

ISSN: 2221-1055  
E-ISSN: 2413-2322

Національний науковий центр «Інститут аграрної економіки»  
ТОВ «Наукові журнали»

---

# ЕКОНОМІКА АПК

Науково-виробничий журнал

---

Заснований у 1994 році  
Випускається 6 разів на рік

**Том 31, № 1**

Київ – 2024

ISSN: 2221-1055  
E-ISSN: 2413-2322

**Співзасновники:**

Національний науковий центр «Інститут аграрної економіки»,  
ТОВ «Наукові журнали»

**Рік заснування: 1994**

*Рекомендовано до друку та поширення  
через мережу Інтернет Вченою радою  
Національного наукового центру «Інститут аграрної економіки»  
(протокол № 1 від 30 січня 2024 р.)*

**Свідоцтво про державну реєстрацію  
друкованого засобу масової інформації**  
серії КВ № 25122-15062 ПР від 17 лютого 2022 р.

**Журнал входить до Переліку наукових фахових видань України**

Категорія «Б». Спеціальності: 051 «Економіка», 071 «Облік і оподаткування»,  
072 «Фінанси, банківська справа та страхування», 073 «Менеджмент»,  
076 «Підприємництво, торгівля та біржова діяльність»  
(наказ Міністерства освіти і науки України від 11 липня 2019 р. № 975)

**Журнал представлено у міжнародних наукометричних базах даних,  
репозитаріях та пошукових системах:** Google Scholar, Index Copernicus International,  
Фахові видання України, Національна бібліотека України імені В. І. Вернадського, Crossref,  
AGRIS, Econlit, ECONBIZ, ZBW, WorldCat, JournalFinder, EZB, SIS, GIF, InfoDase, PBN, CiteFactor, UBL,  
JIFACTOR, TIB, I2OR, General Impact Factor, BASE, ERIH PLUS, EBSCO, DOAJ, EuroPub,  
Ulrich's Serials Analysis System

**Адреса редакції:**

Національний науковий центр «Інститут аграрної економіки»  
03127, вул. Героїв Оборони, 10, м. Київ, Україна  
E-mail: [info@eapk.com.ua](mailto:info@eapk.com.ua)  
<https://eapk.com.ua/uk>

ISSN: 2221-1055  
E-ISSN: 2413-2322

National Scientific Center “Institute of Agrarian Economics”  
LLC “Scientific Journals”

---

# **EKONOMIKA APK**

Scientific and Production Journal

---

Founded in 1994  
Published six times per year

**Volume 31, No. 1**

Kyiv – 2024

ISSN: 2221-1055

E-ISSN: 2413-2322

**Co-founders:**

National Scientific Center "Institute of Agrarian Economics",  
LLC "Scientific Journals"

**Year of foundation: 1994**

*Recommended for printing and distribution  
via the Internet by the Academic Council  
of National Scientific Center "Institute of Agrarian Economics"  
(Minutes No. 1 of January 30, 2024)*

**Certificate of state registration  
of the print media**

Series KV No. 25122-15062 PR of February 17, 2022

**Journal is included in the List of Scientific professional publications of Ukraine**

Category "B". Specialty's: 051 "Economics", 071 "Accounting and Taxation",  
072 "Finance, Banking and Insurance", 073 "Management",  
076 "Entrepreneurship, Trade and Stock Market Activity"  
(order of the Ministry of Education and Science of Ukraine of July 11, 2019, No. 975)

**Journal is presented international scientometric databases, repositories  
and scientific systems:** Google Scholar, Index Copernicus International, Professional Publications  
of Ukraine, Vernadsky National Library of Ukraine, Crossref, AGRIS, Econlit, ECONBIZ, ZBW, WorldCat,  
JournalFinder, EZB, SIS, GIF, InfoDase, PBN, CiteFactor, UBL, JIFACTOR, TIB, I2OR, General Impact Factor,  
BASE, ERIH PLUS, EBSCO, DOAJ, EuroPub, Ulrich's Serials Analysis System

**Editors office address:**

National Scientific Center "Institute of Agrarian Economics"  
03127, 10 Heroiv Oborony Str., Kyiv, Ukraine  
E-mail: [info@eapk.com.ua](mailto:info@eapk.com.ua)  
<https://eapk.com.ua/en>

## Редакційна колегія

### Головний редактор

**Ольга Василівна Ходаківська** – доктор економічних наук, професор, член-кореспондент Національної академії аграрних наук України, заступник директора з науково-проектної роботи, Національний науковий центр «Інститут аграрної економіки», Україна

### Заступники головного редактора

**Юрій Олексійович Лупенко** – доктор економічних наук, професор, академік Національної академії аграрних наук України, директор, Національний науковий центр «Інститут аграрної економіки», Україна

**Леонід Григорович Мельник** – доктор економічних наук, професор, завідувач кафедри, директор Науково-дослідного інституту економіки розвитку МОН України та НАН України, Сумський державний університет, Україна

### Члени редакційної колегії

#### С. В. Андрос

доктор економічних наук, доцент, Національний науковий центр «Інститут аграрної економіки», Україна

#### А. О. Гуторов

доктор економічних наук, професор, головний науковий співробітник, Національний науковий центр «Інститут аграрної економіки», Україна

#### Ю. І. Данько

доктор економічних наук, професор, проректор, Сумський національний аграрний університет, Україна

#### В. М. Жук

доктор економічних наук, професор, академік Національної академії аграрних наук України, головний науковий співробітник, Національний науковий центр «Інститут аграрної економіки», Україна

#### Л. В. Забуранна

доктор економічних наук, професор, член-кореспондент Національної академії аграрних наук України, професор кафедри, Національний університет біоресурсів і природокористування України, Україна

#### О. В. Захарчук

доктор економічних наук, професор, завідувач відділу, Національний науковий центр «Інститут аграрної економіки», Україна

#### В. В. Зіновчук

доктор економічних наук, професор, завідувач кафедри, Поліський національний університет, Україна

#### М. Й. Малік

доктор економічних наук, професор, академік Національної академії аграрних наук України, головний науковий співробітник, Національний науковий центр «Інститут аграрної економіки», Україна

#### О. В. Орлова-Курилова

доктор економічних наук, доцент, виконувач обов'язків завідувача кафедри, Луганський національний аграрний університет, Україна

#### Н. І. Патица

доктор економічних наук, професор, завідувач відділу, Національний науковий центр «Інститут аграрної економіки», Україна

#### М. І. Пугачов

доктор економічних наук, професор, академік Національної академії аграрних наук України, заступник директора, Національний науковий центр «Інститут аграрної економіки», Україна

#### М. П. Сичевський

доктор економічних наук, професор, академік, академік-секретар відділення Національної академії аграрних наук України, Україна

<b>М. А. Хвесик</b>	доктор економічних наук, професор, академік Національної академії аграрних наук України, директор, Державна установа «Інститут економіки природокористування та сталого розвитку Національної академії наук України», Україна
<b>В. С. Шибанін</b>	доктор технічних наук, професор, академік Національної академії аграрних наук України, ректор, Миколаївський національний аграрний університет, Україна
<b>О. Г. Шпикуляк</b>	доктор економічних наук, професор, член-кореспондент Національної академії аграрних наук України, учений секретар, Національний науковий центр «Інститут аграрної економіки», Україна
<b>Міжнародні члени редколегії</b>	
<b>В. Л. Валентинов</b>	доктор економічних наук, професор, Лейбніц-Інститут аграрного розвитку в країнах з перехідною економікою, Федеративна Республіка Німеччина
<b>І. Ю. Гришова</b>	доктор економічних наук, професор, Цянзуський педагогічний університет, Китай
<b>Р. Мелнікіене</b>	доктор соціальних наук, директор Інституту економіки та розвитку сільських територій Литовського центру соціальних наук, заступник директора, Литовський центр соціальних наук, Литовська республіка
<b>Ц. Лерман</b>	доктор економічних наук, професор, Єврейський університет в Єрусалимі, Ізраїль
<b>Ш. Бойнець</b>	доктор економічних наук, професор, Приморський університет, Республіка Словенія
<b>І. Ферте</b>	доктор філософії, Центр економічних і регіональних досліджень, Угорщина
<b>Н. Лаце</b>	доктор економічних наук, професор, Ризький технічний університет, Латвійська Республіка
<b>А. Целік</b>	ординарний професор за спеціальністю "Економіка", Варшавський університет, Республіка Польща
<b>Г. Л. Кіріакопулос</b>	доктор філософії, фахівець з викладання та досліджень, Школа електротехніки та комп'ютерної інженерії, Національний технічний університет Афін, Греція

## Editorial Board

### Editor-in-Chief

**Olga Khodakivska** – Doctor of Economic Sciences, Professor, Corresponding Member National Academy of Agrarian Sciences of Ukraine, Deputy Director for Research and Project Work, National Scientific Center “Institute of Agrarian Economics”, Ukraine

### Deputy Editors-in-Chief

**Yurii Lupenko** – Doctor of Economic Sciences, Professor, Academician of the National Academy of Agrarian Sciences of Ukraine, Director, National Scientific Centre “Institute of Agrarian Economics”, Ukraine

**Leonid Melnyk** – Doctor of Economic Sciences, Professor, Head of the Department, Director Research Institute of Development Economics of the Ministry of Education and Science of Ukraine and the National Academy of Sciences of Ukraine, Sumy State University, Ukraine

## Editorial Board Members

### S. Andros

Doctor of Economic Sciences, Associate Professor, National Scientific Center “Institute of Agrarian Economics”, Ukraine

### A. Hutorov

Doctor of Economic Sciences, Professor, Chief Research Fellow, National Scientific Center “Institute of Agrarian Economics”, Ukraine

### Y. Danko

Doctor of Economic Sciences, Professor, Vice-Rector, Sumy National Agrarian University, Ukraine

### V. Zhuk

Doctor of Economic Sciences, Professor, Academician of National Academy of Agrarian Sciences of Ukraine, Chief Research Fellow, National Scientific Center “Institute of Agrarian Economics”, Ukraine

### L. Zaburanna

Doctor of Economic Sciences, Professor, Corresponding Member of National Academy of Agrarian Sciences of Ukraine, Professor of the Department, National University of Life and Environmental Sciences of Ukraine, Ukraine

### O. Zakharchuk

Doctor of Economic Sciences, Professor, Head of Department, National Scientific Center “Institute of Agrarian Economics”, Ukraine

### V. Zinovchuk

Doctor of Economic Sciences, Professor, Head of the Department, Polissia National University, Ukraine

### M. Malik

Doctor of Economic Sciences, Professor, Academician of National Academy of Agrarian Sciences of Ukraine, Chief Research Fellow, National Scientific Center “Institute of Agrarian Economics”, Ukraine

### O. Orlova-Kurilova

Doctor of Economic Sciences, Associate Professor, Acting Head of the Department, Luhansk National Agrarian University, Ukraine

### N. Patyka

Doctor of Economic Sciences, Professor, Head of Department, National Scientific Center “Institute of Agrarian Economics”, Ukraine

### M. Pugachov

Doctor of Economic Sciences, Professor, Academician of National Academy of Agrarian Sciences of Ukraine, Deputy Director, National Scientific Center “Institute of Agrarian Economics”, Ukraine

### M. Sychevskiy

Doctor of Economic Sciences, Professor, Academician, Academician-Secretary of the Department of National Academy of Agrarian Sciences of Ukraine, Ukraine

<b>M. Khvesyk</b>	Doctor of Economic Sciences, Professor, Academician of National Academy of Agrarian Sciences of Ukraine, Director, State Institution "Institute of Environmental Economics and Sustainable Development of the National Academy of Sciences of Ukraine", Ukraine
<b>V. Shebanin</b>	Doctor of Technical Sciences, Professor, Academician of National Academy of Agrarian Sciences of Ukraine, Rector, Mykolaiv National Agrarian University, Ukraine
<b>O. Shpykuliak</b>	Doctor of Economic Sciences, Professor, Corresponding Member of National Academy of Agrarian Sciences of Ukraine, Scientific Secretary, National Scientific Center "Institute of Agrarian Economics", Ukraine

**International Members of the Editorial Board**

<b>V. Valentinov</b>	Doctor of Economic Sciences, Professor, Leibniz-Institute for Agrarian Development in Countries in Transition, Federal Republic of Germany
<b>I. Gryshova</b>	Doctor of Economic Sciences, Professor, Jiangsu Pedagogical University, China
<b>R. Melnikiene</b>	Doctor of Social Sciences, Director of the Institute of Economics and Rural Development of the Lithuanian Center for Social Sciences, Deputy Director, Lithuanian Center for Social Sciences, Republic of Lithuania
<b>Z. Lerman</b>	Doctor of Economic Sciences, Professor, Hebrew University of Jerusalem, Israel
<b>Š. Bojnec</b>	Doctor of Economic Sciences, Professor, University of Primorska, Republic of Slovenia
<b>I. Fertő</b>	Doctor of Philosophy, Centre for Economic and Regional Studies, Hungary
<b>N. Lāce</b>	Doctor of Economic Sciences, Professor, Riga Technical University, Republic of Latvia
<b>A. Cieřlik</b>	Professor Ordinarius in the specialty "Economics", University of Warsaw, Republic of Poland
<b>G. L. Kyriakopoulos</b>	Doctor of Philosophy, Teaching and Research Specialist, School of Electrical and Computer Engineering, National Technical University of Athens, Greece

## ЗМІСТ / CONTENTS

### **В. О. Борисенко, Д. В. Борисенко**

Оптимізація виробництва та моделювання собівартості продукції в селянських господарствах..... 10

### **V. Borysenko, D. Borysenko**

Optimisation of production and modelling of production costs in farms ..... 10

### **О. М. Бородіна, І. В. Прокопа, О. В. Риковська**

Посилення ролі локальних агропродовольчих систем у подоланні  
наслідків використання продовольства як зброї в Україні ..... 19

### **O, Borodina, I, Prokopa, O, Rykovska**

Strengthening the role of local agri-food systems in overcoming the consequences  
of using food as a weapon in Ukraine..... 19

### **Я. В. Долгіх**

Оцінка ефективності аграрних закладів вищої освіти України  
та динаміки її зміни методом data envelopment analysis ..... 29

### **Ya. Dolgikh**

Evaluation of the efficiency of agricultural higher education institutions of Ukraine  
and the dynamics of its change by data envelopment analysis..... 29

### **М. Й. Малік, С. А. Кравченко, О. Г. Шпикуняк, Г. О. Гудзь**

Розвиток суб'єктів малого підприємництва з виробництва зернових,  
бобових і насіння соняшнику в умовах воєнного часу..... 41

### **M. Malik, S. Kravchenko, O. Shpykuliak, H. Hudz**

Development of small businesses producing cereals, legumes, and sunflower seeds in wartime conditions..... 41

### **Л. В. Смолій, М. І. Мостов'як**

Україна на ринках органічної агропродовольчої продукції країн  
Європейського Союзу: аналітика, тренди та перспективи..... 54

### **L. Smolii, M. Mostoviak**

Ukraine in the markets of organic agri-food products of the European Union: Analytics, trends, and prospects ..... 54

### **Е. Шахіні**

Аграрна економіка Албанії: трансформація, можливості  
та виклики для сучасних сільськогосподарських підприємств ..... 64

### **E. Shahini**

Albania's agricultural economy: Transformation, opportunities and challenges for modern agricultural enterprises ... 64



UDC 631.1, 004

## Optimisation of production and modelling of production costs in farms

**Volodymyr Borysenko\***

PhD in Economic Sciences, Scientific Researcher  
Ukrainian Research Institute of Agricultural Productivity  
03035, 2 Solomyanska Sq., Kyiv, Ukraine  
<https://orcid.org/0000-0002-8742-146X>

**Dmytro Borysenko**

Master's Student  
Ukrainian Research Institute of Agricultural Productivity  
03035, 2 Solomyanska Sq., Kyiv, Ukraine  
<https://orcid.org/0009-0002-1021-4726>

► **Abstract.** A significant area of improvement of the economic efficiency of agricultural enterprises, especially in the context of martial law, is to optimise production and use of resource potential. The purpose of this study was to develop scientific and practical recommendations for optimising the production activities of farms. The study employed the following methods: system analysis and synthesis to determine the reserves of the types of resources involved; economic-mathematical modelling and optimisation to determine best solutions; analytical-calculation method to calculate production indicators; correlation and regression analysis to determine the dependence of milk production costs on resource consumption; graphical method and extrapolation to find the values of the regression function. The principal stages and features of building an economic-mathematical model for optimising the resource potential of enterprise were identified. The model was used to analyse data, identify reserves of resource potential, find an optimisation solution for product sales volumes using the Solution Search spreadsheet tool, and adopt a strategy for improving economic efficiency. The study offered a solution for the economic and mathematical modelling of the best structure of production of a farm, which factors in the available production resources. The modelling found that the maximum income can be obtained by redistributing the production volumes of certain types of products and, accordingly, the resources for their production, considering the standard costs of production per unit of product, prices for products and resources. Using the modelling, the study obtained a regression dependence of the cost of milk produced in household farms on the cost of feed, labour costs, wages, and the number of cows. The study found the impact of certain types of resources on the production cost and builds the corresponding graphical dependencies. The practical value of the findings of this study lies in the possibility of using the recommendations directly by members of farms in planning, organising production activities, and optimising the use of resource potential

► **Keywords:** optimisation of the production structure; modelling; regression analysis; production resources; household farming

### ► Introduction

In market conditions, especially during the period of martial law in Ukraine, mechanisms for optimising the production activities of agricultural producers of all forms of management: enterprises of various forms of ownership, farm enterprises and household farms, are becoming increasingly important. Considerable changes in the

external environment of agricultural enterprises require the development of innovative methods, approaches, and management systems that determine the need for economic and mathematical modelling. Most agricultural enterprises focus on insufficiently formed and clear goals, which is conditioned by the lack of suitable

► **Suggested Citation:** Borysenko, V., & Borysenko, D. (2024). Optimisation of production and modelling of production costs in farms. *Ekonomika APK*, 31(1), 10-18. doi: 10.32317/2221-1055.202401010.

\*Corresponding author



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

tools and methods for solving optimisation problems among agricultural specialists (Pasechko *et al.*, 2019; Vishnevsky *et al.*, 2020).

M. Levina Kostiuk *et al.* (2021) covered the methodological foundations for optimising the production activities of farms based on economic and mathematical modelling to ensure their sustainable development and expanded reproduction and the development of practical recommendations. S. Nuzhna & N. Samarets (2018) analysed some aspects of the development and construction of an economic and mathematical model for optimising the production resources of agricultural enterprises and finding reserves and rational use of resource potential, improving the economic efficiency of production.

R. Skrynkovskyy *et al.* (2022) improved the structural scheme (triple continuum model as a conceptual scheme of information technologies) of financial and technological processes management, innovation risks, which considers the impact of innovations on the activities (internal variables, business processes) of the enterprise, restrictions (on production, sales, supply, financing), and the conditions for their compliance with the best production (sales) volume, as well as the synergistic effect in the context of profit maximisation, in the “type of innovation – type of development” system, in the system of sustainable development values. L. Malyarets *et al.* (2019, 2020) describe the formulation of a multi-objective task of optimising the indicators of enterprise development and substantiate the choice of a genetic algorithm for solving the problem of multi-objective optimisation of enterprise development indicators by analysing the disadvantages and advantages of modern methods for solving multi-objective optimisation problems.

An analytical approach to the construction of partial criteria in a multi-objective optimisation problem in the economy was considered as stochastic dependencies of production components on indicators in the form of latent factors that should be noted by factor analysis (Audet *et al.*, 2021). D. Bertsimas & N. Kallus (2019) investigated an analogous stochastic optimisation problem, where some decision variables, such as price, may be affected by uncertainty, and their causal outcomes are unknown. When developing a model for forecasting the volume of sales of agricultural enterprise, Y. Kharchenko (2021) recommends using adaptive modelling to improve operational planning of production and, if necessary, quickly make changes to production plans. It is proposed to use the developed automated decision-making system based on the information-logic model as a result of research on the use of modelling for making best management decisions (Domaskina & Kolomojtssev, 2018).

Ways of solving the problem of efficient operation of farms and optimisation of agricultural production were proposed in scientific studies by many researchers. However, modelling the production activities of household farms has not received sufficient attention in such research. Thus, the purpose of this study was to develop economic and mathematical models and recommendations for optimising production of products and improving the economic efficiency of economic activity.

To achieve this, the following tasks need to be completed:

- to develop a mathematical model for optimising production and allocating resource potential for farms;
- using the model, to determine the optimised sales volumes of each type of product and, accordingly, the required quantities of each type of resource;
- to develop a correlation and regression model of the dependence of production costs on resource consumption, and to build the corresponding graphical dependencies.

## ► Materials and Methods

The method of system analysis and synthesis was used to determine the types of resources involved in production in general and for certain types of products, as well as their limitations. Furthermore, the study used economic and mathematical modelling and optimisation methods to determine the best solutions for resource provision, as well as the analytical and calculation method to determine the cost of resources. Using the methods of regression analysis, the study derived an analytical dependence of milk cost on the cost of certain types of resources (feed, labour, number of livestock, etc.), determined the magnitude of the impact of resource costs on production cost, and built corresponding graphical dependencies.

The efficiency of agricultural production and the development of recommendations for its improvement were assessed according to the indicators of production of household farms (HF) in the Menskyi district of Chernihiv region for 2022, namely, based on the financial statements of the owner (based on research materials according to the scientific and technical complex programme “Scientific research and development of methodological approaches and economic and regulatory systems for the expenditure of labour and material resources in the production of products (works, services) to ensure and improve the socio-economic development of the agro-industrial complex and territorial communities for 2021-2023”) (Report on the implementation..., n.d.).

The structural model of the problem, considering the consumption rates of resources, their quantity and sales prices, is presented below.

$$\begin{cases} R_{max} = c_1x_1 + c_2x_2 + c_3x_3 + \dots + c_{ij}x_j \dots + c_nx_n \\ a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \dots + a_{ij}x_j \dots + a_{1n}x_n \leq Q_1 \\ a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \dots + a_{ij}x_j \dots + a_{2n}x_n \leq Q_2 \\ a_{i1}x_1 + a_{i2}x_2 + a_{i3}x_3 + \dots + a_{ij}x_j \dots + a_{in}x_n \leq Q_m \\ a_{m1}x_1 + a_{m2}x_2 + a_{m3}x_3 + \dots + a_{ij}x_j \dots + a_{mn}x_n \leq Q_m \\ x_1 \geq 0, x_2 \geq 0, x_3 \geq 0, \dots, x_n \geq 0 \\ j = 1, \dots, n; i = 1, \dots, m, \end{cases} \quad (1)$$

where  $R_{max}$  is the income from the sale of farm products (UAH);  $c_j$  is the sale price of a unit of the  $j$ -th type of manufactured products (UAH);  $x_j$  is the number of products of the  $j$ -th type (100 kg);  $a_{ij}$  is the cost norms of the  $i$ -th type of resource required to produce a unit of the  $j$ -th type of product (UAH/100 kg);  $Q_i$  is the factual volume of the  $i$ -th type of resource (UAH);  $n$  is the number of types of products produced by the farm;  $m$  is the number of types of resources used in production.

