

ANALYSIS OF THE DYNAMICS AND IDENTIFICATION OF SEASONAL FLUCTUATIONS IN UKRAINIAN AGRICULTURAL EXPORTS BY TYPE OF TRANSPORT

Olesia TOTSKA

Lesya Ukrainka Volyn National University, Department of Management, 28 Vynnychenko Street, Lutsk, 43021, Ukraine, E-mail: Totska.Olesia@vnu.edu.ua

Corresponding author: Totska.Olesia@vnu.edu.ua

Abstract

The purpose of this article is to analyse the dynamics and identify seasonal fluctuations in Ukraine's agricultural exports by type of transport from March 2022 to February 2024. The analysis uses a dashboard on the state of foreign trade in agricultural products. It contains a number of interactive diagrams on border crossings for nine types of goods (corn, wheat, sunflower oil, meal, rapeseed, soya beans, barley, sunflower seeds, soya oil) and four types of transport (ports, rail, road, ferries). The analysis shows that in March 2022 – February 2024, Ukrainian farmers exported an average of 4.768 million tonnes of products per month, of which 3.548 million tonnes were exported through ports, 837.9 thousand tonnes by rail, 321.2 thousand tonnes by road, and 61.6 thousand tonnes by ferries. The lowest volumes of exports of agricultural products were observed in March 2022, followed by a gradual increase. Exports by all types of transport are characterised by two waves of seasonality: growth (seasonality indices exceeding 100%) and decline (seasonality indices below 100%). For ports, these phases last in September-February and March-August; for rail transport, in August-February and March-July; for road transport, in July-November and December-June; and for ferries, in July-October and November-June. The seasonality of agricultural exports is related to the seasonality of their production, weather conditions, and the work of the customs services of Ukraine and the countries through which they are exported.

Key words: exports, agricultural products, seasonal fluctuations, types of transport, Ukraine

INTRODUCTION

Ukraine is a major agricultural country that supplies agricultural products not only to the domestic market but also to other countries around the world. Due to the special conditions that the country faced in February 2022, domestic farmers faced a number of challenges, including transporting their products for export. Today, exporters can use the following four types of transport: ports, rail, road, and ferries.

Various aspects of the use of transport by agricultural enterprises of Ukraine have been studied by the following domestic scholars: M. V. Babii (2017) analysed the problems of transport logistics in the agricultural sector of Ukraine and proposed directions that would increase the balance between different types of transport due to the developed highly efficient logistics programmes [1]. K. S. Chymosh, (2020) studied the conditions for the development of transport logistics in the agricultural sector of the economy [2].

I. Yu. Lesnikova *et al.* (2023) determined the optimal route for the transportation of agricultural products under martial law [6]. M. O. Mikulina *et al.* (2020) investigated methods of improving the efficiency of transport technologies in agricultural production [7].

K. V. Nechyporenko (2014, 2015) studied the peculiarities of organisation and management in the use of vehicles by agricultural enterprises [9], analysed the state and trends in the development of transport logistics of agricultural enterprises [10].

S. V. Pron and I. I. Vysotska (2016) formed the author's definition of the "transport system of agricultural works", taking into account the peculiarities of growing crops and resource-saving technologies [13].

H. Yu. Rodashchuk (2013) determined the importance of taking into account the transport factor in the production sector of agriculture [14].

A. M. Shashman and I. Yu. Hlukhova (2017) studied the organisation of the work of motor

transport of agricultural enterprises in the Donetsk region and provided directions for improving the efficiency of motor transport use in modern conditions [15]. A. Ye. Velychko and I. Yu. Hlukhova (2013) analysed the work of motor transport units of agricultural enterprises of Donetsk region to determine unused reserves [21].

In addition, L. Nekrasenko *et al.* (2021) identified the peculiarities of logistics and searched for alternative forms and methods of delivering grain products to storage and sales locations (ports) [11].

O. Totska analysed the foreign trade in agricultural products of Ukraine (2022a, 2022b, 2022c, 2022d) [16, 17, 18, 19].

Foreign scientists have studied the following aspects of agricultural transporting: P. Coto-Millan *et al.* (2018) estimated the price and income elasticities for transporting agribusiness products for air import and export in Spain [3].

S. M. Ferguson and M. R. Olfert (2016) assessed the impact of the abolition of railroad subsidies on the adoption of production technology on Western Canadian farms [4].

R. S. Gray (2020) assessed how disruptions in transport services related to COVID-19, as well as new demands for transport services, could affect Canadian agricultural supply chains [5].

