of Ukraine, 2024). Profitability decreased from 45% in 2015 to 8% this year. Vegetable production is carried out based on simple reproduction, which does not allow enterprises to recover costs in the required amounts. Therewith, the producer, regardless of the invested assets, cannot sell the products at its own price, and therefore in this case, state intervention is needed to promote the formation of equally competitive conditions for the distribution of income from sales in the market among all participants in the infrastructure link "producer-processor-consumer and marketing infrastructure" (Bryukhovetska *et al.*, 2019). However, in the Ukrainian reality, this aspect of market regulation is practically not implemented, which is one of the reasons for the considerable loss of income by agricultural producers (Table 15).

**Table 15.** Structure of retail average prices for vegetable products in the Ukrainian consumer market in 2023

Indicator	Late cabbage		Onion		Carrot	
	UAH	%	UAH	%	UAH	%
Retail price in the retail network	20.0	100	33.0	100	29.8	100
Including the share of the price that remains:						
with the manufacturer	9.0	45.0	14.0	42.4	12.8	42.9
in the retail network	11.0	55.0	19.0	57.6	17.0	57.1

**Source:** calculated according to data from the State Statistics Service of Ukraine (2024)

The table shows that over 55% of the retail price stays in the infrastructure part of the market, which is not directly involved in the production of this product, which is a negative phenomenon that creates demotivation for the producer. Thus, the state should help producers to receive adequate income by regulating market pricing processes through active actions on the borderline of “minimum price” and “price formed based on supply and demand”. It means that the state should, by compensating for the lost profits (price difference), provide the producer with a minimum price to ensure expanded reproduction and, therefore, economic inter-

est. Therefore, determining the minimum producer price is a necessary condition at the current stage of functioning of the agricultural economy. The state should determine how to compensate for the difference, otherwise producers will lose motivation to their businesses. The minimum price is determined at a given rate of technological inputs and asset ratios according to a given yield. According to the State Statistics Service of Ukraine (2024), despite the increase in market prices in the current year compared to 2022, the costs incurred for the production in the 2023 season do not cover the costs of their production (Tables 16, 17).

**Table 16.** Average consumer prices for borshch vegetables in Ukraine in 2023, UAH/kg

Product name	December	January	February	March	April	May	June	July	August	September	October	November	December	Average annual price
White cabbage	13.0	12.8	13.9	22.2	23.8	37.6	45.6	23.3	11.0	9.1	8.5	8.8	11.2	19.0
Onion	30.6	32.1	42.3	52.1	52.7	56.2	55.0	36.1	18.1	12.9	13.1	13.4	15.1	33.3
Beetroot	12.3	12.2	11.4	10.9	9.8	9.7	10.4	32.4	14.6	10.3	9.2	9.4	11.5	12.7
Carrot	22.4	24.5	28.8	39.6	44.0	54.7	59.6	47.5	17.6	11.0	9.5	9.5	11.4	29.8
Potatoes	9.2	9.4	9.6	9.6	9.5	9.9	12.0	20.3	12.9	11.0	10.2	11.9	15.1	11.8

**Source:** calculated according to data from the State Statistics Service of Ukraine (2024)

According to the Ukrainian Research Institute of Agricultural Productivity, as of 6 February 2024, there is an increase in the cost of a borshch set, as evidenced by the data of 51 regional and district markets of Ukraine for borshch vegetables (The cost of the “borscht set” ..., 2024). The price of sunflower oil fell. The prices of the above products were compared to

the prices as of 23 January 2024. Thus, the minimum cost of borshch set products as of 6 February 2024 was UAH 29.76, while two weeks earlier the average cost was UAH 29.71, which indicates a price increase of UAH 0.05. According to the data, the largest price increases (+) were for potatoes, beetroot, cabbage, carrots, onions, and tomatoes (Table 17).

**Table 17.** The cost of a “borshch set”: trends in April 2024 Price – standard cost ratio

Product name	Quantity, g	Price as of 6 February 2024, UAH	Price as of 23 January 2024, UAH	Trend, %	Standardised production costs			Price to standard ratio, UAH/kg, +, -
					per 1 ha, UAH thsd	per 1 kg, UAH	pre product weight, UAH	
Potatoes	150	2.84	3.04	+6.9	255.4	7.3	20.27	+12.97
Cabbage	100	1.68	1.68	+0.24	135.9	2.5	11.20	+8.70
Carrot	50	0.96	0.98	+2.5	146.5	4.2	6.53	+2.33
Beetroot	50	0.97	0.97	+0.2	126.3	2.8	6.47	+3.67
Onion	50	0.98	1.01	+2.4	188.3	4.2	6.73	+2.53
Tomatoes	50	4.70	4.75	+1.1	213.5	3.6	31.67	+28.07

**Source:** calculated according to the State Statistics Service of Ukraine (2024); The cost of the “borscht set” ..., 2024

Setting the minimum price level for the vegetable industry is significant for establishing scientifically sound cost standards while achieving a balance of material, labour, and cash resources, which regulate standard costs, raw materials, fuel, and other resources. The implementation of these technical and technological solutions in vegetable growing will reduce the cost per unit of production and ensure the development of

vegetable growing in terms of expanded reproduction with a production profitability of at least 35%. Practical implementation of the proposed technical and technological solutions will allow solving the issues of economic independence of the regions, food, and national security, to reduce its import dependence, in the vector of institutional development of the economy and development of Ukraine’s European integration policy.