The task is solved using the *Excel* spreadsheet processor. The farm under study produces four types of agricultural products ( $n=4$ ) and uses 9 main types of resources

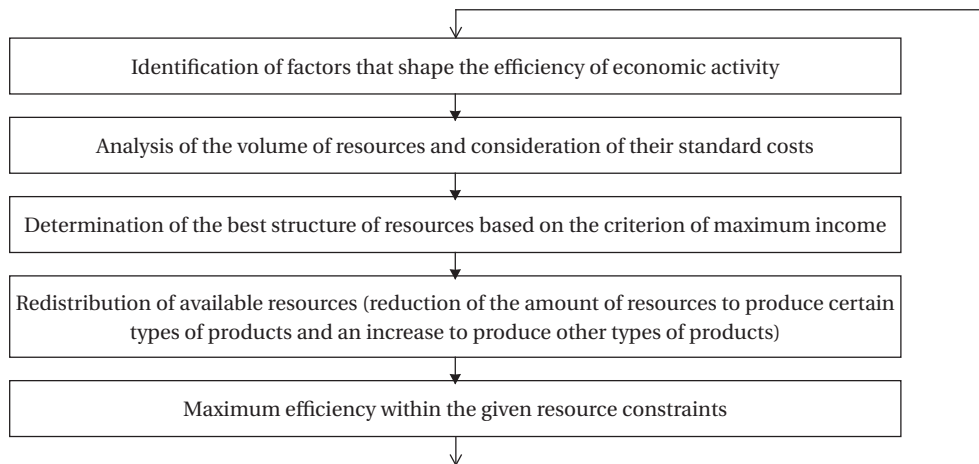
( $m=9$ ). The following notation was introduced for production volumes and, accordingly, the resources used:  $x_1$  is the amount of milk, 100 kg;  $x_2$  is the amount of pork, 100 kg;  $x_3$  is the amount of eggs, thous. pcs.;  $x_4$  is the amount of cattle meat, 100 kg;  $Q_1, Q_2, \dots, Q_9$  are the factual amounts of resources, respectively: labour costs, feed costs, energy costs, maintenance, animal protection products, fuel, bedding, other direct costs, cost of services.

When determining the analytical model of production indicators using the methods of correlation and regression analysis, the information base of the study included data on resource consumption and production costs based on the business results of household farms in Chernihiv and Volyn regions in 2022 (Report on the implementation..., n.d.).

The modelling of agricultural production indicators by regression analysis was performed using computer software "RegMod" (Borysenko & Bosiy, 2010), which provides automation of calculations of the regression equation parameters and assessment of the adequacy and definition of economic indicators.

### ► Results and Discussion

When optimising the resource potential of production, it is necessary to determine the necessary volumes of resources and their rational correlation for the economic activity and maximum income (Zhmuđenko & Lishchuk, 2021). The model of optimising the resource potential of a farm can be represented as a flowchart presented in Figure 1.



**Figure 1.** A model for optimising the resource potential of a farm

**Source:** compiled by the authors of this study

The task is to find the maximum revenue from the sale of products, considering the constraints of production resources. The numerical mathematical model is based on the data on the consumption of resources to produce agricultural products. The main activity of the farm is the production of livestock products, namely: raising pigs,

chickens, cattle for the sale of milk, cattle meat, pork, and chicken eggs.

According to the annual report of production costs of household farms, Table 1 summarises the costs of each type of input, their total volumes, and sales prices by product type.

**Table 1.** Expenditure of material resources to produce agricultural products

Resource	Resource consumption rates per unit of output, UAH/100 kg				Amount of resources, UAH
	milk	pork	eggs	cattle meat	
Remuneration of labour	254.19	1,386.67	829.11	1,246.53	28,279
Cost of feed	110.63	1,004.71	581	2,238.89	16,472
Energy resources	11.79	43.14	35.21	83.33	1,282
Current repairs	16.26	58.82	42.25		1,582
Animal protection products	16.1	109.8	28.17	152.78	1,886
Fuel	22.76	143.14	72.77	145.83	2,628
Bedding	7.32	39.12	14.08	41.67	728
Other direct costs	30.49	509.8	187.79	152.78	4,580
Cost of services	18.7	68.63	23.47	173.61	1,999
Sales price of 100 kg of products	750	4,400	2,250	4,300	
Products sold, 100 kg	80.00	2.70	2.90	1.44	

**Source:** developed by the authors of this study based on the Report on the implementation of the thematic plan of research activities of the research institute "UkrAgroProductivity" (n.d.)

According to the structural model of optimisation of the resource potential of the agricultural household, the

numerical detailed mathematical model of the problem can be represented as a system of equations:

$$\begin{cases}
 R_{max} = 750 x_1 + 4,400 x_2 + 2,250 x_3 + 4,300 x_4 \\
 254.19 x_1 + 1,386.67 x_2 + 829.11 x_3 + 1,246.53 x_4 \leq 28,279 \\
 110.63 x_1 + 1,004.71 x_2 + 581 x_3 + 2,238.89 x_4 \leq 16,472 \\
 11.79 x_1 + 43.14 x_2 + 35.21 x_3 + 83.3 x_4 \leq 1,282 \\
 16.26 x_1 + 58.82 x_2 + 42.25 x_3 \leq 1,582 \\
 16.1 x_1 + 109.8 x_2 + 28.17 x_3 + 152.78 x_4 \leq 1,886 \\
 22.76 x_1 + 143.14 x_2 + 72.77 x_3 + 145.83 x_4 \leq 2,628 \\
 7.32 x_1 + 39.12 x_2 + 14.08 x_3 + 41.67 x_4 \leq 728 \\
 30.49 x_1 + 509.8 x_2 + 187.79 x_3 + 152.78 x_4 \leq 4,580 \\
 18.7 x_1 + 68.63 x_2 + 2,347 x_3 + 173.61 x_4 \leq 1,999 \\
 x_j \geq 0; j = 1, \dots, 4.
 \end{cases} \quad (2)$$

The modelling has revealed that farms can achieve maximum income by producing certain types of products and in their certain volumes. The best redistribution of available resources was obtained considering the production of all types of products, the use of production resources, the standard costs of producing a unit of each type of product and its selling price in 2023: milk – 850 UAH/100 kg, pork – 5,500 UAH/100 kg, eggs – 3,200 UAH/1000 pieces, cattle meat – 5,100 UAH/100 kg. As a result of solving the problem using the *Excel* spreadsheet processor, the optimised volumes of material resources to produce agricultural products were obtained, which are presented in Table 2.

**Table 2.** Optimised consumption of resources for production

Products	Amount of resources, UAH	Resource growth coefficient
Milk	34,177	0.88
Pork	6,728	0.74
Eggs	14,329	5.0
Cattle meat	4,235	0.69
Total resources	59,469	1

**Source:** compiled by the authors of this study

The modelling results suggest that if the available resources are redistributed to the production of certain types of products according to Table 2 and considering the sales prices in 2023, the company's resources will be used most efficiently.

The increase in the values of the indicators of the efficiency of production of agricultural enterprises compared to the previous year, expected as a result of optimising the allocation of production resources, is summarised in Table 3.

**Table 3.** Performance indicators before and after production optimisation

Products	Performance indicators									
	for 2022				planned after optimising resource allocation					
	Revenue, UAH	Prime cost, UAH	Profit, UAH	Profitability	Income, UAH	Growth coefficient	Prime cost, UAH	Profit, UAH	Profitability	Sales, 100 kg
Milk	60,000	39,059	20,941	53.61	59,500	1.05	34,177	25,323	74	70
Pork	11,880	9,082	2,798	30.8	10,800	0.91	6,728	4,072	60.5	2
Eggs	6,525	5,260	1,265	24.05	25,280	3.87	14,329	10,951	76.42	7.9
Cattle meat	6,192	6,099	93	1.52	5,300	0.86	4,235	1,065	25.14	1
By HF	84,597	59,500	25,097	42.18	100,880	1.19	59,469	41,411	69.6	

**Source:** compiled by the authors of this study

The above profitability figures will be slightly reduced for the cost of resources at the time of calculation in the HF. The performance indicators after optimisation show that the maximum income can be achieved by increasing the production of chicken eggs ( $x_3$ ), since the income received from the sale of chicken eggs is much higher than when raising cattle or pigs for milk ( $x_1$ ), pork ( $x_2$ ) and cattle meat ( $x_4$ ). Based on the results obtained, the farms under

study have the potential to increase the level of profitability and efficiency of production activities. For agricultural producers, it is vital to forecast the price of products sold on the Ukrainian market, as emphasised, for instance, by N. Shyian *et al.* (2021). Next, the study considered the correlation and regression modelling of the dependence of milk production costs on the consumption of certain resources (Table 4) required to produce the final product.

**Table 4.** Input data for determining the model of milk cost dependence on influencing factors

Number of livestock, total heads	Labour costs, man-hours/100 kg	Labour remuneration, UAH/100 kg	Feed cost, UAH/100 kg	Production cost, UAH/100 kg
3	14.3	254.19	110.63	488.24
2	16.38	281.48	138.29	580.7
1	14.2	366.68	147.44	661.7

Table 4, Continued

Number of livestock, total heads	Labour costs, man-hours/100 kg	Labour remuneration, UAH/100 kg	Feed cost, UAH/100 kg	Production cost, UAH/100 kg
3	7.64	170.20	524.40	737
5	9.88	226.50	348.75	632
1	14.83	221.95	213.75	527.45

Source: developed by the authors of this study based on the Report on the implementation of the thematic plan of research activities of the research institute "UkrAgroProductivity" (n.d.)

According to the methodology for determining the regression equation, the economic and mathematical model includes those types of resource costs that have a substantial impact on the prime cost. The modelling process

uses regression analysis to determine the regression equation for the specified dependent variable (milk production cost) on the independent variables: feed cost, labour costs, wages, and the number of cows (Fig. 2).

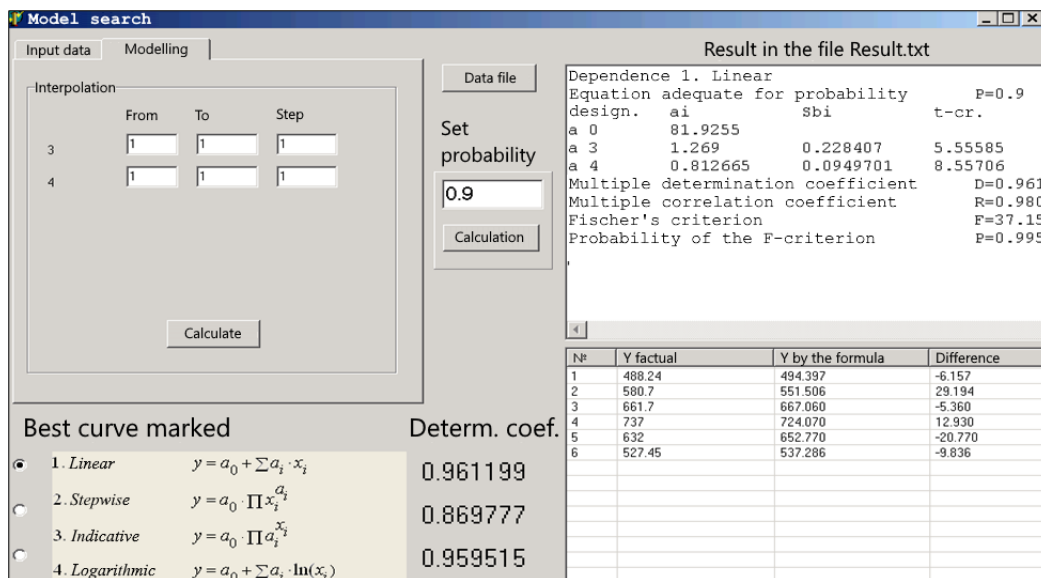


Figure 2. The panel of the regression analysis programme when creating a model

Source: developed by the authors of this study based on V. Borysenko & M. Bosiy (2010)

As a result of processing the input data of Table 2 with a regression analysis computer software, the analytical model was determined in the form of a linear function:

$$C = 81.93 + 1,269 \times L_R + 0.813 \times F, \quad (3)$$

where  $L_R$  is the labour remuneration, UAH, calculated per 100 kg of milk produced;  $F$  is the cost of feed, UAH per 100 kg of milk.

The adequacy of the obtained regression equation is evidenced by the following statistical indicators: the coefficients of multiple determination are not less than 0.96, significant at the probability level of 0.99, and the regression coefficients are significant at the same probability. In this case, the regression coefficients of the labour costs and the number of cows in household farms were insignificant at a given probability, and the software excluded these independent variables from the analysis, i.e., the columns of the correlation matrix of the original data were excluded in the output table. This situation occurs frequently in research and is usually the result of the following circumstance: the variance of a variable is very small relative to its mean. Then it is concluded that at any value of this variable in this range of studies, the function (the

desired indicator) will not change significantly (Lu, 2019; Borysenko, 2022).

According to the defined equation, it is possible to calculate the value of the cost price (function) depending on changes in the value of production inputs (independent variables) (Hassani *et al.*, 2019). To verify the adequacy of the created model, the working panel of the program displays the factual prime cost values and those calculated using the regression equation. The maximum deviation of the model's prime cost of 551.51 UAH/100 kg with labour costs of 281.48 UAH/100 kg and feed costs of 138.29 UAH/100 kg from the factual value is 5%, which is sufficiently accurate to use the resulting relationship in forecasting calculations. As a result of the software processing, elasticity coefficients were also obtained, which show how much the prime cost will change in percentage terms if the values of these variables change by 1% and are 0.532 and 0.332% for labour costs and feed costs, respectively.

According to the established mathematical dependence, the cost of milk produced is determined according to the planned labour and feed costs. The results of modelling the cost of milk produced by household farms in relation to feed costs with fixed labour costs are summarised in Table 5.

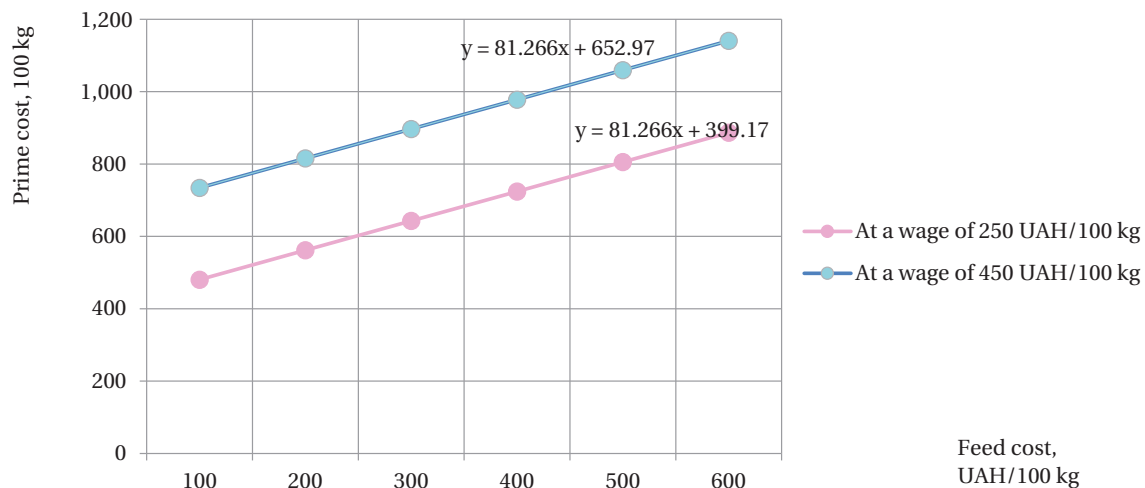
**Table 5.** The value of the cost of milk produced by the HF according to the regression model in relation to feed and labour costs

Feed cost, UAH/100 kg	Production cost, UAH/100 kg	
	at a wage of 250 UAH/100 kg	at a wage of 450 UAH/100 kg
100.00	480.44	734.24
200.00	561.71	815.51
300.00	642.97	896.77
400.00	724.24	978.04
500.00	805.51	1,059.31
600.00	886.77	1,140.57

**Source:** compiled by the authors of this study

Regression modelling allows planning or adjusting the cost of production for future periods, considering changes in the cost of resources, and compare the real production figures with the modelled ones. The corresponding

graphical dependencies of the cost of milk production in the subsidiary farms on the cost of feed at fixed values of another variable – labour remuneration costs – are presented in Figure 3.

**Figure 3.** Dependence of milk production cost on feed cost according to the planned labour remuneration variants

**Note:** the function  $y=81.266-x+399.17$  was obtained at a labour remuneration of 250 UAH/100 kg; the function  $y=81.266-x+652.97$  was obtained at a labour remuneration of 450 UAH/100 kg

**Source:** compiled by the authors of this study

Thus, the use of regression dependence of the cost of livestock production on production conditions will allow obtaining the cost of milk production for any value of resource consumption for production, as well as a comparative economic assessment of the dynamics of the impact of the consumption of certain types of resources on production indicators.

In the study of optimisation methods in agriculture, G.C. Lomte & S.R. Dhavale (2022) developed a farm model using linear programming to determine the best combination of seasonal crops, their distribution in different seasons to increase production. In solving these problems, a linear programming model is used to optimally allocate limited resources to maximise farm profits. The purpose and methods of the cited study were the same as in the present study, but the objects of optimisation are different: the crop and livestock sectors.

R. Skrynkovskyy *et al.* (2022) proposed a multiplicative criterion for the effectiveness of innovation risk management in the task of maximising the enterprise's profit, considering, apart from methods for assessing the functions

and parameters of the economic, environmental, and social criteria of the system for ensuring sustainable development, the methods for determining the indicator of the quality of enterprise development, as well as methods of enterprise management as a system for obtaining a type of development under the influence of a type of innovation. Thus, the authors' study has an analogous purpose, but uses both different methods and a more general object of study.

Y. Kharchenko (2021) analysed the statistical data of agricultural enterprises in the Poltava region, specifically, the author identified several influential factors and proposed to perform a regression analysis in the development of a linear multifactorial model and obtain an adaptive model to find the best forecast model of production volumes. Thus, the researcher also used regression analysis for the forecast model, but to determine production volumes, not production costs, as in the present study.

B. Noeldeke *et al.* (2022) compares several decision-making approaches to the transition of smallholder farmers to agroforestry, and creates a simulation model

for rural Rwanda based on data from a socio-economic survey of smallholder farmers on the adoption of agroforestry. The modelling results show that decision-making based on the theory of rational choice and the econometric approach should be based on the criteria of maximum profit and sales revenue. It was suggested that model developers substantiate the approach to decision-making in the issues of enterprise economics based on maximum compliance with real processes and considering undiscounted and discounted profit maximisation. The conclusions drawn regarding the choice of scientific approaches to solving the tasks set coincide with the approaches used in the present study.

S. Nuzhna & N. Samarets (2018) confirmed the effectiveness of the use of economic and mathematical methods in assessing both the resource potential of agricultural enterprises and optimising the volume of product sales, and modelling agricultural production provides management opportunities at different stages of the enterprise's functioning. In contrast to the one proposed in the present study, the authors optimise production in household farms and propose regression modelling.

In analogous studies conducted by V. Zhmudenko & R. Lishchuk (2021) created a model of an optimised combination of resources to achieve maximum profit of a limited liability company with limited resources, but the authors of this study developed models with a more detailed analysis of economic indicators and predictive modelling based on regression analysis.

Summarising the review of the conducted studies, it can be concluded that the recommendations for optimising the production of farms by means of economic and mathematical modelling of the best production structure and regression modelling of production costs depending on changes in resource costs are relevant for practical use.

### ► Conclusions

According to the purpose of this study, scientific and practical recommendations for optimising the production activities of farms were developed based on modelling optimised sales volumes and forecasted indicators of their cost. A structural model and a flowchart of the model of optimisation of the resource potential of farming were developed. An optimisation solution for achieving the

### ► References

- [1] Audet, C., Bigeon, J., Cartier, D., Le Digabel, S., & Salomon, L. (2021). [Performance indicators in multiobjective optimization](#). *European Journal of Operational Research*, 292(2), 397-422.
- [2] Bertsimas, D., & Kallus, N. (2019). From predictive to prescriptive analytics. *Management Science*, 66(3), 1025-1044. [doi: 10.1287/mnsc.2018.3253](#).
- [3] Borysenko, V. (2022). Simulation of performance indicators of field units on the base of knowledge bases of the fields of sciences as a component of the digital economy. *Energy and Automation*, 94-106. [doi: 10.31548/energiya2022.04.094](#).
- [4] Borysenko, V., & Bosiy, M. (2010). [The basics of the methodology and methods of simulation modeling of the operation of field units to substantiate their effective use](#). Kyiv: RI "Ukrainian Industrial Productivity".
- [5] Domaskina, M., & Kolomoitsev, A. (2018). [Automatic selection of the optimal solution in the agricultural household](#). *Ukrainian Black Sea Region Agrarian Science*, 22(1), 95-104.
- [6] Hassani, L., Kakhki, M.D., Sabouhi, M., & Ghanbari, R. (2019). The optimization of resilience and sustainability using mathematical programming models and metaheuristic algorithms. *Journal of Cleaner Production*, 228, 1062-1072. [doi: 10.1016/j.jclepro.2019.04.324](#).
- [7] Kharchenko, Y. (2021). Developing models for forecasting agricultural enterprises sales volume. *Economic Scope*, 167, 134-139. [doi: 10.32782/2224-6282/167-24](#).

maximum income of UAH 100,880 (an increase of almost 20%) by a producer was found on the example of livestock production in a household farm in the Menskyi district of Chernihiv region.

Considering the optimisation criterion and the model's constraints on the volume of resources, the coefficients of the system of equations of the numerical detailed mathematical model of the problem were determined following the performance indicators of the enterprise in terms of output and provision with individual resources. The modelling found that the maximum income can be obtained by redistributing the production volumes of certain types of products and, accordingly, the resources for their production, considering the standard costs of production per unit of product, prices for products and resources. The more than 1.5-fold increase in profit and profitability achieved is evidence of a considerable increase in business efficiency.

The study offered modelling of indicators of agricultural production according to methods of regression analysis. The study considered the modelling of regression dependencies of the cost of milk production on the cost of feed, labour costs, wages, and the number of cows based on the business results of household farms. The graphical dependencies of the cost of milk production in a household farm on the cost of feed at fixed labour costs were constructed. Regression analysis was used to determine the impact of the consumption of certain types of resources on the cost of milk production. The developed economic and mathematical models ensure the achievement of minimum production costs and maximum income from the sale of products and, as a result, increase the economic efficiency of the economic activity of the farm. Prospects for further research, considering the global processes of digitalisation and digital transformation of economic sectors, are the development of decision support systems based on economic and mathematical methods of modelling and system optimisation of technical and technological solutions.

### ► Acknowledgments

None.

### ► Conflict of Interest

The authors of this study declare no conflict of interest.