J. C. Perez-Mesa *et al.* (2020) studied the viability of intermodal transporting of horticultural products from southeastern Spain to the rest of Europe [12].

B. Wetzstein *et al.* (2021) studied the cost of transporting agricultural goods on the Mississippi River system in the USA [22].

The purpose of this article is to analyse the dynamics and identify seasonal fluctuations in Ukraine's agricultural exports by type of transport since March 2022.

MATERIALS AND METHODS

Agricultural exports from Ukraine are taken from the dashboard "State of Foreign Trade in Agricultural Products" (2024) [8].

Seasonality indices are calculated using the formula:

$$i_s = \frac{\bar{y}_i}{\bar{y}} \times 100, \quad (1)$$

where:

$\bar{y}_i = \frac{\sum_i y_i}{k}$ – the average value of the export indicator for the i -th month;

y_i – the value of the export indicator for the i -th month;

k – number of years ($k = 2$);

$\bar{y} = \frac{\sum_{i=1}^{12} \bar{y}_i}{n}$ – the average value of the export indicator for the entire period (in our case, March 2022 – February 2024);

n – number of months ($n = 12$).

RESULTS AND DISCUSSIONS

The dashboard "State of Foreign Trade in Agricultural Products" is a joint development of the Ministry of Agrarian Policy and Food of Ukraine, the Ministry of Infrastructure of Ukraine, and the State Agency "Entrepreneurship and Export Promotion Office".

It contains a number of interactive diagrams to inform stakeholders about export volumes by certain types of goods and modes of transport according to the Unified Automated Information System "Delivery Control".

The charts show exports by the following types of agricultural products: corn;

wheat; sunflower oil; meal; rapeseed; soya beans; barley; sunflower seeds; soya oil.

Border crossings of agricultural products are shown in Table 1 and Table 2.

The dynamics of the indicators in Table 1 indicates that the lowest exports of agricultural products were observed in March 2022, followed by a gradual increase (due to the adaptation of commodity producers and carriers to the new conditions in which the country found itself).

The highest export figures were observed for ports in February 2024, rail transport in December 2022, road transport in November 2022, and ferries in August 2023.

The maximum exports of agricultural products by all types of transport could be observed in March 2023.

Table 1. Dynamics of border crossings of agricultural products by type of transport, tonnes

Year	Month	Ports	Railways	Road	Ferries	Total
2022	March	55,670.16	252,916.31	22,893.92	76.20	331,556.59
	April	265,656.93	601,739.47	91,551.34	9,368.31	968,316.05
	May	798,803.25	709,616.00	212,089.23	22,112.31	1,742,620.79
	June	1,069,847.23	746,792.96	323,375.32	28,418.82	2,168,434.33
	July	1,405,173.25	832,374.84	477,605.67	36,501.87	2,751,655.63
	August	2,941,375.62	954,962.84	624,886.59	41,817.72	4,563,042.77
	September	5,166,260.36	1,030,253.74	639,668.89	31,814.16	6,867,997.15
	October	5,239,526.23	970,199.89	638,569.51	45,974.34	6,894,269.97
	November	4,060,184.42	1,119,027.16	676,682.37	46,902.71	5,902,796.66
	December	5,075,521.89	1,152,357.52	480,113.75	41,669.32	6,749,662.48
2023	January	3,959,208.86	1,069,546.31	422,996.71	31,711.64	5,483,463.52
	February	4,802,926.46	1,020,485.31	465,462.33	41,105.69	6,329,979.79
	March	5,792,583.48	1,075,272.58	483,404.16	100,369.66	7,451,629.88
	April	4,568,183.86	644,344.29	229,811.22	89,438.16	5,531,777.53
	May	3,526,873.83	638,584.70	186,095.84	85,251.47	4,436,805.84
	June	3,900,758.38	675,281.24	190,290.32	90,423.91	4,856,753.85
	July	2,364,863.25	681,612.15	197,672.66	143,948.12	3,388,096.18
	August	2,391,881.80	913,325.72	258,925.37	146,566.97	3,710,699.86
	September	2,322,819.09	956,812.94	247,689.16	107,985.04	3,635,306.23
	October	3,130,703.28	861,969.62	225,879.79	118,546.48	4,337,099.17
	November	4,294,667.09	941,695.65	184,747.15	36,034.05	5,457,143.94
	December	6,141,763.71	839,775.62	135,648.78	60,239.08	7,177,427.19
2024	January	5,485,271.20	685,686.52	139,925.62	53,092.94	6,363,976.28
	February	6,381,011.52	733,861.21	153,672.54	69,821.87	7,338,367.14

– minimum values,
 – maximum values.