## DISCUSSION

Ukraine has every opportunity to ensure food security in the internal market and can substantially influence its strengthening at the global level. According to K. Mazur and Ya. Gontaruk (2023) and T. Oliynyk *et al.* (2019), vegetable production should be export-oriented, and in this case it can become efficient. Therewith, it is imperative to ensure measures to regulate the internal vegetable market to overcome its deficit through the possibility of substitution of production, which will allow national producers to overcome difficulties and strengthen their positions in the internal market. Furthermore, according to N. Palapa *et al.* (2022), L. Galat (2019), Ukraine's position in food security can be strengthened by other factors: rising incomes; achieving political stability; physical and economic availability of the required quantity and range of food, effective government policy, etc. At the same time, it is necessary to use the benefits of international economic integration, specifically, in terms of removing trade barriers, foreign direct investment, new technologies, etc. Considering this, Ukraine has already concluded regional trade agreements with such integration groups as the EU, the European Free Trade Association (EFTA), as well as dozens of countries, including Canada, the UK, and Turkey, which are significant trading partners in the world market, including in agri-food trade (Ministry of Agrarian Policy and Food of Ukraine, n.d.).

Thus, according to the researchers, to achieve this, Ukraine needs to solve a series of important sectoral tasks, including those related to food security under martial law, prevention of hunger, malnutrition of Ukrainians, etc. Thus, in the context of the shortage of vegetable production, it is necessary to identify new opportunities for regional production, ensure the possibility of substituting the production of certain vegetable crops by their types, and solve the problems of developing Ukrainian seed production and pricing.

The analysis shows a rather negative trend of decreasing vegetable production in Ukraine, especially in the context of military operations and environmental hazards, in contrast to the global dynamics, and confirms the relevance of recommendations on the feasibility of increasing it. Therewith, we fully share the opinion of R. Lohosha *et al.* (2018) on the need to orientate production towards the organic vector. Therewith, the EU-Ukraine Association Agreement (Association Agreement No. 984\_011, 2023) states that the parties shall strengthen cooperation on environmental issues and intensify the development of green economies (Article 360), cooperate to promote the development of agriculture and rural areas (Article 403), etc.

To improve the efficiency of the formation and functioning of the vegetable market in Ukraine, especially in the context of its convergence with the EU markets, K. Mazur and Ya. Gontaruk (2023) suggest considering the practices of other countries. However, in our opinion,

direct borrowing of the classical European model of the economic mechanism for regulating the vegetable market without accommodating sectoral characteristics and local organisational and economic conditions of the market environment is impossible, which is conditioned by the need to introduce an original and more efficient way of development. Furthermore, we believe that at the current stage of development, state support is needed, especially in the implementation of sectoral and regional programmes for the development of vegetable production in the future. At the same time, the amount of state support for the vegetable market depends on the real capabilities of the budget; tax, credit, price, investment, export-import, customs, and monetary policies. A. Gumenyuk and O. Harmatyuk (2021) note that in the future, it is necessary to increase Ukraine's competitiveness by introducing state levers for the formation of new integrated associations in vegetable production. The authors of the present study came to the same conclusion and believe that expanding integration ties will enable more efficient implementation of innovations at enterprises, reduce production costs, and increase the competitiveness of enterprises. This applies primarily to cooperation with developed countries and integration groups with which regional trade agreements have been concluded, including the EU, EFTA, Canada, the UK, etc.

As noted above and considering the findings of this study on the state, trends, features, and reasons for the decline in vegetable production, the issues of product competitiveness, increased profitability, consumer preferences, identification of regional reserves for production development, and improvement of product quality are still open. The study proved that the problem of food shortages should be solved with due regard to the possibilities of domestic production and maximum security guarantees. L. Teryokhina *et al.* (2020) share the same opinion, emphasising that today vegetable growing is the basis for sustainable development of crop production and requires the introduction of innovative technologies, considering regional characteristics. The introduction of zonal innovative technical and technological solutions, according to O. Mogylna *et al.* (2020), will help to solve the issue of economic independence of individual regions in the post-war economy. Therefore, considering the above, in the future, when developing the principal aspects of the strategy for the sustainable formation and functioning of the vegetable growing industry, priority should be given to the implementation of the innovation and investment model of development.