- [8] Levina Kostiuk, M., Melnychuk, O., Danilenko, O., Lagodienko, V., & Tkachuk, H. (2021). Optimization of farm production activity using economic and mathematical methods. *Ukrainian Journal of Applied Economics and Technology*, 6(4), 112-120. doi: [10.36887/2415-8453-2021-4-13](https://doi.org/10.36887/2415-8453-2021-4-13).
- [9] Lomte, G.C., & Dhavale, S.R. (2022). Optimization techniques in agriculture sector. *International Journal of Physics and Mathematics*, 4(1), 47-49. doi: [10.33545/26648636.2022.v4.i1a.53](https://doi.org/10.33545/26648636.2022.v4.i1a.53).
- [10] Lu, Y. (2019). Artificial intelligence: A survey on evolution, models, applications and future trends. *Journal of Management Analytics*, 6(1), 1-29. doi: [10.1080/23270012.2019.1570365](https://doi.org/10.1080/23270012.2019.1570365).
- [11] Malyarets, L., Babenko, V., Nazarenko, O., & Ryzhikova, N. (2019). [The modeling of multi-criteria assessment activity in enterprise management](#). *International Journal of Supply Chain Management*, 8(4), 997-1004.
- [12] Malyarets, L., Iastremska, O., Herashchenko, I., Iastremska, O., & Babenko, V. (2020). optimization of indicators for management of enterprise: Finance, production, marketing, personnel. *Studies in Applied Economics*, 38(4). doi: [10.25115/eea.v38i4.4028](https://doi.org/10.25115/eea.v38i4.4028).
- [13] Noeldeke, B., Winter, E., & Ntawuhiganayo, E.B. (2022). Representing human decision-making in agent-based simulation models: Agroforestry adoption in rural Rwanda. *Ecological Economics*, 200, article number 107529. doi: [10.1016/j.ecolecon.2022.107529](https://doi.org/10.1016/j.ecolecon.2022.107529).
- [14] Nuzhna, S., & Samarets, N. (2018). Optimization of use of manufacturing resources by enterprises of the agricultural sector. *Economic Analysis*, 28(4), 225-234. doi: [10.35774/econa2018.04.225](https://doi.org/10.35774/econa2018.04.225).
- [15] Pasechko, D.-V., Kushnerenko, V., & Dashevska, L. (2019). Use of correlation, regression and logistic models for the losses estimation of dairy industry from the heat stress. *Ukrainian Black Sea Region Agrarian Science*, 23(1), 77-83. doi: [10.31521/2313-092X/2019-1\(101\)-11](https://doi.org/10.31521/2313-092X/2019-1(101)-11).
- [16] Report on the implementation of the thematic plan of research activities of the research institute "UkrAgroProductivity". (n.d.). Retrieved from [https://uapp.in.ua/naukovo-vidavnychia-dijalnist/zvit\\_16-20\\_ukragropromproduktynst-1-pdf/](https://uapp.in.ua/naukovo-vidavnychia-dijalnist/zvit_16-20_ukragropromproduktynst-1-pdf/).
- [17] Shyian, N., Moskalenko, V., Shabinskyi, O., & Pechko, V. (2021). Milk price modeling and forecasting. *Agricultural and Resource Economics: International Scientific E-Journal*, 7(1), 81-95. doi: [10.51599/are.2021.07.01.05](https://doi.org/10.51599/are.2021.07.01.05).
- [18] Skrynkovskyy, R., Pavlenchyk, N., Tsyuh, S., Zanevskyy, I., & Pavlenchyk, A. (2022). Economic-mathematical model of enterprise profit maximization in the system of sustainable development values. *Agricultural and Resource Economics: International Scientific E-Journal*, 8(4), 188-214. doi: [10.51599/are.2022.08.04.09](https://doi.org/10.51599/are.2022.08.04.09).
- [19] Vishnevsky, V., Harkushenko, O., Kniaziev, S., Lypnytskyi, D., & Chekina, V. (2020). [Digitalization of the economy of Ukraine: Transformational potential](#). Kyiv: PH "Akademperiodika".
- [20] Zhmudenko, V., & Lishchuk, R. (2021). Optimization of resource potential as a strategic direction of enterprise development. *Economic Scope*, 165, 70-75. doi: [10.32782/2224-6282/165-12](https://doi.org/10.32782/2224-6282/165-12).

## Оптимізація виробництва та моделювання собівартості продукції в селянських господарствах

### Володимир Олексійович Борисенко

Кандидат економічних наук, науковий співробітник

Український науково-дослідний інститут продуктивності агропромислового комплексу

03035, пл. Солом'янська, 2, м. Київ, Україна

<https://orcid.org/0000-0002-8742-146X>

### Дмитро Володимирович Борисенко

Магістрант

Український науково-дослідний інститут продуктивності агропромислового комплексу

03035, пл. Солом'янська, 2, м. Київ, Україна

<https://orcid.org/0009-0002-1021-4726>

- **Анотація.** Важливим напрямом підвищення економічної ефективності діяльності сільськогосподарських підприємств, особливо в умовах воєнного стану, є оптимізація виробництва та використання ресурсного потенціалу. Метою досліджень була розробка науково-практичних рекомендацій щодо оптимізації виробничої діяльності селянських господарств. В дослідженні використано методи: системного аналізу та синтезу при визначенні резервів задіяних видів ресурсів, економіко-математичне моделювання і оптимізації для визначення оптимальних рішень, аналітично-розрахунковий метод – в розрахунках показників виробництва продукції, кореляційно-регресійний аналіз при визначенні залежності собівартості виробництва молока від витрат ресурсів, графічний метод та екстраполяції для знаходження значень функції регресії. Виявлено основні етапи та особливості побудови економіко-математичної моделі оптимізації ресурсного потенціалу підприємства. З використанням моделі проведено аналіз даних, виявлено резерви ресурсного потенціалу, знайдено оптимізаційне рішення з обсягів реалізації продукції із застосуванням засобу електронних таблиць «Пошук рішення», прийнято стратегію підвищення економічної ефективності виробництва. Запропоновано до практичного використання економіко-математичне моделювання оптимальної структури виробництва селянського господарства, що враховує наявні виробничі ресурси. В результаті моделювання визначено, що максимальний дохід можна отримати шляхом перерозподілу обсягів виробництва певних видів продукції і, відповідно, ресурсів на їх виробництво з урахуванням нормативних витрат на виробництво одиниці виду продукції, цін на продукцію і ресурси. З використанням моделювання отримано регресійну залежність собівартості молока, виробленого в особистих селянських господарствах, від вартості кормів, витрат праці, оплати праці, чисельності поголів'я корів. Визначено величини впливу окремих видів ресурсів на собівартість виробництва та побудовано відповідні графічні залежності. Практичною цінністю результатів роботи є можливість використання викладених рекомендацій безпосередньо членами селянських господарств в процесах планування, організації виробничої діяльності та оптимізації використання ресурсного потенціалу
- **Ключові слова:** оптимізація структури виробництва; моделювання; регресійний аналіз; виробничі ресурси; особисте селянське господарство



UDC 338.43.02: 338.439.63-049.5(477)]

## Strengthening the role of local agri-food systems in overcoming the consequences of using food as a weapon in Ukraine

### Olena Borodina

Doctor of Economic Sciences, Professor  
Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine  
01011, 26 Panasa Myrnoho Str., Kyiv, Ukraine  
<http://orcid.org/0000-0002-9937-5907>

### Ihor Prokopa

Doctor of Economic Sciences, Professor  
Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine  
01011, 26 Panasa Myrnoho Str., Kyiv, Ukraine  
<https://orcid.org/0000-0002-3681-2655>

### Oksana Rykovska\*

PhD in Economic Sciences, Senior Research Fellow  
Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine  
01011, 26 Panasa Myrnoho Str., Kyiv, Ukraine  
<https://orcid.org/0000-0002-2723-8313>

► **Abstract.** One of the vulnerabilities of Ukraine, which was highlighted by the use of food as a weapon in the Russian war against it, was its excessive raw material export orientation and weak internal rooting of the agri-food system, as well as the insufficient resilience of its local links. The purpose of this study was to substantiate the potential for strengthening local agri-food systems through the fuller involvement of small-scale agricultural producers with a focus on meeting the food needs of all segments of the population. The study employed the following methods: system analysis, grouping and classification, statistical analysis, formalisation, abstract and logical. The study covered the manifestations of Russia's use of food to achieve political and military goals in Ukraine, as well as the role of small agricultural producers in mitigating their adverse consequences. It was found that the key to strengthening the sustainability of the agri-food system at both the local and national levels is to provide farm enterprises and household farms with diversified access to domestic markets by stimulating demand for their agricultural products. The study substantiated the forms of implementation of this task through the introduction of programmes of linked food subsidies for vulnerable groups of the population, public procurement from small producers for school meals, and promotion of solidarity food security at the community level. The study assessed the need for resources for these programmes and the potential of small farms to produce the necessary products, showing that the introduction of these programmes will facilitate the transition of agriculture to agroecology. The study also covered the possibility of financing measures to overcome the consequences of the use of food as a weapon while supporting small producers through the use of the National Bank's targeted issue with partial involvement of budgetary funds within the framework of strengthening the national rootedness of the agri-food system, as well as donor support. The practical significance of the findings of this study lies in the possibility of their use in the implementation of food support measures for vulnerable groups and the preparation of a lawsuit to the International Criminal Court regarding the weaponisation of food by the Russian Federation in the war against Ukraine

► **Keywords:** local agri-food systems; smallholder farmers; food subsidies; school meals; solidarity agriculture; agroecology

► **Suggested Citation:** Borodina, O., Prokopa, I., & Rykovska, O. (2024). Strengthening the role of local agri-food systems in overcoming the consequences of using food as a weapon in Ukraine. *Ekonomika APK*, 31(1), 19-28. doi: 10.32317/2221-1055.202401019.

\*Corresponding author



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

## ► Introduction

From the first days of the full-scale military invasion of Ukraine, Russians have been deliberately using food as a weapon, attacking food warehouses and granaries, destroying crops and soil, food and water supplies, restricting agricultural exports, etc. The consequences of these hostile actions include the impossibility or restriction of public access to food, destruction of food stocks, destruction of the material and technical base of agricultural production, loss of foreign exchange earnings, etc. highlighted one of the key shortcomings of the national agri-food system – the imbalance of the organisational and, accordingly, socio-economic structure of agriculture, which weakens the sustainability of its functioning. It was caused, on the one hand, by the excessive raw material export orientation of the corporate sector tolerated by the state and its focus on large-scale production of a limited set of high-margin agricultural products, and, on the other hand, by insufficient attention to ensuring the progressive development of the family farming system, which has been given the role of food self-sufficiency and filling internal food markets with all other products in emergency situations.

Strengthening the resilience of the agri-food system in general and at the local level specifically is one of the aspects of ensuring food security in extreme conditions. Prior to Russia's full-scale invasion of Ukraine, this aspect was covered in the academic literature mainly in connection with the COVID-19 pandemic. Ya. Gadzalo *et al.* (2020), assessing the formation of demand for food in unforeseen situations, determined that the most vulnerable segments of the population will not be able to provide themselves with even cheap food in such conditions and will need state support. Z. Gerasymchuk & L. Gasukha (2021) substantiated the need to ensure all components of food security at the regional level and strengthen the responsibility of local authorities for this task. As noted by V. Zhuk (2023), in the context of military operations, the focus of scientific research has shifted towards assessing losses and damage from them. N. Klymenko (2022) investigated changes in food security, while A. Zemko (2022) identified the elements of the food system that were most negatively affected. S. Kvasha (2022) covered the main areas of adjusting the state regulation of the food segment of the agricultural market during the war, D. Krylov (2023) explored the general steps to overcome the threats to food security caused by it. They contain, albeit indirectly, the motive of using food as a weapon of Russian military aggression against Ukraine. T. Kharytonova & K. Hryhorieva (2023) consider food as a weapon alongside other forms of destabilisation of food security in war, while M.M. Krawczyk (2021) and C. Dowd *et al.* (2023) – as a special means of achieving military and political goals. Analysing the negative effects of Russia's military aggression on Ukraine's agricultural sector and the need to restore both agricultural infrastructure and export opportunities, O. Skydan *et al.* (2023) outlined the potential of farming and identified areas of support that will further strengthen food security at the national and global levels. At the same time, these studies do not highlight the role of local agri-food systems in meeting the population's

food needs in extreme conditions, the capabilities of small-scale agricultural producers and the mechanisms for their involvement in ensuring the sustainable functioning of these systems.

This suggests that, both under martial law and during the post-war reconstruction of the national economy, measures should be taken to strengthen the sustainability of the agri-food system at the grassroots (local) level and to form its internal roots. This, along with maintaining Ukraine's position on global food markets, will strengthen the social and socio-political framework for sustainable agricultural and rural development, facilitate access to quality food produced by the general population, and help overcome the food shortages and hunger caused by the war. The purpose of this study was to substantiate the mechanisms for strengthening local agri-food systems in overcoming the consequences of the use of food as a weapon in Russia's war against Ukraine.

## ► Materials and Methods

The methodological framework of the study included theoretical generalisations and substantiation of the role of agri-food systems in providing food to the population in the context of a large-scale war. The findings were obtained through the following methods: system analysis – in formulating the problem and defining the purpose of the study; grouping and classification – in identifying groups of producers, types of products, beneficiaries of food support programmes; statistical analysis – in determining the farming potential and the needs of certain categories of consumers for the relevant agricultural products; formalisation – in modelling scenarios and determining the need for financial resources; abstract and logical – for summarising the findings and formulating proposals.

The study was based on legal regulations, namely the Laws of Ukraine, Resolutions and Orders of the Cabinet of Ministers of Ukraine and relevant Ministries governing social standards, provision of certain categories of the population with food, determination of physiological needs and rational consumption norms, etc. Specifically, the Law of Ukraine “On the State Budget” defines the subsistence minimum and minimum wage as basic social standards (Law of Ukraine No. 2710-IX..., 2022). The Law of Ukraine “On State Social Assistance to Low-income Families” (Law of Ukraine No. 1768-III..., 2000), which regulates the support of vulnerable groups of the population, Order of the Ministry of Health of Ukraine No. 1073 “On Approval of Norms of Physiological Needs of the Population of Ukraine in Basic Food Substances and Energy” (2017), and the MOH recommendations on the “Plate of healthy food” (Plate of healthy food, 2021) define rational food consumption norms.

Data from the State Statistics Service of Ukraine (Agriculture of Ukraine for 2022..., 2023) were used to determine the potential of small producers of vegetable, fruit and berry, and dairy products (farm enterprises and household farms) in the context of their participation in the implementation of food subsidy programmes and school meals for children. The information based on the results of state statistical observations (absolute and relative indicators) is provided without considering the

temporarily occupied territory of the Autonomous Republic of Crimea, the city of Sevastopol, and part of the temporarily occupied territories. Statistical data reflect the volume of production of the relevant products and their structure by category of farms, as well as the volume of consumption of these products in households.

The calculation of the need for funds to implement the School Milk programme was based on the rational norms for the consumption of dairy products by children in educational institutions approved by the Cabinet of Ministers of Ukraine (Resolution of the Cabinet of Ministers of Ukraine No. 305..., 2021), current information on the purchase price of milk in November 2023 (The price of extra-grade raw..., 2023), and information on the number of children enrolled in educational institutions at the end of 2022 (Preschool education..., n.d.). The national monetary poverty criteria (Law of Ukraine No. 2710-IX..., 2022) and expertly modelled data on the number of poor people in Ukraine in 2023 (Two-thirds of Ukrainians live below..., 2023) were used to determine the number of poor people in Ukraine and assess the need for healthy food.

The proposed scenarios demonstrate the potential for variation in decision-making on food support for vulnerable populations depending on changes in the parameters and financial capabilities of the state and allow assessing the synergistic effect of introducing this type of support.

## ► Results and Discussion

The use of criminal methods of warfare using food has been condemned by the international community. In 2018, the UN Security Council adopted a resolution (Adopting resolution..., 2018) that condemned the use of hunger as a means of warfare, recognising it as a war crime, and identified three areas of action that indicate the use of food as a weapon. Russia has used them against Ukraine in full, as documented by international and Ukrainian experts: the impossibility of food supplies due to the blockade of Ukrainian cities and villages from the first days of the war, blocking the supply routes of international humanitarian food and drinking water, etc.; deliberate destruction of food warehouses and production facilities of agricultural businesses, farm enterprises and rural estates that provided livelihoods for millions of rural residents; impeding the export of Ukrainian grain to many countries of the world, on which Ukraine's economic security depends, since the main foreign exchange earnings in the country's economy came from agricultural exports (Vasylchenko, 2023). A group of international human rights lawyers, together with the Ukrainian prosecutor's office, are collecting evidence of these war crimes to file a lawsuit with the International Criminal Court (ICC) for Russia's systematic creation of the preconditions for famine in Ukraine (Nosalska, 2023).

According to the Kyiv School of Economics, the availability of food in Ukraine has decreased by 15-43% in the six months since the start of Russia's full-scale aggression (Stolnikovych *et al.*, 2022). Under martial law, small-scale agricultural producers – primarily farm enterprises and household farms, joined by other citizens and temporarily displaced persons through participation in Victory

Gardens, communal agricultural enterprises, cooperatives, and other community projects – have met the most urgent needs of society for a variety of agricultural products and food (News. Initiatives, n.d.). These experiences and aspirations need to be sustained, developed, and consolidated to overcome war-related damage to the agri-food system and to strengthen its resilience at both local and national levels.

Based on the results of research into active international practices, the key to achieving this objective in Ukraine is to provide small farm enterprises and household farms with diversified access to internal markets by stimulating demand for their agricultural products and food through the introduction of programmes of: (i) linked food subsidies to promote healthy eating among vulnerable populations, (ii) organising public procurement from small producers for special school meals, and (iii) promoting solidarity in food security at the community level. This is essential for strengthening local agri-food systems, as the food in question will be produced, processed, sold (distributed), and consumed in a particular area.

This approach to providing small farm enterprises and household farms with diversified access to markets by stimulating demand for their agricultural products creates an informal space where buyers and sellers meet; a place where political, social, and cultural relationships are formed, and where all participants interact with each other with varying degrees of interdependence and solidarity. Interaction between producers, processors, sellers, and consumers is predominantly horizontal and is based largely on trust.

At the same time, favourable conditions are being created for a fuller transition of agriculture to agroecology, which is especially important given Ukraine's aspirations for membership in the European Union. Global experience shows that the principles and functions of agroecology are most fully implemented at the local level, where the relevant approaches are used by as many small producers as possible, strong links are established between producers and between them and consumers of safe products, and local agri-food markets are formed. This increases the production of healthy food and its consumption by different segments of the population, expands the area of environmentally friendly use of natural resources in agriculture, conserves biodiversity, and strengthens the social and inclusive nature of the agri-food system.

The mobilisation of financial resources for the implementation of the above measures can be carried out based on strategic planning and the use of targeted issuance by the National Bank with partial involvement of budgetary funds: this is how mechanisms are built for simultaneous and interconnected monetisation of needs and investment in the production of goods to meet these needs and connect supply and demand (Grytsenko, 2023). The mechanisms of food supply are not inflationary, as supply and demand are linked and balanced by state indirect financing of the basic human right to national food and the promotion of solidarity for its production and consumption. Such relationships in the food system operate according to a set of rules that are agreed upon between producers, consumers, and various authorities in the respective territory. The gap

between producers and end users is narrowing, distribution chains are becoming much shorter, and financially backed demand is driving supply.

**Linking food subsidies to promote healthy diets provided by smallholder/household farms.** The adaptive capacity and resilience of household farming is embedded in both the biophysical aspects of the agri-food system (through biodiversity conservation, maintaining healthy soil systems, supporting the self-purification of natural water bodies, etc.) and its socio-economic aspects (knowledge transfer, development or organisational capacity, breaking cycles of poverty, etc.). At the first stage of introducing food subsidies in Ukraine, it is advisable to provide payments for the consumption of vegetables, melons and fruits to restore the immunity of Ukrainians, which has been considerably impaired by the stressful environment exacerbated by direct hostilities. Over time, the list of subsidised foods can be expanded to include other foods that are essential for healthy eating. People who are unable to provide themselves with a sufficient level of nutrition – the poor – need support.

During the war, the number of poor people increased significantly, and by the end of 2022, the poverty rate in Ukraine was 24%. According to the World Bank, in 2023, the poverty rate will reach 55%, meaning that about 18 million people in Ukraine will survive on less than \$5.50 a day (How the poverty level..., 2023). Ukrainian researchers calculate poverty by the subsistence level in factual market prices. Due to the restrictions of martial law and the impossibility of conducting certain studies, “all the data of 2022-2023 are modelled data, according to which poverty was 60% in 2022 and 67% in 2023” (Two-thirds of Ukrainians live below..., 2023). Such is the number of people that will not be able to meet their basic needs and will need state assistance, including food. The poor are more vulnerable (compared to the average Ukrainian) in terms of the level and quality of food consumption. Notably, on average, Ukrainians already consume insufficient amounts of fruit (64% of the norm), milk (52%), fish (59%), and meat (66%) (Halytskyi & Michkovska, 2023). And the poor population falls far short of the average consumption of these food groups (only 50-60%). There-with, the poor are also vulnerable in terms of vegetable consumption (70% of the average), compensating for their lack of vegetables with potatoes. The most vulnerable segments of the population and those who need support the most are households with children, especially those under 3 years of age, as well as families with students and non-working pensioners (Expenditure and resources..., 2022). Making them priority beneficiaries of certain types of assistance should be a pilot project to test the food support programme. In today's unstable environment, the need for food subsidies, including the purchase of fruit and vegetable products, can be calculated in different ways, depending on the priorities for maintaining the lives and health of its citizens.

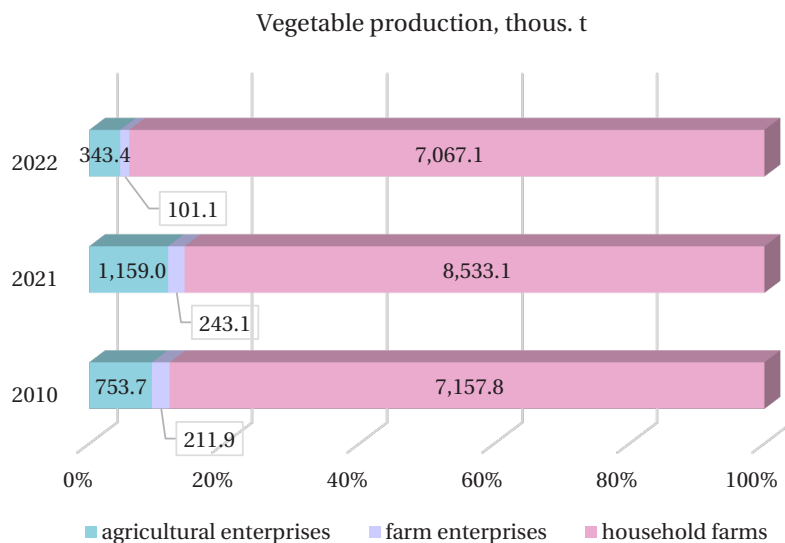
Variant I. In Ukraine, the subsistence minimum is the basic state social standard based on which state social guarantees, social benefits, and social payments are determined. In 2023, the subsistence minimum was approved in the amount of UAH 2,589.0 per month per person. Given that the recommended ceiling for food

expenditures is 60%, i.e., UAH 1,553.4 per month, and the share of expenditures on fruit and vegetable products is about 18% of the total cost of the consumer basket (Ukrainian consumer basket..., 2019), it is estimated that the population will spend UAH 279.6 per month on these products. Based on projected estimates of the number of poor people in Ukraine (18 million) and the estimated need for the purchase of vegetables and fruits at UAH 279.6 per month, the food subsidy will amount to UAH 5.03 billion per month.