Source: Generated by the author based on dashboard data (2024) [8].

Table 2. Border crossings of agricultural products by type of product and type of transport, tonnes

Products	Ports	Railways	Road	Ferries	Total
Corn	35,450,311	10,122,373	1,674,427	172,260	47,419,371
Wheat	24,545,504	2,877,778	1,080,980	223,670	28,727,932
Sunflower oil	6,780,251	1,491,728	1,310,974	387,662	9,970,615
Meal	4,651,958	2,069,256	486,321	308,359	7,515,894
Rapeseed	3,747,157	1,739,467	1,054,743	53,338	6,594,705
Soya beans	3,944,485	941,584	729,355	150,235	5,765,659
Barley	3,948,160	210,841	136,031	67,439	4,362,471
Sunflower seeds	2,042,766	394,432	1,023,585	94,185	3,554,968
Soya oil	30,943	261,034	213,243	22,043	527,263
Total	85,141,535	20,108,493	7,709,659	1,479,191	114,438,878

Source: Generated by the author based on dashboard data (2024) [8].

According to Table 2, during the analysed period, the overall exports of agricultural products by individual types of transport were as follows: ports: 85.142 million tonnes; rail transport: 20.108 million tonnes; road transport: 7.710 million tonnes; ferries: 1.479 million tonnes.

In other words, domestic farmers mainly use ports and rail transport to export their products, and to a lesser extent, road transport and ferries. Ports are the leaders in terms of transportation of corn, wheat, sunflower oil, meal, rapeseed, soya beans, barley and

sunflower seeds; railways are the leaders in terms of soya oil.

It is worth noting that, according to the Register of Seaports of Ukraine [20], nine ports are currently open: Bilhorod-Dnistrovskiy seaport; Izmail seaport; Mykolaiv seaport; seaport of Odesa; specialised seaport of Olvia; seaport of Pivdennyi; seaport of Reni; Ust-Dunaisk seaport; seaport of Chornomorsk.

Their number has decreased: in 2014, the ports of Yevpatoria, Kerch, Sevastopol, Feodosia, Yalta were closed in the temporarily occupied territory of the Autonomous Republic of

Crimea; in 2022, the ports of Berdiansk, Mariupol, Skadovsk, and Kherson were closed due to the inability to ensure an adequate level of shipping safety.

The average values of the indicators and the seasonality indices calculated on their basis are presented in Table 3.

Table 3. Average values (\bar{y}_i) and seasonality indices (i_s) of agricultural exports by type of transport for each month

Month	Average values, tonnes					Seasonality indices, %				
	Ports	Railways	Road	Ferries	Total	Ports	Railways	Road	Ferries	Total
January	4,722,240	877,616	281,461	42,402	5,923,720	133	105	88	69	124
February	5,591,969	877,173	309,567	55,464	6,834,173	158	105	96	90	143
March	2,924,127	664,094	253,149	50,223	3,891,593	82	79	79	81	82
April	2,416,920	623,042	160,681	49,403	3,250,047	68	74	50	80	68
May	2,162,839	674,100	199,093	53,682	3,089,713	61	80	62	87	65
June	2,485,303	711,037	256,833	59,421	3,512,594	70	85	80	96	74
July	1,885,018	756,993	337,639	90,225	3,069,876	53	90	105	146	64
August	2,666,629	934,144	441,906	94,192	4,136,871	75	111	138	153	87
September	3,744,540	993,533	443,679	69,900	5,251,652	106	119	138	113	110
October	4,185,115	916,085	432,225	82,260	5,615,685	118	109	135	133	118
November	4,177,426	1,030,361	430,715	41,468	5,679,970	118	123	134	67	119
December	5,608,643	996,067	307,881	50,954	6,963,545	158	119	96	83	146
Average (\bar{y})	3,547,564	837,854	321,236	61,633	4,768,287	100	100	100	100	100

– less than 100 %,
 – more than 100 %.

Source: Calculated by the author on the basis of Table 1.

Thus, during March 2022 – February 2024, Ukrainian farmers exported an average of 4.768 million tonnes of products per month, of which 3.548 million tonnes were exported through ports, 837.9 thousand tonnes by rail, 321.2 thousand tonnes by road, and 61.6 thousand tonnes by ferries.