It was found that the dysfunctions of the vegetable market are caused by insufficient scientific understanding of the role of the factor of legal support for the regulation of the agro-industrial complex and the formation of sectoral markets. In this regard, we fully share the opinion of R. Lohosha *et al.* (2020) on the need to

regulate the price mechanism and the complexity of institutional support as a necessary element of market reforms, especially in the context of food shortages. Other researchers, such as I. Gruzinska (2022), emphasise that the increase in the efficiency and competitiveness of the vegetable growing industry at both the national and regional levels is considerably influenced by factors such as technical and technological, biological, financial and economic, legal, social, etc. The present study proved that to improve the efficiency of the vegetable growing industry, it is necessary to improve the existing approaches by combining the institutional-legal, institutional-organisational, and institutional-informational components.

### CONCLUSIONS

To overcome the production deficit, it is necessary to introduce an innovation and investment model for the development of the industry. Furthermore, efforts should be made to stimulate vegetable exports, diversify its geographical and product structure, and promote the export of processed products. Ukraine's vegetable exports have increased considerably since 2003 but are generally fluctuating. The trade balance was active and passive. Ukraine's largest exporters are mainly countries with which regional trade agreements have been concluded, while in 2003 these were countries with which RTAs were already in force or were about to be concluded. This suggests that integration promotes trade and vice versa. It is worth noting a positive trend, specifically the geographical diversification of vegetable exports, but some of the world's largest importers, such as China, the US, and Japan, are not among Ukraine's key importers. An analysis of the commodity structure of exports shows the need to diversify it and increase

production of products that are largely imported, such as tomatoes, onions, and cucumbers. However, it is not a question of restricting imports, as the needs of consumers and the seasonality of vegetable growing must be considered. Exports should be increased through the use of RTAs, improved product quality, and harmonisation of quality standards with European ones, which should also help to provide the population with quality products and increase vegetable production. This is one of the main prerequisites for entering and increasing exports to developed markets, which will help to boost vegetable production.

One of the key factors of efficiency is sales, and a valuable tool for the comprehensive improvement of the vegetable growing economy is the improvement of pricing. Thus, with rising energy costs and higher wages for vegetable growers, the focus of the pricing policy is to partially increase prices while increasing labour productivity and reducing production costs. Labour productivity can be increased by mechanising labour-intensive processes, while costs can be reduced by introducing intensive vegetable growing technologies and standardised costs. Thus, the promotion and intensive implementation of modern scientific developments will considerably increase the profitability of the industry, ensure the sustainable development of vegetable agrocenoses, reduce the adverse impact of technology on the environment, improve product quality, and solve a series of socio-economic issues.

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### CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

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## Овочівництво під впливом продовольчих небезпек, екологічних чинників та міжнародних інтеграційних процесів

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**Анотація.** Важливість виробництва овочів зумовлена потребою населення у вітамінній продукції, переробних підприємств у сировині, особливо у воєнний час, в умовах продовольчої та екологічної небезпеки та доцільністю нарощування експортних можливостей з врахуванням міжнародних інтеграційних процесів. Метою статті є дослідження впливів війни на економічну доступність та екологічну безпечність продовольства, визначення та оцінка складових та напрямків управління продовольчою та екологічною безпекою, оцінка та сприяння експорту продукції в контексті міжнародної економічної інтеграції. При дослідженні використовувались методи аналізу та синтезу, узагальнення та конкретизації, математичні та графічний метод. Джерела інформації – дані Продовольчої та сільськогосподарської організації ООН (ФАО), агентства Всесвітньої торгової організації (ІТС), Державної служби статистики України. В результаті дослідження здійснено аналіз сучасного стану виробництва овочів, визначено основні проблеми під впливом продовольчих небезпек, екологічних чинників та інтеграційних процесів. Досліджено вплив війни на економічну доступність та екологічну безпечність продовольства, здійснено оцінку обсягів дефіциту виробництва овочевої продукції, визначено основні економічні та екологічні проблеми та напрями підвищення ефективності галузі на перспективу. Встановлено обсяги дефіциту виробництва овочів та визначено розміри втрачених площ посіву; причини незадовільного стану овочівництва. Визначено, що останніми роками в країні спостерігається досвід тимчасового голоду, що є неприпустимим у європейському просторі. Встановлено, що для мінімізації агропродовольчої кризи, екологічних загроз, необхідно спрямувати роботу щодо втілення запропонованих заходів для підтримки ефективності виробництва, впровадження яких дозволить вирішити питання самостійності та продовольчої безпеки територіальних громад, особливо в умовах війни, удосконалити функціонал органів управління, господарюючих суб'єктів, інвесторів, науковців, виробників на засадах сталого розвитку. Практичність результатів дослідження підтверджується ефективністю розроблених пропозицій, що можуть бути використані при впровадженні заходів щодо нарощування обсягів виробництва овочів та підвищення експорту

**Ключові слова:** екологія; овочівництво; виробництво; споживання; інноваційний розвиток; експорт; міжнародна економічна інтеграція

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