Variant II. According to the World Food Programme, at the end of October 2023, there were 3.8 million undernourished people in Ukraine (HungerMap, n.d.). Due to their limited resources, almost half of them use survival strategies (reducing the number of meals, starving, begging, working for food, etc.) and primarily need financial support for food. According to the average rational consumption norms of the Ministry of Health, an adult should consume 161 kg of vegetable and melon products and 90 kg of fruit and berries during the year (Halytskyi & Michkovska, 2023). Based on the Ukrainian consumption standards, 611.8 thous. t of vegetables and 342.0 thous. t of fruit are needed to meet the needs of 3.8 million people for fruit and vegetables. According to the State Statistics Service, consumer prices increased by 32.1% between December 2021 and November 2023 (Consumer price indices..., n.d.), which led to an increase in the cost of all food products, and the average price of vegetables in November 2023 was 27.8 UAH/kg, and fruit – 46.2 UAH/kg (Product prices, n.d.). Thus, UAH 2.7 billion per month is needed to finance food subsidies for the purchase of fruit and vegetable products for the those in need.

The potential of small producers of vegetable and fruit and berry products in Ukraine is quite sufficient to meet the needs of potential recipients of food subsidies. In the pre-war period, household farms and farm enterprises played a decisive role in the production of these products, although agricultural enterprises, specifically those that used agroecological practices, were increasingly interested in growing the crops in question. Between 2010 and 2021, vegetable production increased by 22.5%, with household farms growing by more than 19%, farm enterprises by almost 15%, and agricultural enterprises by 54%. During this period, production of fruit and berry products increased by 28%: by 4.3 times in farm enterprises, and by 21.3-21.4% in household farms and agricultural enterprises. In 2021, household farms and farm enterprises (small producers) accounted for 88.3% of vegetable production and 86.4% of fruit and berry production (Agriculture of Ukraine for 2021, 2022).

Russia's full-scale military invasion of Ukraine has had a considerable impact on the volume and structure of vegetable production. According to the State Statistics Service, the gross harvest of vegetable crops in 2022 was 7,511.6 thous. t, which is almost a quarter less than in 2021 (Agriculture of Ukraine for 2022, 2023). Generally, the volume of vegetable production decreased by 3.4 times in agricultural enterprises, by 2.4 times in farm enterprises, and by 17% in household farms. As a result, the shares of different categories of farms in total production were as follows: agricultural enterprises – 4.6%, farm enterprises – 1.3%, and household farms – 94.1% (Fig. 1).

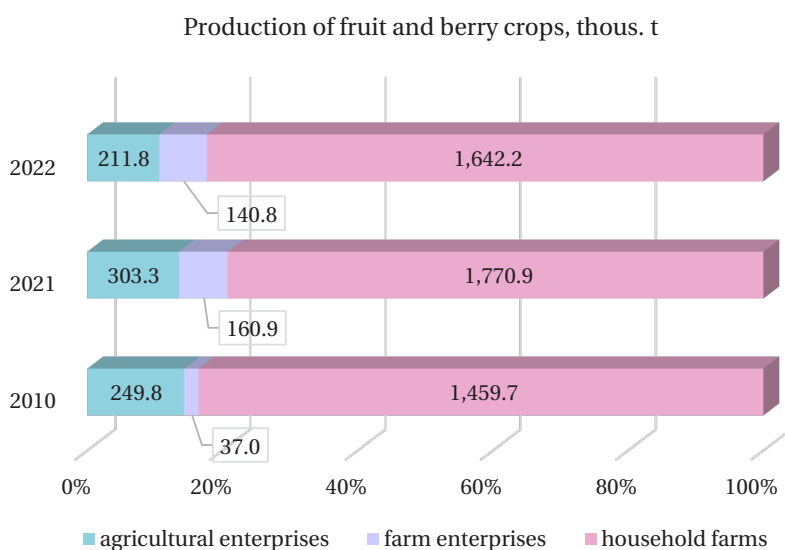


**Figure 1.** Production of vegetable crops in Ukraine by different categories of farms, 2010-2022

**Source:** built based on the data from Agriculture of Ukraine for 2022 (2023)

In the fruit and berry sector, the decline in production in 2022 was weaker than in vegetable production, as its main volumes were concentrated in areas outside the active hostilities. Gross harvest of fruits and berries totalled 1,994.8 thous. t, down 10.8% year-on-year. In

agricultural enterprises, production declined by more than 30%, and their share of the total decreased to 10.6%; in farm enterprises, the corresponding figures were 12.5% and 7.1%, while in household farms – 7.3% and 82.3% (Fig. 2).



**Figure 2.** Production of fruit and berry crops in Ukraine by different categories of farms, 2010-2022

**Source:** built based on the data from Agriculture of Ukraine for 2022 (2023)

Thus, in a war situation, small producers of vegetable and fruit and berry products (farms and households) show higher resilience and, therefore, the ability to recover from damage. This strongly suggests that during the reconstruction of the national economy, pre-war production volumes in these sectors can be quickly restored and further increased thanks to the production of these products being stimulated in the household farming segment. There is a lot of evidence that farmers from the occupied territories are organising the cultivation of vegetable and fruit crops in new locations (Farmer from the Kharkiv region..., 2023; Growing watermelons in Rivne..., 2023).

Households are also increasing the area under these crops (Popp & Zavadiak, 2023; Konovalova & Melnyk, 2023), which is also facilitated by the support of international organisations (Over 40,000 households..., 2023). The Government of Ukraine provides grant support to small and medium-sized farms for the development of horticulture, berry growing, viticulture, and greenhouse farming (Grants for the development of horticulture..., 2023). According to preliminary data, as of the beginning of November 2023, the harvest of vegetable crops reached 7.1 million tonnes (This year, farmers harvested..., 2023), and therefore, the forecast of vegetable production, which is expected to

reach 99% of the previous year (Bublyk, 2023), can be considered realistic. As for fruits and berries, their supply (1.5-1.8 million tonnes) should be sufficient to meet the needs of the internal market (Ukrainian fruit continues..., 2023).

The predominance of small businesses in the production of vegetable and fruit and berry products is partly because rural and urban residents produce a certain amount of these products for their own consumption (food self-sufficiency). In 2021, the share of home-grown produce in the consumption of vegetables and gourds in rural households was almost 57% and 9% in urban households, and of fruits and berries was 32% and 4%, respectively. Under martial law, these shares have clearly increased. Therewith, calculations suggest that the difference between production and domestic consumption of vegetables and fruit and berry products in households and farms is sufficient to meet market demand for them. This demand is constrained by the low solvency of vulnerable groups. Food subsidies, combined with support for family farming, will unlock it and create reliable channels for selling farm products.

**Public procurement from small producers for special needs school meals.** All the world's largest school feeding programmes are based on the procurement of locally sourced food. This makes markets more predictable, helps create jobs and opportunities for children to develop lifelong preferences for fresh local produce. School meals are particularly important for children living in con-

flict zones, as they contribute to peace and social cohesion. In a country facing military action, school meals can be a major safety net, as they create a sense of normalcy and help keep children learning.

The methodological approaches to calculating the need for funds for the School Milk Programme are based on the rational norms of milk consumption in educational institutions approved by Resolution of the Cabinet of Ministers of Ukraine No. 305 (Resolution of the Cabinet of Ministers of Ukraine No. 305..., 2021), information on the number of children enrolled in educational institutions at the end of 2022 (Preschool education..., n.d.) and current information on the purchase price of milk in November 2023 (The price of extra-grade raw..., 2023). According to the norms of physiological needs, pupils of preschool educational institutions should consume 12 servings of milk per week, specifically, for children under 4 years old a portion is 150 ml, for children under 7 years old – 200 ml; students of secondary education institutions should consume 5 servings of 200 ml of milk per week. The duration of children's stay in institutions was also considered, namely, schoolchildren study 36 weeks a year, and children stay in preschool education institutions for up to 52 weeks a year. At the end of 2022, the total number of children enrolled in preschool and secondary education institutions and potentially benefiting from the programme was about 5 million people (Table 1).

**Table 1.** Demand for vegetables, fruits, and milk among preschool and secondary education students, 2022

Indicators	Students in preschool education institutions		Students in secondary education institutions		TOTAL
	from 1 to 4 years	4 to 6 (7) years	School age		
Number of children (persons)	247,169	687,186	4,041,976		
Portioning (units)	Number of servings per week	Weight of servings		Number of servings per week	Weight of servings
Varied, seasonal vegetables, except potatoes; fresh, frozen, or pickled	15 servings	60 g	80 g	15 servings	100 g
<b>Annual demand (thous. t)</b>		<b>11.6</b>	<b>42.9</b>		<b>218.3</b>
Varied fruit and berries, seasonal, fresh, or frozen	10 servings	60 g	80 g	10 servings	100 g
<b>Annual demand (thous. t)</b>		<b>7.7</b>	<b>28.6</b>		<b>145.5</b>
Milk and dairy products	12 servings	150 ml	200 ml	5 servings	200 ml
<b>Demand per year (thous. t)*</b>		<b>23.8</b>	<b>88.3</b>		<b>149.9</b>
					<b>262.0</b>

Note: \*1 l of milk = 1.03 kg

Source: calculated by the authors of this study based on "The price of extra-grade raw milk has increased by 5.1%" (2023)

Thus, 262.0 thous. t of milk per year are needed to meet the physiological needs of children under 17. Based on the purchase price for milk in November 2023, which was UAH 13.92/kg, the total cost of the School Milk programme is UAH 3.7 billion per year. In the future, a healthy diet for schoolchildren may include locally grown vegetables and fruits, the consumption of which currently does not meet national recommendations for healthy nutrition. The estimated average cost of a fruit and vegetable set at current prices in November 2023 is 59.2 UAH/kg (Product prices, n.d.), which means that the amount of subsidy required is UAH 1.35 billion/month. To meet the

demand for fruit and berry consumption, UAH 0.8 billion/month is needed.

Milk production in Ukraine was constantly declining in the pre-war period, but the household sector held its leadership. In 2021, 8,713.9 thous. t of milk were produced, down 22.5% from the 2010 level (a decrease of approximately 2% per year). The share of agricultural enterprises in it was 29%, farm enterprises – 2.8%, and household farms – 68.2%. In 2022, gross production decreased to 7,767.7 thous. t, down 11% year-on-year. Therewith, agricultural enterprises produced 2,388.6 thous. t (-5.2%), farm enterprises – 255.6 thous. t (+4.8%), and household

farms – 5,123.5 thous. t (-13.8%). The ratio between these three groups of producers was 30.8%:3.3%:65.9% (Agriculture of Ukraine..., 2023). In January–November 2023, farms of all categories produced 4.6% less milk than in the corresponding period of the previous year, but the dynamics of production in business entities (agricultural and farm enterprises) was growing (+7%), and in household farms – declining (-12%). At the same time, household farms are still the main producers of milk, accounting for more than 62% of its total volume (Enterprises increased the production..., 2023). Analysts note that the decrease in milk production by agricultural enterprises and farms in the regions affected by the hostilities was partially offset by an increase in production by the same categories of farms in the central and western regions, including through the relocation of production. Milk-producing households suffered substantial losses from military aggression, as they were forced to sell or abandon their livestock when leaving their homes in the occupied territories and in the areas of active hostilities to save their lives and the lives of their children (Decline in production..., 2023).

Evaluating the above from the perspective of subsidising healthy school meals, it can be noted that despite the negative trend of declining production in the dairy industry, which has been substantially exacerbated by the war, farm enterprises and household farms are quite capable of providing the necessary amount of products. At the same time, the introduction of such a subsidy programme aimed at using the potential of small (local) producers can substantially support the establishment of an extensive network of family dairy farms in the post-war period, and participation in the programme will encourage them to apply agro-ecological practices, as the conditions of keeping and feeding cows and the quality characteristics of milk will be directly controlled by school and parental communities and local governments.

**Promoting solidarity in food security at the community level.** A valuable tool for improving local food security and establishing direct interaction between local producers and consumers of agri-food products in overcoming the consequences of the use of food as a weapon in Ukraine could be a model of crop sharing or agricultural production supported by consumer communities. In international practice, this model is called Community Supported Agriculture (CSA). CSA is a form of social interaction that directly connects producers and consumers in the food system, allowing consumers to subscribe to the harvest of a particular family farm or group of farms to build food security at the family and community level. It is a socio-economic model of agriculture and food distribution that allows the producer and consumer to share the risks of agricultural production for a more sustainable food supply through local markets.

Community-supported agriculture is a practice of socialisation, the management of the production and distribution of goods and services under the guidance of the community. The organisation of food supply through community complements the horizontal axis of market-mediated food production and consumption and the vertical axis of state distribution and regulation of food security. In this system, market actors interact not only and rather than as competitors, but as members of a

community who cooperate in taking collective action for the benefit of the commonwealth and each other's welfare. Examples of the use of the CSA model in the world and the prospects for its implementation in Ukraine are described in scientific publications (Overview of community..., 2016; Yarovyi & Fraier, 2019).

The provision of food subsidies to vulnerable groups can be used by recipients to support local small-scale producers and their families through CSAs. The introduction of a state programme to stimulate the creation of local CSA models as a means of multi-vector support for producers (farm enterprises and household farms), food consumers and rural communities will help to form new relationships and reliable communication between food producers and consumers based on the principles of partnership, solidarity, mutual responsibility in the production and consumption of safe and high-quality food, and the development of new behavioural strategies to achieve a new quality of life.

Notably, international studies of the cost-effectiveness of programmes such as the ones outlined above suggest that they have a multi-directional effect: they bring benefits not only to nutrition and health, but also to social protection, environmental safety, and local development. According to the UN World Food Programme (WFP), in 2023, the return on investment in school feeding programmes was USD 9 for every dollar invested in their implementation (WFP, 2023). Research by the Food and Agriculture Organization of the United Nations (FAO) confirms WFP's findings and shows that food support and school feeding programmes using local products, while requiring large public expenditures, have a multi-directional effect and considerable returns.

Programmes to support food security with a multidimensional effect are used in many countries, especially in low-income countries, and are actively supported by donor organisations, including the United States Agency for International Development, FAO, WFP, and the World Bank. The proposed approaches and estimates of the needs for funds to implement such programmes in Ukraine can serve as a basis for negotiations with these organisations to obtain additional donor funds for food aid to alleviate the suffering of the population from the aggression of the Russian Federation, which uses food as a weapon to destroy Ukrainians.

## ► Conclusions

The study outlined the consequences of Russia's use of food as a weapon in the war against Ukraine, covered the significance of local agri-food systems for overcoming them, and substantiates mechanisms for more comprehensive involvement of small agricultural producers in strengthening the resilience of these systems to meet the food needs of all, especially vulnerable, segments of the population.

The manifestations of Russia's use of food as a weapon in Ukraine include preventing the population's access to food and water by blocking settlements and transport infrastructure, destroying food stocks, the material base of agricultural and food producers, etc., as well as undermining the economic security of the state by preventing the export of its products. In overcoming these consequences

in the context of the war and post-war reconstruction of Ukraine, it will be essential to strengthen local agri-food systems, in which small producers – farm enterprises and household farms – should play a crucial role. This involves providing them with diversified access to internal markets by stimulating demand for their agricultural products and food.

The key ways to achieve this goal include the introduction of food subsidies for vulnerable groups of citizens to purchase the most necessary products produced by family-type farms; public procurement of products for school meals from small producers; and promotion of solidarity in food security at the community level. The calculations show that smallholder farms can produce the required products in the volumes determined for the specified needs. Strengthening local agri-food systems and supporting small-scale agricultural producers will also help to transition agriculture to an agroecological approach.

To finance programmes to overcome the consequences of the use of food as a weapon while supporting small agricultural producers, the National Bank's targeted issue with partial budgetary support can be used to strengthen the national rootedness of the agri-food

system, which involves the use of mechanisms for simultaneous and interrelated monetisation of needs and investment in the production of goods to meet these needs. Considering the multidirectional nature of the effects of such programmes and their humanitarian focus, one can also hope for donor support.

The practical significance of the findings presented in this study lies in the possibility of their use by the authorities and self-government bodies when implementing food support measures for vulnerable groups of the population and by human rights lawyers who, together with the Ukrainian prosecutor's office, are preparing documents for filing a lawsuit with the International Criminal Court regarding the use of food as a weapon by the Russian Federation. Further research could focus on improving the institutional framework for the functioning of local agri-food systems in the post-war development of Ukraine.

#### ► Acknowledgements

None.

#### ► Conflict of Interest

The authors of this study declare no conflict of interest.

#### ► References

- [1] Adopting resolution 2417 (2018), Security Council strongly condemns starving of civilians, unlawfully denying humanitarian access as warfare tactics. (2018). Retrieved from <https://press.un.org/en/2018/sc13354.doc.htm>.
- [2] Agriculture of Ukraine for 2021. (2022). Retrieved from [https://ukrstat.gov.ua/druk/publicat/kat\\_u/2022/zb/09/sg\\_21\\_pdf.zip](https://ukrstat.gov.ua/druk/publicat/kat_u/2022/zb/09/sg_21_pdf.zip).
- [3] Agriculture of Ukraine for 2022. (2023). Retrieved from [https://www.ukrstat.gov.ua/druk/publicat/kat\\_u/2023/zb/09/S\\_gos\\_22.pdf](https://www.ukrstat.gov.ua/druk/publicat/kat_u/2023/zb/09/S_gos_22.pdf).
- [4] Bublyk, O. (2023). *Gross crop production will decrease by 2.1%*. Retrieved from <https://agrotimes.ua/agromarket/vyrobnytstvo-valovoyi-produktsiyi-roslynnyctva-skorotytsya-na-21-%ef%bf%bc/>.
- [5] Consumer price indices for goods and services (up to December 2010). (n.d.). Retrieved from [https://km.ukrstat.gov.ua/ukr/statinf/ct/isc\\_pml223.htm](https://km.ukrstat.gov.ua/ukr/statinf/ct/isc_pml223.htm).
- [6] Decline in production, loss of livestock, fall in purchasing prices for raw milk – results of the year of the dairy sector of Ukraine. (2023). Retrieved from <https://avm-ua.org/uk/post/spad-virobnictva-vtrati-pogoliva-padinna-zakupivelnih-cin-na-moloko-sirovinu-pidsumki-roku-molocnogo-sektoru-ukraini>.
- [7] Dowd, C., Gleason, K., Polzin, S., Ripamonti, D., Garvey, A., & Patel, R. (2023). *Conflict and food systems – Haiti report*. Dublin: Concern Worldwide.
- [8] Enterprises increased the production of raw milk by 7% in January-November 2023. (2023). Retrieved from <http://milkua.info/uk/post/pidpriemstva-narostili-virobnictvo-moloka-sirovini-na-7-v-sicni-listopadi-2023-roku>.
- [9] Expenditure and resources of households of Ukraine in 2021 year. (2022). Retrieved from [https://www.ukrstat.gov.ua/druk/publicat/kat\\_u/2022/zb/07/zb\\_vrd\\_21.pdf](https://www.ukrstat.gov.ua/druk/publicat/kat_u/2022/zb/07/zb_vrd_21.pdf).
- [10] Farmer from the Kharkiv region moved his business to Zhytomyr and wants to employ 300 people. (2023). Retrieved from <https://www.sq.com.ua/uk/novini/12.06.2023/fermer-iz-xarkivskoyi-oblasti-perenis-svii-biznes-u-zitomirsku-i-xoce-dati-robotu-300-lyudyam>.
- [11] Gadzalo, Ya., Sychevskiy, M., Kovalenko, O., Deineko, L., & Yashchenko, L. (2020). Assessment of global food demand in unexpected situations. *Innovative Marketing*, 16(4), 91-103. doi: 10.21511/im.16(4).2020.08.
- [12] Gerasymchuk, Z., & Gasukha, L. (2021). *Food balance and regional reserves as tools of food security mechanism in regions*. *Economic Forum*, 1, 43-51.
- [13] Grants for the development of horticulture, berry growing, viticulture: Key changes, criteria and requirements. (2023). Retrieved from <https://minagro.gov.ua/pidtrimka/nadannya-grantiv-dlya-stvorenniya-biznesu/granti-dlya-sadivnictva-yagidnictva-ta-vinogradarstva/granti-dlya-rozvitku-sadivnictva-yagidnictva-vinogradarstva-kyuchovi-zmini-kriteriyi-ta-vimogi>.
- [14] Growing watermelons in Rivne region to replace Kherson watermelons on the markets. (2023). Retrieved from <https://rivne.media/news/na-rivnenshchini-pochali-viroshchuvati-kavuni-shchob-zaminiti-na-rinkakh-khersonski>.
- [15] Grytsenko, A. (2023). Nationally rooted economic development as a local response to the global geoeconomic shifts. *Ekonomy of Ukraine*, 4, 38-54. doi: 10.15407/economyukr.2023.04.038.
- [16] Halytskyi, A., & Michkovska, N. (2023). *They love potatoes and salt, but ignore cheese: How Ukrainians eat in 2023*. Retrieved from <https://focus.ua/uk/economics/587182-lyublyat-kartoplyu-i-sil-ale-ignoruyut-sir-yak-harchuyutsya-ukrayinci-u-2023-roci>.