Seasonality indices with a value of more than 100% were observed for ports in September-February, for rail transport in August-February, for road transport in July-November, and for ferries in July-October. Seasonality indices with a value of less than 100% were observed for ports in March-August, for rail transport in March-July, for road transport in December-June, and for ferries in November-June, respectively. This is due to the seasonality of production, weather conditions and the work of the customs services of Ukraine and the countries through which the goods are transported.

Seasonal waves of agricultural exports for each type of transport are shown in Figures 1–4.

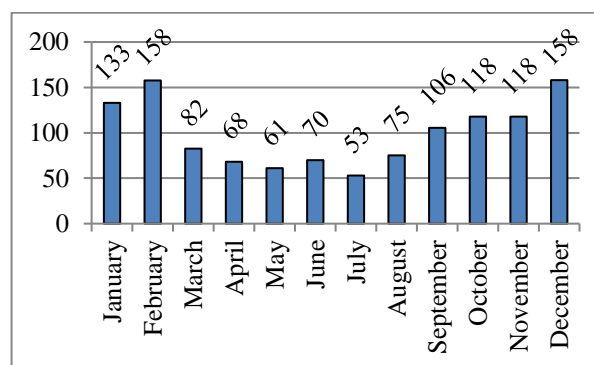


Fig. 1. Seasonal wave of agricultural exports through ports

Source: Built by the author on the basis of Table 3.

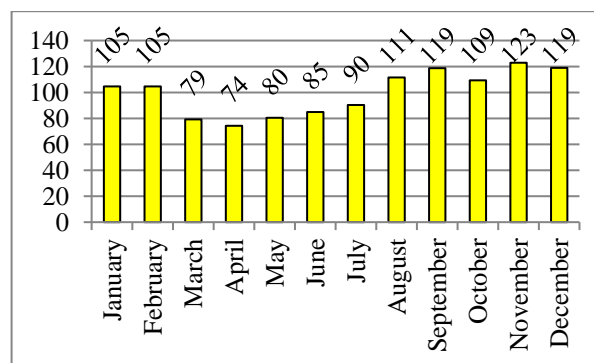


Fig. 2. Seasonal wave of agricultural exports by rail

Source: Built by the author on the basis of Table 3.

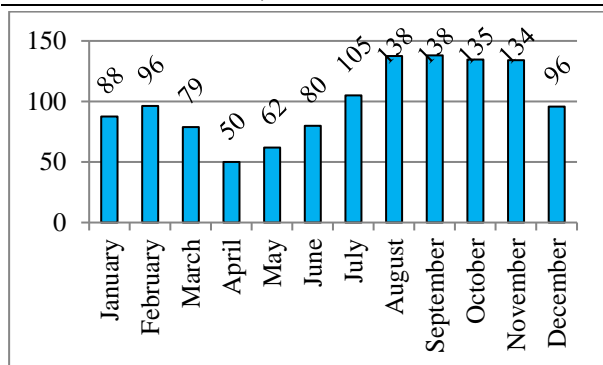


Fig. 3. Seasonal wave of agricultural exports by road
 Source: Built by the author on the basis of Table 3.

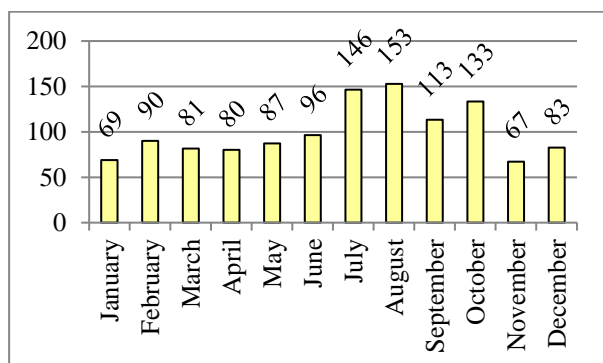


Fig. 4. Seasonal wave of agricultural exports by ferries
 Source: Built by the author on the basis of Table 3.

Figures 1–4 show that the peak seasonality of agricultural exports through ports was in December-February; by rail – September, November-December; by road – August-October; by ferries – July-August and October. The seasonal minimum for exports of agricultural products through ports was observed in April-May and July; by rail and road – from March to May; and by ferries – in January, April, and November.

CONCLUSIONS

Ukrainian farmers, carriers and other stakeholders have been able to track information on agricultural exports since March 2022, using a dashboard developed jointly by the Ministry of Agrarian Policy and Food of Ukraine, the Ministry of Infrastructure of Ukraine, and the State Agency "Entrepreneurship and Export Promotion Office". It contains a number of interactive diagrams on border crossings for nine types of goods (corn, wheat, sunflower oil, meal, rapeseed, soya beans, barley, sunflower seeds,

soya oil) and four types of transport (ports, railways, road transport, ferries).

The dynamics of exports of agricultural products indicates that the lowest volumes were observed in March 2022, after which they gradually increased (due to the adaptation of producers and carriers to the new conditions in which the country found itself). The highest export figures were observed for ports in February 2024, rail transport in December 2022, road transport in November 2022, and ferries in August 2023.

Between March 2022 and February 2024, Ukrainian farmers exported an average of 4.768 million tonnes of products per month, of which 3.548 million tonnes were exported through ports, 837.9 thousand tonnes by rail, 321.2 thousand tonnes by road, and 61.6 thousand tonnes by ferries.

Exports by all modes of transport are characterised by two waves of seasonality: growth (seasonality indices exceeding 100%) and decline (seasonality indices below 100%). For ports, these phases last in September-February and March-August; for rail transport, in August-February and March-July; for road transport, in July-November and December-June; and for ferries, in July-October and November-June. The seasonality of agricultural exports is related to the seasonality of their production, weather conditions, and the work of the customs services of Ukraine and the countries through which the goods are transported.

REFERENCES

- [1] Babii, M. V., 2017, Problemy transportnoi lohistyky v aharnomu sektori Ukrainy [Transport logistic problems in agricultural sector of Ukraine], Bulletin of the Kharkiv Petro Vasylenko National Technical University of Agriculture, 184:130–135, http://nbuv.gov.ua/UJRN/Vkhdtusg_2017_184_24, (In Ukrainian). Accessed on March 11, 2024.
- [2] Chymosh, K. S., 2020, Analiz suchasnykh svitovykh ta vitchyznianskykh tendentsii rozvytku transportnoi lohistyky v aharnomu sektori ekonomiky [Analysis of modern world and domestic trends in the development of transport logistics in the agricultural sector of the economy], Economy and State, 9:112–114, http://nbuv.gov.ua/UJRN/ecde_2020_9_21, (In Ukrainian). Accessed on March 11, 2024.
- [3] Coto-Millan, P., Sainz-Gonzalez, R., Hontanon, P. C., Inglada, V., Fernandez, X. L.,