- [17] How the poverty level has changed in Ukraine. (2023). Retrieved from <https://www.slovoidilo.ua/2023/05/04/infografika/ekonomika/yak-zminyuvavsvya-riven-bidnosti-ukrayini>.
- [18] HungerMap. (n.d.). Retrieved from <https://hungermap.wfp.org/>.
- [19] Kharytonova, T., & Hryhorieva, K. (2023). Food security in the conditions of modern military conflicts: Legal experience of foreign countries. *Juridical Scientific and Electronic Journal*, 2, 287-291. doi: 10.32782/2524-0374/2023-2/65
- [20] Klymenko, N. (2022). Ensuring food security under the martial law: Status, problems, prospects. *Public Management and Administration in Ukraine*, 30, 128-132. doi: 10.32843/pma2663-5240-2022.30.22.
- [21] Konovalova, O., & Melnyk V. (2023). *Free seedlings are grown for the community in Khmelnytsky region*. Retrieved from <https://suspilne.media/451590-na-hmelniccini-virosuut-bezplatnu-rozsadu-dla-gromadi/>.
- [22] Krawczyk, M.M. (2021). *Hunger as a political weapon*. Retrieved from <https://wszystkoconajwazniejsze.pl/mateusz-krawczyk-glod-jako-bron-polityczna/>.
- [23] Krylov, D. (2023). Problems of ensuring food security of Ukraine in modern conditions. *Problems of Modern Transformations. Series: Economics and Management*, 7. doi: 10.54929/2786-5738-2023-7-03-07.
- [24] Kvasha, S. (2022). *Measures of agrarian policy in ensuring food security*. In *Food and environmental security in wartime and postwar: Legal challenges for Ukraine and the world: Materials of the international scientific and practical online/offline conferences* (pp. 17-23). Kyiv: FOP Yamchynskiy O.V.
- [25] Law of Ukraine No. 1768-III "On State Social Assistance to Low-Income Families". (2000, June). Retrieved from <https://zakon.rada.gov.ua/laws/show/1768-14#Text>.
- [26] Law of Ukraine No. 2710-IX "On the State Budget of Ukraine for 2023". (2022, November). Retrieved from <https://zakon.rada.gov.ua/laws/show/2710-20#Text>.
- [27] News. Initiatives. (n.d.). Retrieved from <https://sadyperemohy.org/novyny/>.
- [28] Nosalska, I. (2023). *Using hunger as a weapon: Putin will find a new iss order*. Retrieved from <https://uanews.net/post/159786>.
- [29] Order of the Ministry of Health of Ukraine No. 1073 "On Approval of Norms of Physiological Needs of the Population of Ukraine in Basic Food Substances and Energy". (2017, September). Retrieved from <https://zakon.rada.gov.ua/laws/show/z1206-17#Text>.
- [30] Over 40,000 households will receive vegetable seeds through USAID. (2023). Retrieved from <https://minagro.gov.ua/news/ponad-40-000-domogospodarstv-otrimayut-nasinnnya-ovochiv-cherez-usaid>.
- [31] Overview of community supported agriculture in Europe. (2016). Retrieved from <https://urgenci.net/wp-content/uploads/2016/05/Overview-of-Community-Supported-Agriculture-in-Europe.pdf>.
- [32] Plate of healthy food. (2021). Retrieved from <https://moz.gov.ua/article/health/tarilka-zdorovogo-harchuvannja>.
- [33] Popp, H., & Zavadiak, O. (2023). *Owners of around 850 households in the village of Zarychchia in the Zakarpattia region cultivate early vegetables*. Retrieved from <https://suspilne.media/441513-vlasniki-blizko-850-dvorogospodarstv-sela-zaricca-zakarpatskoj-oblasti-virosuut-ranni-ovoci/>.
- [34] Preschool education in Ukraine in 2022. (n.d.). Retrieved from [https://ukrstat.gov.ua/operativ/operativ2005/osv\\_rik/osv\\_u/dosh\\_osvit/arch\\_dosh\\_osv.htm](https://ukrstat.gov.ua/operativ/operativ2005/osv_rik/osv_u/dosh_osvit/arch_dosh_osv.htm).
- [35] Product prices. (n.d.). Retrieved from <https://index.minfin.com.ua/ua/markets/wares/prods/fruits-vegetables/>.
- [36] Resolution of the Cabinet of Ministers of Ukraine No. 305 "On Approval of the Norms and Procedure for Organizing Catering in Educational Institutions and Children's Health and Recreation Facilities". (2021, March). Retrieved from <https://zakon.rada.gov.ua/laws/show/305-2021-%D0%BF#n13>.
- [37] Skydan, O., Dankevych, V., Garrett, R.D., & Nimko, O. (2023). The state of the agricultural sector in Ukraine during wartime: The case of farmers. *Scientific Horizons*, 26(6), 134-145. doi: 10.48077/scihor6.2023.134.
- [38] Stolnikovych, H., Neiter, R., & Bohonos, M. (2022). *Food security in Ukraine in six months wars*. Retrieved from [https://kse.ua/wp-content/uploads/2022/11/1page\\_6-Months-Food-Security\\_ukr\\_mib\\_final.pdf](https://kse.ua/wp-content/uploads/2022/11/1page_6-Months-Food-Security_ukr_mib_final.pdf).
- [39] The price of extra-grade raw milk has increased by 5.1%. (2023). Retrieved from <https://avm-ua.org/uk/post/moloko-sirovina-ekstra-gatunku-podorozcala-na-51>.
- [40] This year, farmers harvested 29 million tons of vegetables. Zhytomyr and Dnipropetrovs'k regions are among the leaders. (2023). Retrieved from <https://minagro.gov.ua/news/u-comu-roci-fermeri-zibrali-29-mln-tonn-ovochiv-u-liderah-zhitomirshchina-ta-dnipropetrovshchina>.
- [41] Two-thirds of Ukrainians live below the poverty line – a demographer. (2023). Retrieved from <https://ukr.radio/news.html?newsID=102498>.
- [42] Ukrainian consumer basket 2019 (updated). (2019). Retrieved from <https://harchi.info/articles/spozhivchiv-koshik-ukrayincya-sucilniy-minimalizm>.
- [43] Ukrainian fruit continues to meet the needs of domestic and foreign markets. (2023). Retrieved from <https://uaexport.org/2023/07/11/ukrayinski-frukti-prodovzhuyut-zabezpechuvati-potrebi-vnutrishnogo-ta-zovnishnogo-rinkiv/>.
- [44] Vasylenko, Yu. (2023). *Hunger as a weapon: Will Africa and Asia support a new ICC lawsuit against russia?*. Retrieved from <https://www.depo.ua/ukr/politics/golod-yak-zbroya-chi-priednaetsya-globalniy-pivden-donovogo-pozovu-v-mks-proti-rosii-202309271452389>.
- [45] WFP. (2023). *State of school feeding worldwide 2022*. Rome: World Food Programme.
- [46] Yarovi, V., & Fraier, O. (2019). The international practice and prospects for the implementation of community supported agriculture in Ukraine. *Ukrainian Society*, 4(71), 84-98. doi: 10.15407/socium2019.04.084.

- [47] Zemko, A. (2022). [Food security in the conditions of war: Legal aspect](#). In *Food and environmental security in wartime and postwar: Legal challenges for Ukraine and the world: Materials of the international scientific and practical online/offline conferences* (pp. 113-116). Kyiv: FOP Yamchynskyi O.V.
- [48] Zhuk, V. (2023) [Scientific support for the policy of determining losses and damage to agricultural enterprises from the war](#). In *Development of the agricultural sector and rural areas in wartime and postwar reconstruction of Ukraine: Materials of the international scientific and practical conference* (pp. 16-21). Kyiv: NSC "IAE".

## Посилення ролі локальних агропродовольчих систем у подоланні наслідків використання продовольства як зброї в Україні

### Олена Миколаївна Бородіна

Доктор економічних наук, професор

Інститут економіки та прогнозування Національної академії наук України

01011, вул. Панаса Мирного, 26, м. Київ, Україна

<http://orcid.org/0000-0002-9937-5907>

### Ігор Васильович Прокопа

Доктор економічних наук, професор

Інститут економіки та прогнозування Національної академії наук України

01011, вул. Панаса Мирного, 26, м. Київ, Україна

<https://orcid.org/0000-0002-3681-2655>

### Оксана Володимирівна Риковська

Кандидат економічних наук, старший науковий співробітник

Інститут економіки та прогнозування Національної академії наук України

01011, вул. Панаса Мирного, 26, м. Київ, Україна

<https://orcid.org/0000-0002-2723-8313>

► **Анотація.** Одним із вразливих місць України, яке висвітлює використання у російській війні проти неї продовольства як зброї, виявилась надмірна сировинно-експортна орієнтація і слабка внутрішня укоріненість агропродовольчої системи, недостатня стійкість її локальних ланок. Метою статті було обґрунтування потенціалу зміцнення локальних агропродовольчих систем через повніше залучення дрібних виробників сільськогосподарської продукції з орієнтацією на задоволення продовольчих потреб усіх верств населення. У дослідженні використані методи: системного аналізу, групування і класифікації, статистичного аналізу, формалізації, абстрактно-логічний. Розкрито прояви використання росією продовольства для досягнення політичних і воєнних цілей в Україні, роль дрібних виробників сільськогосподарської продукції в пом'якшенні їх негативних наслідків. Встановлено, що визначальним напрямом посилення стійкості агропродовольчої системи як на локальному, так і національному рівнях є надання фермерам і селянським господарствам диверсифікованого доступу на внутрішні ринки через стимулювання попиту на вироблену ними сільськогосподарську продукцію. Обґрунтовано форми реалізації цього завдання шляхом запровадження програм зв'язаних продовольчих субсидій для вразливих верств населення, державних закупівель від дрібних виробників для потреб шкільного харчування та заохочення солідарної продовольчої безпеки на рівні спільнот. Оцінено потребу в ресурсах для згаданих програм і потенціал малих господарств у виробництві необхідної продукції, показано, що запровадження програм сприятиме переходу сільського господарства до функціонування на засадах агроекології. Розкрито можливість фінансування заходів з подолання наслідків застосування продовольства як зброї з одночасною підтримкою дрібних виробників за рахунок використання цільової емісії Національного банку з частковим залученням бюджетних коштів у межах посилення національної укоріненості агропродовольчої системи, а також донорської підтримки. Практичною значимістю результатів дослідження є можливість їх використання при запровадженні заходів продовольчої підтримки вразливих груп населення та підготовці позову до Міжнародного кримінального суду щодо застосування російською федерацією продовольства як зброї у війні проти України

► **Ключові слова:** локальні агропродовольчі системи; дрібні виробники сільськогосподарської продукції; продовольчі субсидії; шкільне харчування; солідарне сільське господарство; агроекологія



UDC 338.43.02:519.87:378:37.012

## Evaluation of the efficiency of agricultural higher education institutions of Ukraine and the dynamics of its change by data envelopment analysis

**Yana Dolgikh\***

PhD in Economic Sciences, Associate Professor  
Sumy National Agrarian University  
40021, 160 Herasim Kondratiev Str., Sumy, Ukraine  
<https://orcid.org/0000-0001-5458-5962>

► **Abstract.** Presently, the process of assessing the effectiveness of higher education institutions and analysing the dynamics of its change needs to be improved, which determines the relevance of this study. The purpose of this study was to improve the assessment of the efficiency of agricultural higher education institutions of Ukraine in the scientific and journalistic context, as well as to investigate the changes in dynamics using the non-parametric method of assessing the relative efficiency of data envelopment analysis. The study used methods of statistical processing and data analysis, linear programming, computer computing to solve research problems, and logical and analytical methods to determine the purpose of the study, the means of achieving it, substantiate the findings of the study, and formulate conclusions. To evaluate the effectiveness of scientific and publishing activities of these higher education institutions, the input-oriented model of variable returns to scale of the data envelopment analysis method was applied. Using statistical data for 2020-2022, the net technical efficiency of scientific and publishing activities of 37 agricultural higher education institutions of Ukraine was assessed. Based on the results of the assessment, a rating of agricultural higher education institutions in Ukraine was compiled. It was found that in 2021 and 2022, 27% of the surveyed higher education institutions were 100% effective. The average net technical efficiency in 2021 and 2022 was 0.91. In 2021-2022, 27% of agricultural higher education institutions increased the efficiency of scientific and publishing activities, 59% did not change, and 14% decreased. On average, there was a 1% increase in the use of educational resources in the field of agricultural higher education. Thus, the scientific and publication activities of agricultural higher education institutions during the study period are progressive. The findings of this study can be used for a reasonable ranking of higher education institutions according to the efficiency of scientific and publishing activities, analysis of the dynamics of changes in efficiency

► **Keywords:** higher education; scientific and publishing activity; non-parametric method of relative efficiency assessment; variable returns to scale model; net technical efficiency; rating; Malmquist index

### ► Introduction

Agrarian universities are business entities engaged in the development of the innovative potential of the agro-industrial complex (AIC), namely training of AIC specialists, provision of information, consulting and expert services, scientific and theoretical, scientific and applied research, making discoveries and inventions in the agricultural sector. Improving the efficiency of higher education institutions (HEIs) with an agricultural focus contributes to the innovative development of the agro-industrial complex. Therefore, it is relevant to develop methods for objective assessment of the level of efficiency of agricultural

universities, identify opportunities for improving efficiency, and analyse trends in the development of agricultural higher education.

Currently, to evaluate and analyse the efficiency of any business entity (including educational institutions), countries widely use a non-parametric method of assessing relative efficiency – data envelopment analysis (DEA). According to the ranking of countries by the number of users (User Count) who have purchased the software from the Data Envelopment Analysis Online Software hosting (Data Envelopment Analysis, n.d.), the United States

► **Suggested Citation:** Dolgikh, Ya. (2024). Evaluation of the efficiency of agricultural higher education institutions of Ukraine and the dynamics of its change by data envelopment analysis. *Ekonomika APK*, 31(1), 29-40. doi: 10.32317/2221-1055.202401029.

\*Corresponding author



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

ranks first (80,600 User Count), India is second (1,600 User Count), followed by Iran, the Islamic Republics (1,436 User Count), and others. The User Count of Ukraine is 32, which indicates that the practical application of the DEA method in Ukraine is not widespread. T. Pham Van *et al.* (2022) conducted a bibliometric analysis of 169 Scopus publications from 1988 to 2021 on the use of data envelopment analysis to assess performance in higher education. The following countries were identified as having the greatest influence on research on this topic: Italy, China, Spain, the United States, and the United Kingdom. Consequently, theoretical research on this topic is not widespread in Ukraine. The DEA method assesses the relative efficiency of converting input factors (resources) into output (performance results) for decision-making units (DMU). Ya. Dolhikh (2020) indicates the advantages of using the DEA method to assess the relative efficiency of similar DMUs, among which are the possibility of simultaneously analysing the impact of input factors on output factors without first determining their functional dependence and identifying the causes of inefficiency.

Among the scientific papers on the application of the data envelopment analysis method to assess the effectiveness of higher education institutions for 2020-2023, it is worth mentioning the study by K. Stefanova & N. Velichkov (2020), which uses the DEA method to investigate the cost-effectiveness of higher education in some EU member states. S. El Gibari *et al.* (2022) proposed a methodology for assessing the effectiveness of Spanish universities based on a combination of a multi-criteria benchmarking scheme to form consolidated performance indicators and the DEA method. G.V. Olariu & S. Brad (2022) assessed the relative effectiveness of 38 study programmes at a Romanian public university using CRS-, VRS-output-oriented DEA models for 2016-2019. R. Puertas *et al.* (2023) used the DEA method to assess the effectiveness of environmental policies of universities in Italy and Spain during 2018-2022. The study found an increase in its efficiency due to the introduction of innovative environmental measures. X. Zhao *et al.* (2023), using the BCC (or VRS) model of the DEA method, assessed the effectiveness of scientific and technological innovation (STI) of Chinese universities in 31 provinces for 2011-2020 and analysed the dynamics of its change. Based on the results obtained, proposals were made to improve the efficiency of STI universities through a scientific innovation alliance, and a mechanism for evaluating and managing innovations was developed. Z. Liu *et al.* (2023) used the DEA BCC model and the Malmquist index to analyse the performance of 34 Chinese universities for 2017-2021. It was found that the use of massive open online courses (MOOCs) contributes to efficiency. Among the scientific studies conducted in Ukraine, it is worth noting the study by O. Hryhorash *et al.* (2022), which uses the DEA method to assess the efficiency of higher education expenditures by students and the state in OECD countries and Ukraine and compares the efficiency of these expenditures. I. Lesik *et al.* (2022) used the data envelopment analysis method to assess the effectiveness of the management of the higher education system in 24 regions of Ukraine. The analysis of these studies revealed a substantial lack of theoretical and practical research on the evaluation of

the effectiveness of Ukrainian HEIs using the DEA method. The purpose of this study was to assess the effectiveness of scientific and publishing activities of agricultural HEIs, rank them by efficiency and analyse the dynamics of changes in efficiency.

### ► Materials and Methods

The study proposes to evaluate the effectiveness of scientific and publishing activities of agricultural HEIs using the DEA method. The essence of the DEA methodology is that  $DMU_k$  ( $k = \overline{1; K}$ ), are studied that have a set of inputs (resources) given by a non-zero vector of input variables  $X_k = (x_{k1}, x_{k2}, \dots, x_{km})$  and outputs (results) given by a non-zero vector of output variables  $Y_k = (y_{k1}, y_{k2}, \dots, y_{kn})$ . The  $DMU_0$  activity under analysis is considered to be 100% technically efficient if it achieves the specified result with minimal resource consumption. For this condition, efficiency is assessed using the input-oriented DEA model, which minimises input variables with fixed outputs. The input-oriented orientation will allow to provide recommendations for achieving maximum results of scientific and publishing activities through resource optimisation, which is appropriate if the results of scientific and publishing activities are determined by the workload of academic staff (AS) and resource savings are required. The use of the input-oriented model provides more opportunities to monitor inputs and adjust them. DEA models are divided into constant returns to scale (CRS) and variable returns to scale (VRS) models. The efficiency calculated using the VRS model factors in the disproportionate change in performance due to changes in the amount of resources spent. The increase in the number of AS and funding of scientific activities does not lead to a proportional increase in scientific publications and their quality indicators. Technical efficiency is assessed using the VRS input-oriented model by solving a linear programming problem (Banker *et al.*, 1984):

$$\min_{E, \lambda_1, \lambda_2, \dots, \lambda_k} E, \quad (1)$$

$$EX_0 \geq \sum_{k=1}^K \lambda_k X_k, Y_0 \leq \sum_{k=1}^K \lambda_k Y_k, \quad (2)$$

$$\sum_{k=1}^K \lambda_k = 1, \lambda_k \geq 0 \quad (k = \overline{1, K}), \quad (3)$$

where  $E$  is the input net technical efficiency;  $\lambda_k$  is the unknown coefficients;  $K$  is the number of  $DMU_k$ ;  $X_0, Y_0$  are the vectors of input and output  $DMU_0$  variables under analysis.

By solving the linear programming problem (1)-(3), the coefficients of the input and output variables are determined so that the calculated value of  $DMU_0$  efficiency belongs to the interval  $[0;1]$  and takes the highest possible value. DMUs with an efficiency equal to one are the most efficient and are called "reference" DMUs. The benchmark DMUs form a so-called efficiency frontier in the space of input-output variables.

A correct solution to the problem (1)-(3) is possible if the following non-degeneracy condition is met (Cooper *et al.*, 2006):

$$K \geq \max\{m \times n; 3(n + m)\}, \quad (4)$$

where  $n$  is the number of output variables;  $m$  is the number of input variables.

The analysis of the change in efficiency determined according to the DEA method should factor in the specific feature of the method, according to which the change in efficiency can be caused by both changes in the input and output parameters of  $DMU_0$  and changes in the reference DMUs. The analysis of the change in the efficiency of  $DMU_k$   $k = (\overline{1}; \overline{K})$  in the current period compared to the previous one is carried out using the Malmquist index (Cooper *et al.*, 2007):

$$Mind = TCng \cdot \frac{E_1^1}{E_0^0}, \quad (5)$$

where  $TCng = \sqrt{\frac{E_1^0}{E_1^1} \cdot \frac{E_0^0}{E_0^1}}$  is the technical shift of the efficiency frontier;  $E_0^0$  is the efficiency of  $DMU_0$  analysed in the period  $T_0$ ;  $E_1^1$  is the efficiency of  $DMU_0$  in the period  $T_1$ ;  $E_0^1$  is the efficiency of  $DMU_0$  with indicators in the period  $T_0$  relative to the frontier of efficient DMUs in the period  $T_1$ ;  $E_1^0$  is the efficiency of  $DMU_0$  with indicators in the period  $T_1$  relative to the frontier of efficient DMUs in the period  $T_0$ .

If  $Mind = 1$ , the efficiency of the  $DMU_0$  under study has not changed, if  $Mind > 1$ , it has increased, if  $Mind < 1$ , it has decreased. According to the formula (5), the Malmquist index is formed by multipliers that characterise the change in the technical (innovation) process ( $TCng$ ) and the change in efficiency ( $E_1^1/E_0^0$ ). The DEA models were

calculated using the developed VBA program for Microsoft Excel.

The statistical database of input data values that characterise the scientific and publishing activities of agricultural HEIs, namely the number of AS, the amount of funding for the HEIs under study, the amount of their funding depending on performance indicators, indicators of large-scale scientific activities of HEIs in 2021, 2022, was formed according to the Distribution of funds from the state budget between higher education institutions (n.d.). The statistical database of output data values, namely the number of publications in Scopus of the AS, the number of citations of the AS, the Hirsch index of the AS of the HEIs under study in 2021, 2022, was formed based on the information of university rankings according to Scopus indicators in 2021, 2022 (Scopus ranking of universities in 2021, 2021; Scopus ranking of universities in 2022, 2022).

Agricultural HEIs of Ukraine, namely universities, academies, institutes with an agricultural focus in research and education, were selected as  $DMU_k$  ( $k = \overline{1}; \overline{K}$ ), to be assessed by the DEA method. Among these HEIs, 37 were selected, which are engaged in educational and research activities in the following areas: "Agricultural Sciences and Food", "Production and Technology", and "Natural Sciences". Table 1 shows a sample of  $DMU_k$  ( $k = \overline{1}; \overline{37}$ ) – agrarian HEIs of Ukraine selected for the study.

**Table 1.** Agrarian HEIs of Ukraine under study

No. DMU	HEI	No. DMU	HEI
1	Bila Tserkva National Agrarian University	20	Odesa State Ecological University
2	Vinnitsia National Agrarian University	21	I.I. Mechnykov Odesa National University
3	Uzhhorod National University	22	Podillia State University
4	Dnipro State Agrarian and Economic University	23	Polissia National University
5	Oles Honchar Dnipro National University	24	Poltava State Agrarian University
6	Zaporizhzhia National University	25	Vasyl Stefanyk Precarpathian National University
7	West Ukrainian National University	26	Sumy National Agrarian University
8	Lutsk National Technical University	27	Lesya Ukrainka Volyn National University (Lesya Ukrainka Eastern European National University)
9	Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies of Lviv	28	Volodymyr Dahl East Ukrainian National University
10	Lviv National Environmental University (Lviv National Agrarian University)	29	Dmytro Motornyi Tavria State Agrotechnological University
11	Bogdan Khmelnytsky Melitopol State Pedagogical University	30	Ternopil Ivan Puluj National Technical University
12	Mykolaiv National Agrarian University	31	Uman National University of Horticulture
13	Ukrainian National Forestry University	32	O.M. Beketov National University of Urban Economy in Kharkiv
14	National Technical University "Kharkiv Polytechnic Institute"	33	Kherson State Agrarian and Economic University
15	Chernihiv Polytechnic National University	34	Khmelnytskyi National University
16	National University of Life and Environmental Sciences of Ukraine	35	Central Ukrainian National Technical University
17	National University of Water and Environmental Engineering	36	Cherkasy State Technological University
18	National University of Food Technologies	37	Yuriy Fedkovych Chernivtsi National University
19	Odesa State Agrarian University		

**Source:** Distribution of funds from the state budget between higher education institutions (n.d.)

The object of the study is the scientific and journalistic activity of agricultural universities in Ukraine. The composition of the factors of the VRS-input-oriented model was formed considering the specific features of the research object and the condition of non-degeneracy (4). The vector of input variables of the VRS-input-oriented model is formed by the following factors: 1)  $x_{1k}$  the number of AS, people; 2)  $x_{2k}$  the amount of funding for higher education institutions, UAH; 3)  $x_{3k}$  the amount of funding for higher education institutions depending on performance indicators, UAH; 4)  $x_{4k}$  the indicator of large-scale activity; 5)  $x_{5k}$  the indicator of scientific activity. The vector of output variables of the input-oriented VRS model is formed by the following factors: 1)  $y_{1k}$  is the

number of publications in Scopus by HEI's AS, pcs; 2)  $y_{2k}$  is the number of citations of HEI's AS, pcs; 3)  $y_{3k}$  is the Hirsch index of the HEI's AS. The selected input variables reflect the educational resources of the HEI, and the output variables are the results of scientific and publishing activities.

### ► Results

**Results of the net technical efficiency assessment, analysis of the dynamics of its change.** The values of the input variables for the construction of VRS models that assess the net technical efficiency of the research and publishing activities of the HEIs under study in 2021 and 2022 are presented in Table 2.