- Castanedo, J., Pesquera, M. A., 2018, Agricultural transportation: air imports and exports, *International Journal of Transport Economics*, 45(1):35–51, doi: 10.19272/201806701003.
- [4]Ferguson, S. M., Olfert, M. R., 2016, Competitive pressure and technology adoption: evidence from a policy reform in Western Canada, *American Journal of Agricultural Economics*, 98(2):422–446, doi: 10.1093/ajae/aav018.
- [5]Gray, R. S., 2020, Agriculture, transportation, and the COVID-19 crisis, *Canadian Journal of Agricultural Economics*, 68(2):239–243, doi: 10.1111/cjag.12235.
- [6]Lesnikova, I. Yu., Khalipova, N. V., Kuzmenko, A. I., Zhyr, S. I., Shapovalov, O. V., 2023, Optymizatsiia transportno-tekhnologichnoi skhemy perevezennia silhospproduktii v osoblyvykh umovakh Ukrainy [Optimization of the transport and technological scheme of transportation of agricultural products in the special conditions of Ukraine], *Systems and Technologies*, 65(1):111–123, <https://doi.org/10.32782/2521-6643-2023.1-65.14>.
- [7]Mikulina, M. O., Solarov, O. O., Tatsenko, O. V., 2020, Rol skladskoj infrastruktury v transportnykh tekhnolohiiakh dlia ahrarnoho vyrobnytstva [The role of warehouse infrastructure in transport technologies for agricultural production], *Engineering of Nature Management*, 4:29–34, http://nbuv.gov.ua/UJRN/Iprk_2020_4_6, (In Ukrainian). Accessed on March 11, 2024.
- [8]Ministry of Agrarian Policy and Food of Ukraine, 2024, Stan zovnishnoi torhivli produktamy APK [The state of foreign trade in agricultural products], https://public.tableau.com/views/vl_Export_of_Agriproducts_v2/Dashboard1?:language=en-US&:display_count=n&:origin=viz_share_link:showVizHome=no&:embed=true, (In Ukrainian). Accessed on March 08, 2024.
- [9]Nechyporenko, K. V., 2014, Osoblyvosti orhanizatsii ta upravlinnia transportnoi lohistykoiu ahrarnykh pidpriemstv [Features of organization and management transporting logistic of agrarian enterprises], *Economic Forum*, 3:176–181, http://nbuv.gov.ua/UJRN/ecfor_2014_3_28, (In Ukrainian). Accessed on March 11, 2024.
- [10]Nechyporenko, K. V., 2015, Transportna lohistyka ahrarnykh pidpriemstv v systemi staloho rozvytku APK [Transport logistics of agrarian companies in system of sustainable development of agrarian complex], *Effective Economy*, 12, http://nbuv.gov.ua/UJRN/efek_2015_12_62, (In Ukrainian). Accessed on March 11, 2024.
- [11]Nekrasenko, L., Pittman, R., Doroshenko, O., Chumak, V., Doroshenko, A., 2019, Grain logistics in Ukraine: the main challenges and effective ways to reach sustainability, *Economic Annals-XXI*, 178(7–8):70–83, doi: 10.21003/ea.V178-06.
- [12]Perez-Mesa, J. C., Aballay, L., Serrano-Arcos, M., Sanchez-Fernandez, R., 2020, Analysis of intermodal transport potentials for vegetables export from southeast Spain, *Sustainability*, 12(20), doi: 10.3390/su12208502.
- [13]Pron, S. V., Vysotska, I. I., 2016, Teoretychni aspekty poniattia transportnoi systemy ahrarnykh robot [Theoretical aspects of the concept transport system of agricultural works], *Young Scientist*, 4:252–256, http://nbuv.gov.ua/UJRN/molv_2016_4_63, (In Ukrainian). Accessed on March 11, 2024.
- [14]Rodashchuk, H. Yu., 2013, Mistse i rol transportu v ahranomu vyrobnytstvi [Place and role of transport in agricultural production], *Innovative Economy*, 3:183–186, http://nbuv.gov.ua/UJRN/inek_2013_3_43, (In Ukrainian). Accessed on March 11, 2024.
- [15]Shashman, A. M., Hlukhova, I. Yu., 2017, Perspektyvy rozvytku avtomobilnoho transportu ta napriamy pidvyshchennia efektyvnosti yoho vykorystannia ahrarnymy pidpriemstvamy Donetskoj oblasti [Prospects for the development of automobile transport and the direction of increasing the efficiency of its use by agricultural enterprises of the Donetsk region], *Productivity of Agro-industrial Production*, 29:40–47, http://nbuv.gov.ua/UJRN/Pav_2017_29_7, (In Ukrainian). Accessed on March 11, 2024.
- [16]Totska, O., 2022a, Forecast modeling of foreign trade in agricultural complex products between Ukraine and Romania, *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, Vol. 22(3):777–782.
- [17]Totska, O., 2022b, Forecasting the value of the export of Ukrainian agricultural products based on fuzzy sets, *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, Vol.22(4):751–760.
- [18]Totska, O., 2022c, The value dimension of Ukrainian exports of grain crops, fats and oils to European Union countries, *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, Vol.22(3):767–770.
- [19]Totska, O., 2022d, Ukraine and Romania: financial aspects of trade in agricultural products, *Scientific Papers. Series Management, Economic Engineering in Agriculture and Rural Development*, Vol. 22(3):771–776.
- [20]Ukrainian Sea Ports Authority, 2024, Register of seaports of Ukraine, <https://www.uspa.gov.ua/rejestro>, (In Ukrainian). Accessed on March 11, 2024.
- [21]Velychko, A. Ye., Hlukhova, I. Yu., 2013, Pidvyshchennia efektyvnosti vykorystannia avtomobilnoho transportu za rakhunok vprovadzhennia nevykorystanykh rezerviv na ahrarnykh pidpriemstvakh Donetskoj oblasti [Improving efficiency use of road transport by introducing untapped reserves in the agricultural enterprises of Donetsk region], *Economics. Management. Innovations. Series: Economic Sciences*, 2(10), http://nbuv.gov.ua/UJRN/eui_2013_2_16, (In Ukrainian). Accessed on March 11, 2024.
- [22]Wetzstein, B., Florax, R., Foster, K., Binkley, J., 2021, Transportation costs: Mississippi River barge rates, *Journal of Commodity Markets*, 21, doi: 10.1016/j.jcomm.2019.100123.