**Table 2.** Input data for building VRS models

No. DMU	For VRS 2021 <sup>1</sup> models					For VRS 2022 <sup>2</sup> models				
	AS, people	Financing of HEIs in 2020, UAH		Performance indicators		AS, people	Financing of HEIs in 2021, UAH		Performance indicators	
		Except for: <sup>3</sup>	depending on performance indicators	large-scale	scientific		Except for: <sup>3</sup>	depending on performance indicators	large-scale	scientific
1	376	87,320,968	5,004	1	1.1	376	103,366,688	14,258,913	1	1.1
2	316	69,723,256	13,456	1	1.1	327	76,474,697	8,763,805	1	1.1
3	1,275	203,580,480	1,485	1.2	1.1	1,285	242,022,316	33,139,287	1.2	1.1
4	343	66,804,992	271	1	1.3	327	88,047,177	13,570,066	1	1.3
5	871	244,274,352	9,906	1.2	1.2	826	238,619,619	25,009,747	1.2	1.2
6	710	128,402,216	2,112	1.2	1.1	665	145,644,765	17,361,578	1.2	1.2
7	686	114,421,632	1,043	1.2	1.1	686	129,709,915	14,559,395	1.2	1.1
8	413	106,160,400	2,211	1.2	1.3	413	136,452,343	24,340,299	1.2	1.3
9	330	84,610,096	6,356	1	1	330	105,460,174	11,458,896	1	1
10	320	80,065,528	518	1	1.1	290	98,732,284	8,931,183	1	1.1
11	278	62,646,868	2,194	1	1.1	278	76,274,031	7,420,337	1	1.1
12	352	80,888,976	5,831	1	1.4	352	107,920,540	12,844,898	1	1.4
13	349	80,075,856	15,337	1	1.2	314	94,061,749	7,982,530	1	1.2
14	1,387	368,192,064	11,321	1.4	1.3	1,387	441,909,986	65,334,853	1.4	1.4
15	311	101,270,840	4,206	1	1.4	260	119,943,862	14,493,104	1	1.4
16	1,270	453,143,712	12,579	1.4	1.4	1,210	532,128,935	70,201,158	1.4	1.4
17	589	135,840,528	8,055	1.2	1.2	549	169,684,683	25,892,383	1.2	1.3
18	608	170,255,792	4,003	1.2	1.1	577	180,078,202	20,070,877	1.2	1.1
19	141	27,885,960	1,432	0.8	1	141	31,496,643	2,884,867	0.8	1
20	179	47,197,424	963	0.8	1.2	168	43,324,650	2,638,414	0.8	1.2
21	759	113,510,200	2,096	1	1.2	759	128,828,526	13,534,966	1	1.3
22	213	55,024,400	7,170	1	1.3	199	60,050,078	7,080,327	1	1.3
23	356	69,505,344	17,623	1	1	356	87,687,366	11,843,556	1	1
24	325	68,667,240	1,909	1	1.1	325	91,467,533	12,418,680	1	1.1
25	893	125,292,944	4,467	1.2	1.1	876	154,785,175	20,665,030	1.2	1.1
26	431	116,555,880	10,042	1.2	1.2	385	149,600,957	25,130,460	1.2	1.3
27	741	147,902,336	7,355	1.2	1.1	722	181,148,090	25,703,717	1.2	1.2
28	379	124,084,840	6,683	1	1	371	128,988,330	12,343,448	1	1.1
29	291	81,642,504	996	1	1.2	292	100,200,652	12,224,238	1	1.2
30	408	82,569,280	3,174	1	1.2	401	94,720,593	12,697,461	1	1.2
31	320	74,766,088	2,108	1	1.2	295	96,850,754	12,687,970	1	1.1
32	499	107,834,272	1,407	1	1.4	499	127,641,942	16,700,369	1	1.3
33	216	46,650,324	11,081	1	1.1	216	59,899,945	7,169,768	1	1.1

Table 2, Continued

No. DMU	For VRS 2021 <sup>1</sup> models					For VRS 2022 <sup>2</sup> models				
	AS, people	Financing of HEIs in 2020, UAH		Performance indicators		AS, people	Financing of HEIs in 2021, UAH		Performance indicators	
		Except for: <sup>3</sup>	depending on performance indicators	large-scale	scientific		Except for: <sup>3</sup>	depending on performance indicators	large-scale	scientific
34	544	101,756,008	2,072	1	1.1	544	119,018,448	13,707,116	1	1.1
35	323	73,545,648	2,234	1	1.1	311	88,162,710	10,091,433	1	1.1
36	369	72,333,984	341	1	1	345	74,946,847	8,034,883	1	1
37	1,101	176,465,248	193	1.2	1.1	1,035	207,844,329	30,050,709	1.2	1.1

**Note:** <sup>1</sup> DEA models assessing the effectiveness of the research and publishing activities of the DMUs studied in 2021; <sup>2</sup> DEA models assessing the effectiveness of the research and publishing activities of the DMUs studied in 2022; <sup>3</sup> 1) social and other payments; 2) reserve

**Source:** Distribution of funds from the state budget between higher education institutions (n.d.)

The values of the output variables for the construction of VRS models that evaluate the effectiveness of scientific and publishing activities of the HEIs under study in 2021, 2022 are presented in Table 3.

Table 3. Input data for building VRS models

No. DMU	For VRS-2021 models			For VRS-2022 models		
	Number of Scopus publications by HEI's AS in 2021, pcs.	Number of citations of HEI's AS in 2021, pcs.	Hirsch Index of HEI's AS in 2021	Number of Scopus publications by HEI's AS in 2022, pcs.	Number of citations of HEI's AS in 2022, pcs.	Hirsch Index of HEI's AS in 2022
1	173	590	13	235	235	14
2	206	515	10	289	951	13
3	2,673	14,444	43	3,078	16,922	45
4	280	765	11	377	1,104	14
5	4,262	18,456	46	4,698	21,159	49
6	972	2,374	21	1,137	3,034	22
7	961	2,765	21	1,161	3,812	23
8	561	1,058	13	650	1,996	15
9	286	1,970	22	352	2,376	23
10	233	722	9	315	1,141	13
11	174	536	11	250	1,030	15
12	205	517	12	315	1,008	15
13	363	3,292	26	425	4,416	28
14	4,890	19,915	48	5,532	24,238	53
15	467	1,825	19	541	2,453	22
16	1,730	6,645	32	2,329	9,770	38
17	722	2,402	19	909	3,714	25
18	717	3,243	25	819	4,102	26
19	34	64	6	58	121	6
20	296	1,631	17	351	2,101	18
21	3,916	25,987	67	4,191	29,503	71
22	101	143	6	142	363	9
23	244	546	11	576	1,121	13
24	243	418	9	331	776	13
25	1,152	11,944	47	1,404	15,648	54
26	463	1,932	20	686	2,901	24
27	975	7,082	32	1,139	8,462	33
28	943	3,498	21	1,172	4,568	25
29	281	668	12	402	1,158	16

Table 3, Continued

No. DMU	For VRS-2021 models			For VRS-2022 models		
	Number of Scopus publications by HEI's AS in 2021, pcs.	Number of citations of HEI's AS in 2021, pcs.	Hirsch Index of HEI's AS in 2021	Number of Scopus publications by HEI's AS in 2022, pcs.	Number of citations of HEI's AS in 2022, pcs.	Hirsch Index of HEI's AS in 2022
30	910	2,832	17	1,052	3,923	22
31	211	306	9	278	429	10
32	597	1,440	17	765	2,224	20
33	123	349	10	182	609	14
34	684	2,812	19	811	3,752	23
35	261	606	10	299	839	13
36	294	1,093	20	336	1,322	20
37	3,995	20,227	64	4,332	23,307	66

Source: Scopus ranking of universities in 2021 (2021); Scopus ranking of universities in 2022 (2022)

The formation of the database of statistical values of input and output variables was carried out considering the time lag – the results of scientific and publishing activities are possible at least 1 year after the action of the input factors. Next, the study checked if the non-degeneracy condition (4) is met:  $37 \geq \max\{5 \times 3; 3(5+3)\}$ ;  $37 \geq 24$ . Thus,

condition (4) is satisfied.

**Results of the net technical efficiency assessment.** Table 4 contains the results of calculations of the net technical efficiency of scientific and publishing activities of Ukrainian agricultural HEIs in 2021 ( $E_0^0$ ) and 2022 ( $E_1^1$ ), and the rankings of agricultural HEIs based on the assessed efficiency.

**Table 4.** Results of calculations of the net technical efficiency of scientific and publishing activities of agricultural HEIs of Ukraine in 2021, 2022 and ratings of agricultural HEIs of Ukraine according to the estimated efficiency values

No. DMU	2021	2022	DMU ranking, 2021			DMU ranking, 2022		
	$E_0^0$	$E_1^1$	No. DMU	$E_0^0$	Rank	No. DMU	$E_1^1$	Rank
1	0.9091	0.9091	5	1	1	5	1	1
2	0.9091	0.9095	9	1	1	9	1	1
3	0.9686	0.9723	14	1	1	14	1	1
4	0.8098	0.8179	19	1	1	19	1	1
5	1.0000	1.0000	20	1	1	20	1	1
6	0.9124	0.8471	21	1	1	21	1	1
7	0.9164	0.9257	23	1	1	23	1	1
8	0.7698	0.7756	28	1	1	25	1	1
9	1.0000	1.0000	36	1	1	36	1	1
10	0.9091	0.9100	37	1	1	37	1	1
11	0.9091	0.9112	25	0.9810	2	13	0.9730	2
12	0.8007	0.8056	3	0.9686	3	3	0.9723	3
13	0.9260	0.9730	27	0.9316	4	28	0.9614	4
14	1.0000	1.0000	13	0.9260	5	33	0.9510	5
15	0.8196	0.8505	34	0.9210	6	34	0.9299	6
16	0.7364	0.7502	7	0.9164	7	7	0.9257	7
17	0.8333	0.7886	18	0.9161	8	18	0.9189	8
18	0.9161	0.9189	6	0.9124	9	11	0.9112	9
19	1.0000	1.0000	33	0.9093	10	24	0.9103	10
20	1.0000	1.0000	1	0.9091	11	10	0.9100	11
21	1.0000	1.0000	2	0.9091	11	35	0.9097	12
22	0.8007	0.8019	10	0.9091	11	2	0.9095	13
23	1.0000	1.0000	11	0.9091	11	1	0.9091	14
24	0.9091	0.9103	24	0.9091	11	31	0.9091	14
25	0.9810	1.0000	35	0.9091	11	30	0.8763	15
26	0.8333	0.8161	30	0.8630	12	27	0.8589	16
27	0.9316	0.8589	29	0.8418	13	29	0.8580	17
28	1.0000	0.9614	31	0.8345	14	15	0.8505	18
29	0.8418	0.8580	17	0.8333	15	6	0.8471	19

Table 4, Continued

No. DMU	2021	2022	DMU ranking, 2021			DMU ranking, 2022		
	$E_0^0$	$E_1^1$	No. DMU	$E_0^0$	Rank	No. DMU	$E_1^1$	Rank
30	0.8630	0.8763	26	0.8333	15	32	0.8371	20
31	0.8345	0.9091	32	0.8204	16	4	0.8179	21
32	0.8204	0.8371	15	0.8196	17	26	0.8161	22
33	0.9093	0.9510	4	0.8099	18	12	0.8056	23
34	0.9210	0.9299	22	0.8007	19	22	0.8019	24
35	0.9091	0.9097	12	0.8007	20	17	0.7886	25
36	1.0000	1.0000	8	0.7698	21	8	0.7756	26
37	1.0000	1.0000	16	0.7364	22	16	0.7502	27

Source: calculated by the author of this study

According to the results of the calculations presented in Table 4, the following agricultural HEIs of Ukraine had the highest relative efficiency of scientific and publishing activities in 2021 and 2022: Oles Honchar Dnipro National University, S.Z. Gzhytskyi Lviv National University of Veterinary Medicine and Biotechnology, National Technical University "Kharkiv Polytechnic Institute", Odesa State Agrarian University, Odesa State Environmental University, I.I. Mechnykov Odesa National University, Polissia National University, Cherkasy State Technological University, Yuriy Fedkovych Chernivtsi National University.

In addition, in 2021, the maximum relative efficiency of scientific and journalistic activities was achieved by the Volodymyr Dahl East Ukrainian National University, and in 2022 – by the Vasyl Stefanyk Precarpathian National University. The minimum effectiveness of scientific and journalistic activities in 2021 and 2022 was achieved by the National University of Life and Environmental Sciences of Ukraine. The calculated value of the estimated efficiency of this HEI was 0.74 in 2021 and 0.75 in 2022. Table 5 shows a summary of the net technical efficiency assessment.

Table 5. Summary indicators of net technical efficiency

Indicators	$E_0^0$	$E_1^1$
Number of effective ones	10	10
Percentage of effective ones	27.03	27.03
Average efficiency	0.9081	0.9104

Source: calculated by the author of this study

According to the calculations presented in Table 5, in 2021 and 2022, the share of agricultural higher education institutions with the highest efficiency of scientific and publishing activities was 27%. Thus, 63% of the surveyed HEIs can improve their performance by reducing the

amount of resources used. The average relative net technical efficiency was 0.91. Table 6 shows the results of the net technical efficiency assessment for 2021 ( $E_0^0$ ) and 2022 ( $E_1^1$ ), indicators of efficiency change ( $E_1^1/E_0^0$ ), technical progress ( $TCng$ ), Malmquist index ( $Mind$ ).

Table 6. Net technical efficiency of scientific and publishing activities of agricultural HEIs of Ukraine in 2021, 2022, indicators of its change for 2021-2022

No. DMU	$E_0^0$	$E_1^1$	$E_1^1/E_0^0$	$TCng$	$Mind$
1	0.9091	0.9091	1.0000	1.0000	1.0000
2	0.9091	0.9095	1.0004	1.0075	1.0079
3	0.9686	0.9723	1.0038	1.0177	1.0216
4	0.8098	0.8179	1.0100	1.0010	1.0110
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.9124	0.8471	0.9284	1.0063	0.9343
7	0.9164	0.9257	1.0101	1.0108	1.0210
8	0.7698	0.7756	1.0075	0.9947	1.0022
9	1.0000	1.0000	1.0000	1.0000	1.0000
10	0.9091	0.9100	1.0010	1.0067	1.0077
11	0.9091	0.9112	1.0023	1.0278	1.0302
12	0.8007	0.8056	1.0061	1.0015	1.0076
13	0.9260	0.9730	1.0508	1.0183	1.0700
14	1.0000	1.0000	1.0000	1.0000	1.0000
15	0.8196	0.8505	1.0377	1.0361	1.0752

Table 6, Continued

No. DMU	$E_0^0$	$E_1^1$	$E_1^1/E_0^0$	<i>TCng</i>	<i>Mind</i>
16	0.7364	0.7502	1.0187	0.9998	1.0186
17	0.8333	0.7886	0.9464	0.9982	0.9447
18	0.9161	0.9189	1.0031	1.0044	1.0074
19	1.0000	1.0000	1.0000	1.0000	1.0000
20	1.0000	1.0000	1.0000	1.0000	1.0000
21	1.0000	1.0000	1.0000	1.0000	1.0000
22	0.8007	0.8019	1.0015	1.0010	1.0025
23	1.0000	1.0000	1.0000	1.0000	1.0000
24	0.9091	0.9103	1.0013	1.0000	1.0013
25	0.9810	1.0000	1.0194	0.9905	1.0096
26	0.8333	0.8161	0.9794	1.0046	0.9839
27	0.9316	0.8589	0.9220	1.0086	0.9299
28	1.0000	0.9614	0.9614	0.9988	0.9603
29	0.8418	0.8580	1.0192	0.9981	1.0173
30	0.8630	0.8763	1.0154	0.9971	1.0125
31	0.8345	0.9091	1.0894	0.9995	1.0889
32	0.8204	0.8371	1.0204	1.0014	1.0218
33	0.9093	0.9510	1.0459	1.0039	1.0499
34	0.9210	0.9299	1.0097	1.0062	1.0159
35	0.9091	0.9097	1.0007	1.0039	1.0045
36	1.0000	1.0000	1.0000	1.0000	1.0000
37	1.0000	1.0000	1.0000	1.0000	1.0000

Source: calculated by the author of this study

Thus, the following agricultural universities did not change their performance in 2021-2022: Bila Tserkva National Agrarian University, Oles Honchar Dnipro National University, Stepan Gzhytskyi National University of Veterinary Medicine and Biotechnologies of Lviv, National Technical University "Kharkiv Polytechnic Institute", Odessa State Agrarian University, Odessa State Environmental University, I.I. Mechnykov Odessa National University, Polissia National University, Cherkasy State Technological University, Yuriy Fedkovych Chernivtsi National University. The following agrarian HEIs have increased their efficiency: Vinnytsia National Agrarian University, Uzhhorod National University, Dnipro State Agrarian and Economic University, Western Ukrainian National University, Lutsk National Technical University, Lviv National University of Environmental Management, Bogdan Khmelnytsky Melitopol State Pedagogical University, Mykolaiv National Agrarian University, National Forestry University of Ukraine, National University "Chernihiv Polytechnic", National University of Life and Environmental Sciences of Ukraine, National University of Food Technologies, Podillia State University, Poltava State Agrarian University, Vasyl Stefanyk Precarpathian National University, Dmytro

Motorny Tavria State Agrotechnological University, Ternopil Ivan Puluj National Technical University, Uman National University of Horticulture, O.M. Beketov National University of Urban Economy in Kharkiv, Kherson State Agrarian and Economic University, Khmelnytskyi National University, Central Ukrainian National Technical University. The following higher education institutions decreased their efficiency: "Zaporizhzhia National University, National University of Water and Environmental Engineering, Sumy National Agrarian University, Lesya Ukrainka Volyn National University, and Volodymyr Dahl East Ukrainian National University.

The analysis of the values of the indicators of change in efficiency ( $E_1^1/E_0^0$ ) and technical progress (*TCng*) presented in Table 6 allows concluding on the reasons for the change in efficiency. For instance, the decrease in the efficiency of scientific and publishing activities of the Sumy National Agrarian University by 1.61% (*Mind* = 0.9839) is conditioned by a decrease in the relative efficiency of the use of resources of the said university by 2.06% ( $E_1^1/E_0^0$ ) = 0.9794) and a shift in the efficiency limit by 0.46% (*TCng* = 1.0046). Table 7 shows the indicators used to analyse the dynamics of changes in net technical efficiency in 2021-2022.

Table 7. Indicators of changes in net technical efficiency for 2021-2022

No.	Indicators	<i>TCng</i>	<i>Mind</i>
1.	Average value	1.004	1.01
2.	DMU share from <i>Mind</i> = 1, %		27
3.	DMU share from <i>Mind</i> > 1, %		59
4.	DMU share from <i>Mind</i> < 1, %		14

Source: calculated by the author of this study

Table 7 shows the calculated average value of the technical progress indicator  $TCng = 1.004$ , which indicates a 0.4% shift in the efficiency frontier. Thus, in 2021-2022, there has been a general progress in the scientific and publishing activities of agricultural universities. The average value of the Malmquist Index  $Mind = 1.01$  calculated for 2021-2022 shows that, on average, the efficiency of using educational resources of the HEIs under study increased by 1%. Thus, to achieve the results of scientific and publishing activities in 2021, agrarian higher education institutions used 1% less educational resources in 2022. The share of agrarian higher education institutions whose effectiveness of scientific and publishing activities did not change in 2021-2022 is 27%, increased – 59%, decreased – 14%.

### ► Discussion

The study assessed the net technical efficiency of the scientific and publishing activities of agricultural universities in 2021 and 2022. The evaluation was based on five input factors (number of AS, total funding of HEIs and funding of HEIs depending on performance indicators, indicators of scale and scientific activity), and three output factors (number of publications in Scopus, number of citations, Hirsch index). The input factors characterise the resources required for the implementation of scientific and journalistic activities, and the output factors are the results of scientific and journalistic activities. Since the results of scientific and publishing activities do not change in direct proportion to the resources involved, the study rejected the hypothesis of constant returns to scale and applied the VRS model, which factors in variable returns. Since the results of scientific and publishing activities of AS of Ukrainian HEIs are regulated by the regulation on the standardisation of scientific work and managers of HEIs are interested in saving educational resources, the input-oriented orientation of the model was chosen.

I. Lesik *et al.* (2022) analyse the higher education system in the regions of Ukraine, and therefore the HEIs of the regions of Ukraine were chosen as DMUs. C. Wang *et al.* (2023), X. Zhao *et al.* (2023) chose universities in the provinces of China as DMUs. T. Qi *et al.* (2022) assess the effectiveness of research activities of different types of universities in China. The following types of universities have been selected as DMUs: Comprehensive University, Engineering University, Agriculture and Forestry University, Pharmaceutical University, Normal University, etc. In the current study, individual universities were selected as DMUs, which allows providing recommendations for improving the efficiency of higher education institutions.

Among the scientific papers on the application of the DEA method in education are those that investigate certain areas of activity of HEIs, namely, training, research, scientific and journalistic, reproduction of scientific personnel, etc. There is no set of standardised indicators that define the input and output parameters of any HEI activity, and therefore there is a wide variety of combinations of input and output factors in scientific articles. M. Sagarra *et al.* (2017) assessed the effectiveness of the implementation of the programme of modernisation of education in Mexican universities, namely its impact on the efficiency of educational activities and research, using

the DEA method. Based on the official statistics of 55 universities, 21 DEA models were built according to various performance criteria. M.B. Canto & L.B. López (2018) conducted a bibliographic analysis of research on the application of the DEA method in higher education to determine the input and output factors used to assess the effectiveness of HEIs. From the bibliographic review, it is concluded that most of the input and output parameters reflect the university's scientific activities. Next, the study analysed the articles investigating the effectiveness of the scientific direction of the HEI. J. Jiang *et al.* (2020) assessed the research efficiency of 105 universities in China and found that the research efficiency of the selected universities differs by their types. T. Qi *et al.* (2022), X. Zhao *et al.* (2023) also noted that research activity depends on the type of university. T. Qi *et al.* (2022) used the DEA method to investigate the static and dynamic trends in the efficiency of research of different types of universities in China for 2016-2020. According to the comparative analysis of the study, the highest level of efficiency is in general education, science and technology, and medical universities, followed by pedagogical universities, agriculture, and forestry. To ensure the correctness of the ranking of higher education institutions by the effectiveness of scientific and publishing activities, the current study selected higher education institutions of the same type. To assess the effectiveness of research activities of Chinese provincial universities, C. Wang *et al.* (2023) selected input and output factors based on the analysis of the percentage of factors used in research papers and a survey of experts on resources and results of research activities. As a result, four input and output factors were selected. The following factors were selected as input factors: the number of academic and research staff, full-time equivalent for R&D (persons/year), funds allocated for research per year, and the total number of research topics. The following were chosen as the initial indicators: the number of monographs, articles, income from technology transfer, and awards for scientific achievements. The qualitative description of some input and output parameters of C. Wang *et al.* (2023) is analogous in its qualitative description of the selected parameters to the present study. Consideration of the percentage of factors used in scientific papers is vital when selecting input and output factors, but in the present study, the main criterion for selecting factors was to obtain data from open sources, which contributes to the transparency of the study and also makes it possible to remotely assess effectiveness. In the present study, it is vital to consider the non-degeneracy condition (4) when forming an array of input and output factors. Failure to factor this condition in can lead to distorted results. T. Qi *et al.* (2022), C. Wang *et al.* (2023) estimated the net technical efficiency using the VRS-input-oriented model, as in the present study. Furthermore, C. Wang *et al.* (2023) assessed technical efficiency using the CRS-input-oriented model, which was used to assess scale efficiency. The assessment of large-scale efficiency and its analysis are planned to be carried out in the following studies. S.M. Chao & M.J. Chen (2023) used the CRS-, VRS-output-oriented DEA models to assess the research efficiency of 40 university departments to measure the effectiveness of research in terms of outputs.

The studies by T. Agasisti *et al.* (2021), T. Qi *et al.* (2022), X. Zhao *et al.* (2023), as well as in the current study, analysed the dynamics of changes in the estimated efficiency using the Malmquist index.

The analysis of scientific studies on the application of the DEA method in higher education has found that the studies differ in the selected DMUs of higher education and educational indicators that characterise the area of their activities. Generally, the issues of using the DEA method to assess the effectiveness of higher education institutions in Ukraine and analyse the dynamics of its change have not been fully studied.

### ► Conclusions

To analyse the effectiveness of scientific and journalistic activities of agricultural higher education institutions of Ukraine, the conducted study chose the DEA method model – input-oriented VRS, as well as input and output factors that factor in the specifics of scientific and publishing activities. According to the study, in 2021 and 2022, ten out of 37 agricultural HEIs in Ukraine had the highest net technical efficiency of scientific and publishing activities. These HEIs are efficient in the use of educational resources. The average net technical efficiency of Ukrainian agricultural universities in 2021 and 2022 was 0.91, which means that there is potential for increasing efficiency – 9% of the educational resources used can be reduced without reducing the results of scientific and publishing activities. Based on the assessed performance values, a rating of agricultural HEIs for 2021 and 2022 was compiled, which can be recommended as a supplement to existing evaluation ratings. Inefficient HEIs can improve their performance by optimising resources.

During 2021-2022, an average increase in the efficiency of scientific and publishing activities of Ukrainian

agricultural universities by 1% was observed. Thus, the process of scientific and journalistic activity of agricultural universities in Ukraine is progressive. The finding of this study can be used to rank agricultural higher education institutions by the efficiency of scientific and publishing activities, to substantiate recommendations for improving efficiency to the maximum level. The analysis of the efficiency estimated according to the DEA method in the dynamics allows investigating the shift of the efficiency limit over time and conclude on the development of scientific and publishing activities of HEIs: progressive or regressive.

Further research is planned to determine the values of resource indicators of agricultural higher education institutions using the DEA method, which will allow inefficient higher education institutions to become 100% efficient. Higher education institutions that rank first can also improve their efficiency. For this, it is necessary to evaluate a sample using the DEA method, which includes DMUs that form the efficiency frontier and new reference DMUs, which can be either the best universities in the world or the country, but with modified indicators. Increasing the efficiency of agricultural HEIs that have 100% efficiency according to the calculations is also a future objective of the research.

### ► Acknowledgements

The author of this study would like to express their gratitude to the reviewer for providing intellectual advice on improving the perception of the article's material, its structure, and to the editors of the *Ekonomika APK* journal for providing technical support in editing the text of the article, which contributed to improving its quality.

### ► Conflict of Interest

The author of this study declares no conflict of interest.

### ► References

- [1] Agasisti, T., Yang, G.L., Song, Y.Y., & Tran, C.-T.T.D. (2021). Evaluating the higher education productivity of Chinese and European "elite" universities using a meta-frontier approach. *Scientometrics*, 126, 5819-5853. doi: 10.1007/s11192-021-03978-z.
- [2] Banker, R.D., Charnes, A., & Cooper, W.W. (1984). *Some models for estimating technical and scale inefficiencies in data envelopment analysis*. *Management Science*, 30(9), 1078-1092.
- [3] Canto, M.B., & López, L.B. (2018). Ranking of global efficiency of the best universities in Europe. *Marketing and Management of Innovations*, 3, 34-47. doi: 10.21272/mmi.2018.3-03.
- [4] Chao, S.-M., & Chen, M.-J. (2023). DEA approach to evaluate research efficiency of departments in university. *Engineering Proceedings*, 38(1), article number 71. doi: 10.3390/engproc2023038071.
- [5] Cooper, W.W., Seiford, L.M., & Tone, K. (2006). *Introduction to data envelopment analysis and its uses with DEA-solver software and references* (1st ed.). New York: Springer. doi: 10.1007/0-387-29122-9.
- [6] Cooper, W.W., Seiford, L.M., & Tone, K. (2007). *Data envelopment analysis. A comprehensive text with models, applications, references and DEA-solver software* (2nd ed.). New York: Springer. doi: 10.1007/978-0-387-45283-8.
- [7] Data Envelopment Analysis Online Software. (n.d.). Retrieved from <https://www.deaos.com/en-us/deaoscustom/statisticspage>.
- [8] Distribution of funds from the state budget between institutions of higher education. (n.d.). Retrieved from <https://mon.gov.ua/ua/osvita/visha-osvita/rozpodil-koshtiv-z-derzhavnogo-byudzhetu-mizh-zakladami-vishoyi-osviti-u-2020>.
- [9] Dolhikh, Ya. (2020). Evaluation and analysis by the DEA method of the effectiveness of the reproduction of scientific personnel of higher education institutions in the regions of Ukraine. *Economics and Management*, 3, 118-126. doi: 10.36919/2312-7812.3.2020.118.
- [10] El Gibari, S., Gómez, T., & Ruiz, F. (2022). Combining reference point based composite indicators with data envelopment analysis: Application to the assessment of universities. *Scientometrics*, 127(5), 4363-4395. doi: 10.1007/s11192-022-04436-0.

- [11] Hryhorash, O., Bocharov, D., Bondar, A., Zhuravka, O., Mordan, Y., & Teslenko, T. (2022). The efficiency of individual and public spending on higher education in OECD countries and in Ukraine. *Financial and Credit Activity Problems of Theory and Practice*, 5(46), 453-462. doi: [10.55643/fcaptop.5.46.2022.3909](https://doi.org/10.55643/fcaptop.5.46.2022.3909).
- [12] Jiang, J., Lee, S.K., & Rah, M.J. (2020). Assessing the research efficiency of Chinese higher education institutions by data envelopment analysis. *Asia Pacific Education Review*, 21, 423-440. doi: [10.1007/s12564-020-09634-0](https://doi.org/10.1007/s12564-020-09634-0).
- [13] Lesik, I., Usykova, O., Petrenko, N., Melnyk, I., & Ananiichuk, Y. (2022). Analysis of factors affecting the efficiency of the higher education system in Ukraine. *Journal of Higher Education Theory and Practice*, 22(6), 86-102. doi: [10.33423/jhetp.v22i6.5231](https://doi.org/10.33423/jhetp.v22i6.5231).
- [14] Liu, Z., Xiong, H., & Sun, Y. (2023). Will online MOOCs improve the efficiency of Chinese higher education institutions? An empirical study based on DEA. *Sustainability*, 15(7), article number 5970. doi: [10.3390/su15075970](https://doi.org/10.3390/su15075970).
- [15] Olariu, G.V., & Brad, S. (2022). Preventive risk management of resource allocation in Romanian higher education by assessing relative performance of study programs with DEA method. *Sustainability*, 14(19), article number 12527. doi: [10.3390/su141912527](https://doi.org/10.3390/su141912527).
- [16] Pham Van, T., Tran, T., Trinh Thi Phuong, T., Hoang Ngoc, A., Nghiem Thi, T., & La Phuong, T. (2022). Over three decades of data envelopment analysis applied to the measurement of efficiency in higher education: A bibliometric analysis. *Journal on Efficiency and Responsibility in Education and Science*, 15(4), 251-265. doi: [10.7160/eriesj.2022.150406](https://doi.org/10.7160/eriesj.2022.150406).
- [17] Puertas, R., Guaita-Martinez, J.M., & Marti, L. (2023). Analysis of the impact of university policies on society's environmental perception. *Socio-Economic Planning Sciences*, 88, article number 101672. doi: [10.1016/j.seps.2023.101672](https://doi.org/10.1016/j.seps.2023.101672).
- [18] Qi, T., Dou, S., & Li, X. (2022). Assessment of research efficiency in China's universities based on data envelopment method. *Technical Gazette*, 29(6), 1964-1974. doi: [10.17559/TV-20220514054609](https://doi.org/10.17559/TV-20220514054609).
- [19] Sagarra, M., Mar-Molinero, C., & Agasisti, T. (2017). Exploring the efficiency of Mexican universities: Integrating data envelopment analysis and multidimensional scaling. *Omega*, 67, 123-133. doi: [10.1016/j.omega.2016.04.006](https://doi.org/10.1016/j.omega.2016.04.006).
- [20] Scopus ranking of universities in 2021. (2021). Retrieved from <https://osvita.ua/vnz/rating/82316/>.
- [21] Scopus ranking of universities in 2022. (2022). Retrieved from <https://osvita.ua/vnz/rating/86513/>.
- [22] Stefanova, K., & Velichkov, N. (2020). [Analysis of the efficiency of tertiary education expenditure in European Union member states from Central and Eastern Europe: An efficiency frontier approach](#). *South-Eastern Europe Journal of Economics*, 18(1), 115-128.
- [23] Wang, C., Zeng, J., Zhong, H., & Si, W. (2023). Scientific research input and output efficiency evaluation of universities in Chengdu-Chongqing economic circle based on data envelopment analysis. *PLoS One*, 18(7), article number 0287692. doi: [10.1371/journal.pone.0287692](https://doi.org/10.1371/journal.pone.0287692).
- [24] Zhao, X., Chen, M., Long, C., Zhao, J., & Wang, S. (2023). Research on evaluation of scientific and technological innovation efficiency in Chinese universities-an analysis based on sample data of 31 provinces. *IEEE Access*, 11, 16297-16309. doi: [10.1109/ACCESS.2023.3241343](https://doi.org/10.1109/ACCESS.2023.3241343).

## Оцінка ефективності аграрних закладів вищої освіти України та динаміки її зміни методом data envelopment analysis

**Яна Володимирівна Долгіх**

Кандидат економічних наук, доцент

Сумський національний аграрний університет

40021, вул. Герасима Кондратьєва, 160, м. Суми, Україна

<https://orcid.org/0000-0001-5458-5962>

► **Анотація.** На теперішній час потребує удосконалення процес оцінки ефективності діяльності закладів вищої освіти та аналізу динаміки її зміни, що обумовлює актуальність дослідження. Мета статті полягала у вдосконаленні процесу оцінки ефективності діяльності аграрних вищих навчальних закладів України в науково-публіцистичному контексті, а також у вивченні змін динаміки за допомогою непараметричного методу оцінки відносної ефективності data envelopment analysis. В дослідженні застосовувались методи статистичної обробки та аналізу даних, лінійного програмування, комп'ютерних обчислень для розв'язання задач дослідження та логіко-аналітичні методи для визначення мети дослідження, засобів її досягнення, обґрунтування результатів дослідження, формулювання висновків. Для оцінки ефективності науково-публіцистичної діяльності зазначених закладів вищої освіти застосовано input-oriented модель Variable returns to scale методу data envelopment analysis. Використовуючи статистичні дані за 2020-2022 роки, здійснено оцінку чистої технічної ефективності науково-публіцистичної діяльності 37 аграрних закладів вищої освіти України. За результатами оцінки складено рейтинг аграрних закладів вищої освіти України. Встановлено, що у 2021 та 2022 році 27 % досліджуваних закладів вищої освіти були 100 % ефективними. Середня чиста технічна ефективність у 2021 та 2022 році складала 0,91. За період 2021-2022 роки 27 % аграрних закладів вищої освіти збільшили ефективність науково-публіцистичної діяльності, 59 % – не змінили, 14 % – зменшили. В середньому, зафіксовано підвищення на 1 % у рівні використання освітніх ресурсів у сфері аграрної вищої освіти. Отже, науково-публіцистична діяльність аграрних закладів вищої освіти за досліджуваний період є прогресивною. Результати проведених досліджень можуть бути використані для обґрунтованого ранжування закладів вищої освіти за ефективністю науково-публіцистичної діяльності, аналізу динаміки зміни ефективності

► **Ключові слова:** вища освіта; науково-публіцистична діяльність; непараметричний метод оцінки відносної ефективності; модель Variable returns to scale; чиста технічна ефективність; рейтинг; індекс Малмквіста



UDC 338.432

## Development of small businesses producing cereals, legumes, and sunflower seeds in wartime conditions

### Mykola Malik

Doctor of Economic Sciences, Professor  
National Scientific Centre "Institute of Agrarian Economics"  
03127, 10 Heroiv Oborony Str., Kyiv, Ukraine  
<https://orcid.org/0000-0001-9198-4460>

### Svitlana Kravchenko\*

Doctor of Economic Sciences, Professor  
National Scientific Centre "Institute of Agrarian Economics"  
03127, 10 Heroiv Oborony Str., Kyiv, Ukraine  
<https://orcid.org/0000-0001-5541-4495>

### Oleksandr Shpykuliak

Doctor of Economic Sciences, Professor  
National Scientific Centre "Institute of Agrarian Economics"  
03127, 10 Heroiv Oborony Str., Kyiv, Ukraine  
<https://orcid.org/0000-0001-5257-5517>

### Henrikh Hudz

PhD in Economic Sciences, Assistant  
Taras Shevchenko National University of Kyiv  
01601, 64/13 Volodymyrska Str., Kyiv, Ukraine  
<https://orcid.org/0000-0003-4931-3350>

► **Abstract.** Small businesses producing cereals, legumes, and sunflower seeds contribute to the country's food security and environmental protection potential. The purpose of this study was to substantiate the social, economic, and conceptual foundations of small business entities' activities in the production of cereals, legumes, and sunflower seeds in modern conditions. The methodological framework of the study included the provisions of institutional economic theory and functional analysis. To generalise the results, the study employed analysis, graphic, and abstract-logical methods, and approaches of generalisation of results. The motivational orientation of the functioning of small businesses engaged in the production of cereals, legumes, and sunflower seeds and their place in production and consumption were determined. The study found that in 2023, the company achieved a record grain yield of 51.8 100 kg/ha, which was driven by favourable weather conditions. It was substantiated that the cost of crop production has increased due to lower prices for agricultural products (maize by -41%; sunflower by -35%; wheat by -37%) and an almost twofold increase in the cost of plant protection products and fuel. It was proved that in 2017-2022, 91.79% of the variation in net profit is explained by the variation in the level of grain, legumes, and sunflower seeds sold by small businesses. It was found that the disruption of the sales system of small businesses producing cereals, legumes, and sunflower seeds, the low level of purchase prices and the considerable increase in prices for material and technical sources of survival and fertilisers due to the hostilities make production inefficient. The development of small businesses and family farming stays one of the priority areas of regional policy. The information and analytical material can be considered when creating regional programmes for the development of agrarian entrepreneurship

► **Keywords:** business entity; adaptation to martial law; small business structures; family farming; agricultural cooperative; private enterprises

► **Suggested Citation:** Malik, M., Kravchenko, S., Shpykuliak, O., & Hudz, H. (2024). Development of small businesses producing cereals, legumes, and sunflower seeds in wartime conditions. *Ekonomika APK*, 31(1), 41-53. doi: 10.32317/2221-1055.202401041.

\*Corresponding author



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

## ► Introduction

The functioning of business entities in agriculture is of great importance in the system of ensuring national food security. Small businesses form an integral element of territorial entities. They have a special potential for shaping food systems. It was established that if the income of a business entity during its operation in the market environment does not exceed EUR 10 million in equivalent, then this entity is small (Filling out the simplified..., 2019). Certain indicators of the functioning of small businesses (up to 50 employees; up to EUR 8 million in net sales revenue; up to EUR 4 million in book value of assets) are set out in the Law of Ukraine "On Accounting and Financial Reporting in Ukraine" (Law of Ukraine No. 996-XIV..., 1999). It is necessary to form a balanced social, environmental, psychological, demographic, and economic activity of rural communities. For this purpose, priority support for small businesses and various forms of their cooperation are of particular importance.

To expand the competitive potential of small and medium-sized enterprises, activate the mechanism of obtaining socio-economic benefits and the potential for survival in extreme conditions, economists J.M. Lopes & S. Gomes (2022) have actualised the attention to the components of the mechanism of sustainable and innovative strategic management. The imperfection of the organisation of the controlling system of small business entities, which affects the growth of production costs, is proved. The researchers substantiate the need to improve the organisation of the internal control system in terms of reorientation to active forms of control to identify the causes and ways to eliminate shortcomings (Kaliuha & Hryshchuk, 2023).

K. Kusnandar *et al.* (2023) substantiated, considering the provisions of behavioural theory and some aspects of organisational culture, the need to develop an innovative culture in the agribusiness of small businesses. The purpose of the model is to change the mindset of small businesses towards innovation, where innovation is considered as a condition for success. It was substantiated that innovative behaviour is reflected in the development of new product variants, the use of e-commerce for sales and the improvement of production technology to increase cost efficiency. Creating a culture of innovation among small businesses will allow them to compete, develop, and become more sustainable. O. Litvak & S. Litvak (2023) have formed a comprehensive approach to the implementation of the principles of the circular economy in agriculture and the agro-industrial complex. The need to implement circular business models and innovative resource-saving technologies is becoming increasingly important. Furthermore, it was substantiated that the activities of small businesses are impossible without cooperation with scientific and educational institutions. The study identified specific sectoral features of readiness to implement innovative ideas and developments.

Researchers have established that small businesses that are risky for investment are the driving force behind economic development. It was found that outdated equipment and technologies are a considerable problem in the operation. Additional financing of small business

entities will help to reveal the investment attractiveness of operation; to reduce the environmental consequences of activities; implement new methods of storage, processing and sales of products; use drones and modern monitoring systems, etc. (Sahachko *et al.*, 2023). S.N. Mohamad Fauzi *et al.* (2023) assessed the risk factors in the market environment for the activities of small businesses in the market environment. As a result of the risk identification and assessment, it was found that the qualities of an entrepreneur are the key risk factor in business.

In the study, the researchers addressed the feasibility of small businesses, the specific features of their development and capital dynamics. The study of the functioning and development of business entities in the context of armed conflict focuses on the possibilities of increasing competitive advantages and investment attractiveness, the system of making the best management decisions, the components of the economic mechanism of adaptation to extreme conditions and allows formulating key aspects of using their potential in the field of food security. However, some issues of the mechanism of functioning of small entrepreneurial structures in the current conditions are not sufficiently covered. Therefore, the purpose of this study was to assess and substantiate the conceptual and some applied principles of socio-economic relations of small entrepreneurial structures in rural areas from the standpoint of the system approach.

## ► Materials and Methods

The information base of the study included the Law of Ukraine No. 996-XIV "On Accounting and Financial Reporting in Ukraine" (1999); Law of Ukraine No. 2524-IX "On Official Statistics" (2022); Resolution of the Cabinet of Ministers of Ukraine No. 916 "On Amending the Resolutions of the Cabinet of Ministers of Ukraine No. 28 dated January 24, 2020, and No. 723 dated July 14, 2021" (2022). The authors used the publications of the international agency (Agriculture Resilience Initiative – Ukraine..., n.d.), as well as data from national agencies: Agravery, Ukrinform, etc. The study is based on the works of international researchers (Abu Hasan *et al.*, 2022; Abdul Rahman & Abdul Rahim, 2023). Furthermore, the study used the findings of Ukrainian researchers (Kyfyak *et al.*, 2022; Parkhomets & Uniat, 2022; Klius *et al.*, 2023) on the development of processes of adaptation of business entities in the agricultural sector of the Ukrainian economy to wartime activities, etc.

The methodological framework of this study included the positions of systemic functional analysis and the concept of institutionalisation. The methods of logic and abstraction were used to determine the essence of the processes of survival of economic entities in crisis conditions. To implement empirical assessments of the activities of small businesses, the study used analysis, graphical, and regulatory methods; approaches to generalising the results for formulating proposals; and establishing interrelationships in characterising the development of individual groups of small businesses.

The parameters  $a_0$ ,  $a_1$  are found using the least-squares method, which involves the formulation and solution of a system of normal equations:

$$y = a_0 + a_1 \cdot x, \quad (1)$$

$$\begin{cases} a \cdot \sum x^2 + b \cdot \sum x = \sum x \cdot y \\ a \cdot \sum x + b \cdot n = \sum y \end{cases}, \quad (2)$$

where  $y$  is the theoretical value of the resultant attribute;  $a_0$  is the starting point, provided that  $x=0$ ;  $a_1$  is the regression coefficient;  $x$  is the value of the factor attribute;  $n$  is the number of observations.

By solving it, we obtain the values of the coefficients  $a_0$ ;  $a_1$  and the analytical expression of the dependence:

$$y = a_0 + a_1 \cdot x. \quad (3)$$

In addition, for a system of two linear equations with two unknowns, the Kramer formulas are calculated as follows:

$$x_1 = \frac{\Delta_1}{\Delta}; x_2 = \frac{\Delta_2}{\Delta}, \quad (4)$$

where  $x_1$  and  $x_2$  are the unknown elements of the system,  $\Delta$  is the determinant of the system matrix,  $\Delta_1$  and  $\Delta_2$  are the determinants of the matrices  $A_1$  and  $A_2$ , respectively,  $A_1$  and  $A_2$  are the matrices obtained from the system matrix by replacing the corresponding column with the vector of the right-hand sides of the system.

Correlation and determination coefficients are calculated using the following formulas:

$$r = \frac{\sum(t_{x_i} \times t_{y_i})}{n} = \frac{\sum x_i \times y_i}{\sum x_i \times \sum y_i}, \quad (5)$$

$$t_x = \frac{x_i - \bar{x}}{\sigma_x}; \quad t_y = \frac{y_i - \bar{y}}{\sigma_y}, \quad (6)$$

$$\sigma_x = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n}}; \quad \sigma_y = \sqrt{\frac{\sum(y_i - \bar{y})^2}{n}}, \quad (7)$$

$$d = r^2, \quad (8)$$

where  $\bar{y}$  is the average value of the resultant attribute;  $\bar{x}$  is the average value of the factor attribute;  $i$  is the experiment;  $r$  is the linear correlation coefficient;  $t_x$ ,  $t_y$  is the intermediate indicators for calculation;  $\sigma_x$  is the standard deviation of the factor attribute;  $\sigma_y$  is the standard deviation of the resultant attribute;  $d$  is the coefficient of determination (or the square of the correlation coefficient). The calculation of the coefficient of determination helps to cover the share of the total variation of the resultant attribute that is revealed by the factor attribute.

Web-based versions of Word, Excel, and trend analysis were used to calculate and forecast annual changes in agricultural sales and net profit for 2030.

## ► Results and Discussion

Small businesses, due to their mobile management system and compact production, are more adapted to wartime operations. Therefore, in the long term, the development of small businesses and family farms should be promoted, which ensure job security and environmental protection. In the conditions of martial law, the perspective of the institution of self-sufficiency and the provision of food aid to other citizens increases, and the development of rural social capital also gains priority. The economic performance indicators of the operating business entities engaged in the production of cereals, legumes, and sunflower seeds in 2018-2023 are covered in Tables 1-3.

**Table 1.** Number of operating businesses and employed workers in the production of grains, legumes, and sunflower seeds in 2018-2022

Indicators	2018	2019	2020	2021	2022	2022 in % to 2018
<b>Number of operating entities, pcs., incl:</b>						
Large	17	25	28	41	32	+146.2
Average	1,459	1,451	1,351	1,333	1,099	-27.74
Small	39,730	39,411	39,152	37,576	34,909	-11.65
Micro	35,607	35,250	34,996	33,230	31,040	-12.43
<b>Number of employees, persons, incl.:</b>						
Large	24,712	30,125	27,863	34,660	27,111	+22.69
Average	189,847	176,491	161,428	152,779	n/a	-19.5*
Small	181,923	178,576	177,203	186,426	n/a	+2.47*
Micro	86,897	81,898	81,548	87,475	78,616	-9.90

**Note:** \* – 2021 in % to 2018; n/a – data are not disclosed following the requirements of the Law of Ukraine “On Official Statistics” to ensure the guarantees of state statistics authorities on statistical confidentiality (Law of Ukraine No. 2524-IX “On Official Statistics”, 2022)

**Source:** Official website of the State Statistics Service of Ukraine (n.d.)

**Table 2.** Number of registered legal entities and individuals-entrepreneurs engaged in the cultivation of cereals, legumes, and sunflower seeds in 2022-2023, units

Years	In agriculture – total		Growing cereals, legumes, and sunflower seeds	
	Legal entities	Individuals-entrepreneurs	Legal entities	Individuals-entrepreneurs
01.01.2022	71,094	16,011	56,385	8,437
01.04.2022	71,556	16,617	56,819	8,897
01.07.2022	71,902	17,183	57,111	9,311

Table 2, Continued

Years	In agriculture – total		Growing cereals, legumes, and sunflower seeds	
	Legal entities	Individuals-entrepreneurs	Legal entities	Individuals-entrepreneurs
<b>01.10.2022</b>	<b>72,218</b>	<b>17,729</b>	<b>57,352</b>	<b>9,552</b>
01.01.2023	72,466	17,825	57,536	9,665
01.04.2023	72,864	18,315	57,875	10,006
01.07.2023	73,228	18,846	58,148	10,190
<b>01.10.2023</b>	<b>73,522</b>	<b>19,270</b>	<b>58,318</b>	<b>10,345</b>
<b>01.10.2023 in % to 01.10.2022</b>	<b>+1.805</b>	<b>+8.692</b>	<b>+1.684</b>	<b>+8.302</b>

Source: Official website of the State Statistics Service of Ukraine (n.d.)

**Table 3.** Key indicators of economic activity of operating business entities engaged in the production of grains, legumes, and sunflower seeds in 2018-2022 (UAH million; constant 2016 prices; end of year)

Indicators	2018	2019	2020	2021	2022	2022 in % to 2018
<b>Sown area updated, thous. ha</b>						
Cereals and pulses	14,839	15,318	15,392	15,995	12,171	<b>-19.97</b>
Sunflower	6,117	5,928	6,457	6,622	5,293	<b>-13.47</b>
Rapeseed	1,042	1,282	1,127	1,311	1,186	<b>+13.81</b>
<b>Production of cereals and pulses by harvested area, thous. t:</b>						
up to 100 ha	2,227.5	2,426.4	1,934.0	2,699.1	1,792.0	<b>-19.55</b>
100.01-200.00 ha	2,050.8	2,388.3	1,899.5	2,717.7	1,828.9	<b>-10.82</b>
200.01-500.00 ha	6,052.8	6,334.1	5,410.0	7,596.6	4,957.7	<b>-18.09</b>
500.01-1,000.00 ha	9,066.3	9,941.4	8,300.4	11,352.0	7,210.8	<b>-20.47</b>
1,000.01-2,000.00	13,682.8	14,031.0	11,694.6	15,567.4	9,469.2	<b>-30.79</b>
2,000.01-3,000.00	7,359.4	7,667.6	6,694.1	8,977.9	5,055.9	<b>-31.30</b>
over 3,000.01	15,656.6	17,193.3	15,785.4	20,778.4	12,000.7	<b>-23.35</b>
<b>Production of cereals and pulses by category of farms, thous. t</b>						
Farms of all categories	70,056.5	75,143.2	64,933.4	86,010.4	53,863.7	<b>-23.11</b>
Enterprises	56,096.2	59,982.1	51,718.0	69,689.1	42,315.2	<b>-24.57</b>
incl. farms	10,104.9	11,489.7	9,649.1	14,195.4	8,407.1	<b>-16.80</b>
Households	13,960.3	15,161.1	13,215.4	16,321.3	11,548.5	<b>-17.28</b>
<b>Sunflower production by harvested area, thous. t:</b>						
up to 100 ha	952.2	1,051.2	771.2	1,060.2	733.0	<b>-23.02</b>
100.01-200.00 ha	990.5	1,090.2	829.3	1,136.8	762.4	<b>-23.03</b>
200.01-500.00 ha	2,609.3	2,830.2	2,267.4	2,797.5	1,901.8	<b>-27.11</b>
500.01-1,000.00 ha	2,722.8	2,865.6	2,496.8	2,940.4	1,866.8	<b>-31.44</b>
1,000.01-2,000.00	2,688.5	2,819.5	2,458.9	2,873.1	1,836.6	<b>-31.69</b>
2,000.01-3,000.00	1,033.5	1,178.5	1,070.9	1,386.9	938.1	<b>-9.23</b>
over 3,000.01	1,196.8	1,253.4	1,598.4	2,019.1	1,950.1	<b>+62.9</b>
<b>Sunflower production by farm category, thous. t</b>						
Farms of all categories	14,165.2	15,254.1	13,110.4	16,392.4	11,328.8	<b>-20.02</b>
Enterprises	12,193.6	13,088.6	11,492.9	14,214.0	9,988.8	<b>-18.08</b>
incl. farms	2,811.6	3,098.9	2,465.4	3,308.9	2,078.8	<b>-26.06</b>
Households	1,971.6	2,165.5	1,617.5	2,178.4	1,340.0	<b>-32.03</b>
<b>Yield of cereals and pulses, tonnes 100 kg/ha of harvested area:</b>						
up to 100 ha	33.2	35.8	30.2	41.3	36.4	<b>+9.63</b>
100.01-200.00 ha	41.2	44.6	36.6	49.8	42.1	<b>+2.18</b>
200.01-500.00 ha	45.7	47.6	40.0	53.5	44.3	<b>-3.06</b>
500.01-1,000.00 ha	47.9	50.3	42.2	56.0	47.0	<b>-1.88</b>
1,000.01-2,000.00	52.1	52.7	46.3	57.9	49.1	<b>-5.76</b>
2,000.01-3,000.00	54.9	56.2	48.6	61.5	53.2	<b>-3.10</b>

Table 3, Continued

Indicators	2018	2019	2020	2021	2022	2022 in % to 2018
over 3,000.01	65.6	65.4	56.6	70.4	61.2	-6.71
<b>Yields of cereals and pulses by category of farms, 100 kg/ha of harvested area</b>						
Farms of all categories	47.4	49.1	42.5	53.9	45.8	-3.38
Enterprises	52.2	53.7	46.4	59.3	50.3	-3.64
incl. farms	41.1	44.0	37.4	50.4	41.8	+1.70
Households	34.4	36.8	31.9	38.8	34.4	0
<b>Sunflower yield, 100 kg/ha of harvested area</b>						
up to 100 ha	19.4	21.8	16.4	21.6	18.2	-6.19
100.01-200.00 ha	23.5	26.4	19.6	25.0	19.9	-15.32
200.01-500.00 ha	24.5	26.8	20.7	25.4	20.9	-14.69
500.01-1,000.00 ha	24.5	27.1	20.8	25.7	21.2	-13.47
1,000.01-2,000.00	24.9	27.9	22.1	26.3	22.3	-10.44
2,000.01-3,000.00	25.1	27.9	24.7	26.8	25.4	+1.19
over 3,000.01	24.4	30.1	24.6	26.7	27.6	+13.11
<b>Sunflower yield by farm category, 100 kg/ha of harvested area</b>						
Farms of all categories	23.0	25.6	20.2	24.6	21.6	-6.09
Enterprises	24.1	27.0	21.4	25.6	22.4	-7.05
incl. farms	21.9	24.5	18.0	23.6	19.0	-13.2
Households	18.0	19.6	14.7	19.7	17.4	-3.33

Source: Official website of the State Statistics Service of Ukraine (n.d.)

In 2023, the total area under spring and winter grains was 10,895 thous. ha (down 980 thous. ha from 2022). Grain yields are at a record high (up to 51.8 hundred kg/ha) due to good weather conditions. Grain harvest volumes increased significantly. For instance, as of the beginning of August 2023, 16.574 million tonnes of grains and pulses were harvested on an area of 3,782 thous. ha with a yield of 44 hundred kg/ha (The Ministry of Agrarian Policy and Food increased..., 2023). As of the end of September 2023, entrepreneurs have

harvested 41.7 million tonnes of new crops: 30.5 million tonnes of grains and 11.2 million tonnes of oilseeds. Cereals and pulses were harvested on an area of 6,972 thousand hectares with a yield of 43.7 hundred kg/ha, and oilseeds were harvested on an area of 4,450 thous. ha (In Ukraine, 41.7 million tonnes..., 2023).

Next, the study considered the principal indicators of economic activity of existing small businesses engaged in the production of cereals, legumes, and sunflower seeds in 2017-2022 (Table 4).

**Table 4.** Key indicators of economic activity of existing small businesses engaged in the production of cereals, legumes, and sunflower seeds in 2017-2022 (UAH million; constant 2016 prices; end of year)

Indicators	2017	2018	2019	2020	2021	2022	2022 in % to 2017
<b>Volume of products sold</b>	154,849.8	174,096.0	181,054.8	210,913.6	293,060.5	224,195.6	+44.78
<i>Share of small businesses in the total volume of grain, legumes, and oilseeds sold, %</i>	43.68	42.71	41.24	43.35	39.97	41.64	-2.04
<b>Net profit (loss)</b>	23,772.1	20,604.4	18,321.3	32,230.7	85,053.8	28,832.9	+21.29
<i>Share of small entities in the total net profit from sales of cereals, legumes, and oilseeds, %</i>	41.03	33.14	21.78	39.99	37.81	33.63	-7.4
<b>Level of profitability of operating activities, %</b>	26.5	20.3	14.1	22.1	46.3	22.8	-3.7
<b>Level of profitability of all activities, %</b>	17.1	12.2	10.2	16.8	42.3	15.6	-1.5
<b>Non-current assets</b>	85,362.9	101,592.8	113,680.5	126,183.3	139,516.4	140,892.9	+65.06
<b>Property, plant and equipment and intangible assets, incl.: Residual value</b>	69,691.4	85,677.9	95,835.1	107,282.0	119,162.8	120,731.7	+73.23
Wear and tear	35,349.6	47,458.9	59,405.3	76,959.8	81,795.1	96,452.9	+172.8
Investment property	3.0	3.5	3.9	4.1	4.2	2.6	-0.4
Long-lived biological assets	722.7	840.9	834.7	987.3	1,119.7	1,170.4	+61.95
Capital investments in progress	5,338.3	4,153.1	4,612.4	5,975.3	6,734.7	6,479.1	+21.37

Table 4, Continued

Indicators	2017	2018	2019	2020	2021	2022	2022 in % to 2017
Long-term financial investments	5,453.9	7,419.9	6,944.1	7,574.5	8,734.9	7,837.9	+43.71
Other non-current assets	4,153.5	3,497.5	5,450.3	4,360.1	3,760.2	4,671.1	+12.46
<b>Current assets</b>	<b>206,720.9</b>	<b>247,188.9</b>	<b>236,936.4</b>	<b>277,498.1</b>	<b>319,609.4</b>	<b>358,010.4</b>	<b>+73.18</b>
Inventory	77,974.1	101,168.5	109,731.1	123,366.5	151,069.8	175,297.0	+124.8
Current biological assets	3,577.9	4,668.9	4,890.4	5,585.9	5,146.7	6,168.1	+72.39
Accounts receivable	109,572.9	124,411.7	104,604.5	123,476.9	136,202.6	146,545.6	+33.74
Current financial investments	596.2	628.8	729.9	582.2	594.2	816.9	+37.02
Cash	6,547.2	7,306.3	8,160.1	14,645.9	17,626.1	19,542.0	+198.5
Prepaid expenses	2,907.9	2,784.6	3,168.3	4,621.0	3,735.2	3,877.8	+33.35
Other current assets	5,544.9	6,220.1	5,651.9	5,219.7	5,234.9	5,763.2	+3.93
<b>Current liabilities and provisions</b>	<b>133,814.9</b>	<b>160,964.2</b>	<b>142,854.6</b>	<b>166,879.8</b>	<b>156,629.1</b>	<b>189,257.6</b>	<b>+41.43</b>
Short-term loans from banks	16,290.9	22,223.5	21,592.3	26,102.0	19,557.4	34,250.5	+110.2
Current accounts payable	42,303.9	46,740.9	42,252.4	48,553.3	43,250.5	56,576.5	+33.73
Current provisions	62.2	72.4	71.2	84.2	406.2	1,456.1	+2241
Deferred income and deferred commission income from reinsurers	1,326.2	1,550.9	1,991.8	1,547.7	1,939.9	2,006.4	+51.29
Other current liabilities	73,831.6	90,376.5	76,946.9	90,592.5	91,475.2	94,968.1	+28.63
<b>Equity</b>	<b>146,824.3</b>	<b>152,091.5</b>	<b>169,063.6</b>	<b>219,051.8</b>	<b>287,207.9</b>	<b>292,047.1</b>	<b>+98.91</b>
Registered capital	15,665.3	14,857.5	16,553.9	19,338.9	20,978.6	22,189.8	+41.65
Additional capital	14,737.3	18,809.6	19,869.6	21,355.6	21,441.7	23,212.2	+57.51
Reserve capital	11,466.2	13,867.5	14,182.3	16,114.2	17,315.9	19,833.5	+72.97
Retained earnings	106,574.4	106,032.6	119,805.5	163,398.3	228,652.8	228,541.4	+114.4
Unpaid and retired capital	1,618.9	1,475.5	1,347.7	1,155.2	1,181.2	1,729.8	+6.85
Balance	292,102.1	348,814.1	350,644.3	403,735.9	459,152.7	498,947.9	+70.81
Personnel costs	8,538.4	11,301.5	13,061.0	14,562.2	16,795.8		-
Labour costs	6,941.2	9,149.1	10,611.8	11,825.9	13,453.6	14,621.8	+110.6

Source: Official website of the State Statistics Service of Ukraine (n.d.)

In 2022, the cost of growing crops increased by 30-60% compared to 2021. The cost of winter wheat, winter rapeseed, and grain maize increased the most. The cost of crop production increased due to lower prices for agricultural products (maize from UAH 7,300 to 4,300 (41%); sunflower from UAH 18,500 to 12,000 (35%); wheat from UAH 8,100

to 5,100 (37%)); and an almost twofold increase in the cost of plant protection and fuel (Official website of the..., n.d.).

The correlation between the volume of sales of cereals, legumes, and sunflower seeds by operating small businesses and net profit for 2018-2022 in million UAH at constant prices of 2016 was established (Tables 5-7).

**Table 5.** Data to establish the correlation between the volume of grain, legumes, and sunflower seeds sold by operating small businesses and net profit

Indicators	2018	2019	2020	2021	2022
Products sold, $X_i$	174,096.0	181,054.8	210,913.6	293,060.5	224,195.6
Net profit (loss), $Y_i$	20,604.4	18,321.3	32,230.7	85,053.8	28,832.9

Source: Official website of the State Statistics Service of Ukraine (n.d.)

**Table 6.** Calculated values of intermediate indicators for establishing a linear dependence function

	$x_i^2$	$x$	$y$	$y_i^2$	$x_i y_i$
1	23,978,460,560.04	154,849.8	23,772.1	565,112,738.41	3,681,104,930.58
2	30,309,417,216	174,096.0	20,604.4	424,541,299.36	3,587,143,622.4
3	32,780,840,603.04	181,054.8	18,321.3	335,670,033.69	3,317,159,307.24
4	44,484,546,664.96	210,913.6	32,230.7	1,038,818,022.49	6,797,892,967.52
5	85,884,456,660.25	293,060.5	85,053.8	7,234,148,894.44	24,925,909,154.9
$\Sigma$	217,437,721,704.29	1,013,974.7	179,982.3	9,598,290,988.39	42,309,209,982.64

Source: developed by the authors of this study using formulas (1-4)

The calculations were performed according to formulas (1-4) and the results were obtained as follows:  $a = 0.491982$ ;  $b = -159,437.56$ ;  $y = 0.491982 \times x - 159,437.56$ . Thus, with an increase in grain, legumes,

and sunflower seeds sold by small businesses by UAH 1 million, net profit increases by UAH 0.491982 million. Next, the correlation coefficient was calculated (Table 7).

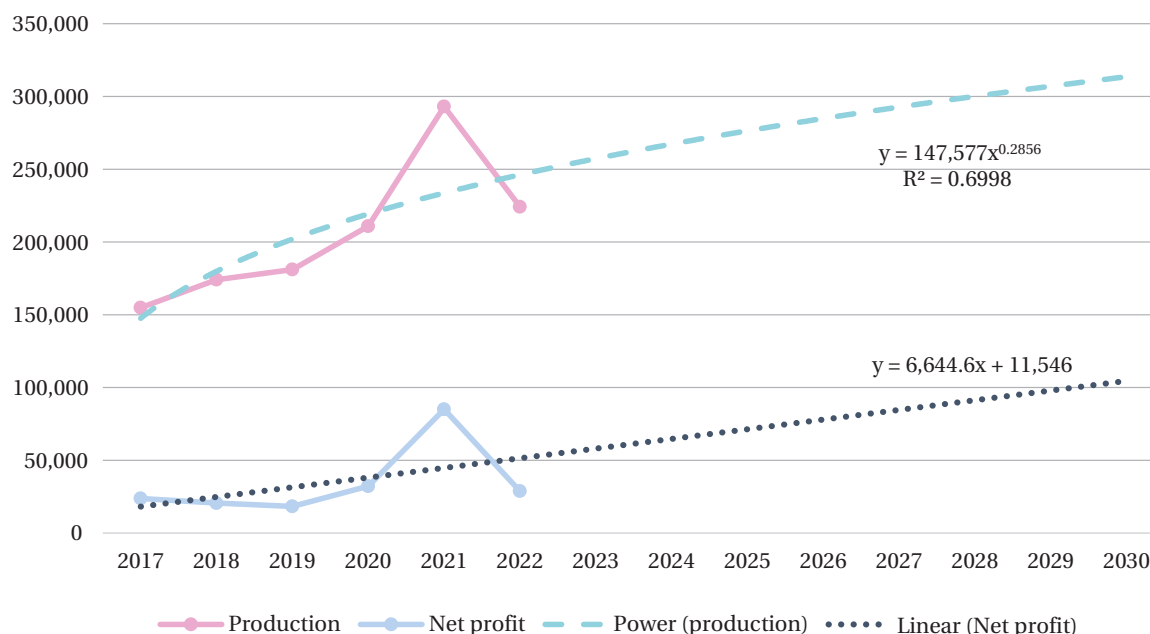
**Table 7.** Estimated values for determining correlation and determination coefficients

	$x$	$x_i - \bar{x}$	$(x_i - \bar{x})^2$	$y$	$y_i - \bar{y}$	$(y_i - \bar{y})^2$	$t_x$	$t_y$	$t_x t_y$
1	154,849.8	-47,945.14	2,298,736,449.6196	23,772.1	-12,224.36	149,434,977.4096	-0.99	-0.49	0.4851
2	174,096.0	-28,698.94	823,629,157.1236	20,604.4	-15,392.06	236,915,511.0436	-0.59	-0.62	0.3658
3	181,054.8	-21,740.14	472,633,687,2196	18,321.3	-17,675.16	312,411,281.0256	-0.45	-0.71	0.3195
4	210,913.6	8,118.66	65,912,640.1956	32,230.7	-3,765.76	14,180,948.3776	0.17	-0.15	-0.0255
5	293,060.5	90,265.56	8,147,871,322.1136	85,053.8	49,057.34	2,406,622,607.8756	1.86	1.96	3.6456
$\Sigma$			11,808,783,256.272			3,119,565,325.732			4.7905

**Source:** developed by the authors of this study using formulas (5-8)

The calculations were performed using formulas (5-8), with the following data obtained:  $R=0.9581$ ;  $D=0.9179$ . Thus, the correlation index value of 0.9581 calculated according to the table data indicates that the factual amount of deviations of the resultant trait is approximately equal to the limit. The coefficient of determination, which characterises the part of the variation

of the resultant trait that depends on the variation of the factor trait, is 0.9179. Thus, in 2017-2022, 91.79% of the variation in net profit was explained by the variation in the level of agricultural products sold by small businesses (grains, legumes, and sunflower seeds). Therefore, the impact of the other factors on the analysed population is insignificant (Fig. 1).



**Figure 1.** Forecast of changes in sales of grain, legumes, and sunflower seeds by small businesses and net profit in 2030 (UAH million; in constant 2016 prices)

**Note:**  $y=147,577 \times x^{0.2856}$  – a power function for forecasting changes in the production of cereals, legumes, and sunflower seeds sold by small businesses in 2030;  $y=6,644.6 \times x + 11,546$  – a linear function for forecasting net profit in 2023; the correlation coefficient is 0.6998

**Source:** Official website of the State Statistics Service of Ukraine (n.d.)

As of 07.10.2023, the state exported 6.918 mln tonnes of grains and pulses, which is 2.707 mln tonnes less than last year. Since the beginning of July 2023, Ukraine has exported: wheat – 3.474 mln tonnes (in 2022/23 MY – 3.461 mln t); maize – 2.785 mln t (in 2022/23

MY – 5.284 mln t); barley – 0.635 mln t (in 2022/23 MY – 0.844 mln t); rye – 0.7 thous. t (in 2022/23 MY – 4.6 thous. t); flour – 37.3 thous. t (in 2022/23 MY – 25.7 thous. t); wheat flour – 36.2 thous. t (in 2022/23 MY – 23.2 thous. t) (Table 8).

**Table 8.** Exports of grains, pulses (with their processed products), and flour from Ukraine in 2023/2024 MY (thous. t)

Crops	2022/2023 MY		2023/2024 MY		2023/2024 MY in % to 2022/2023 MY total	2023/2024 MY in % to 2022/2023 MY in October
	Total	including: in October 2022	Total	including: in October 2023		
<b>Cereal and leguminous crops</b>	<b>9,625</b>	<b>932</b>	<b>6,918</b>	<b>249</b>	<b>-28.12</b>	<b>-73.28</b>
Wheat	3,461	420	3,474	137	+0.376	-67.38
Barley	844	70	635	13	-24.76	-81.43
Rye	4.6	0.3	0.7	0.0	-84.78	-100.0
Maize	5,284	440	2,785	98	-47.29	-77.73
Wheat flour	23.2	1.1	36.2	0.8	+56.03	-27.27
Other flour	2.5	0.0	1.1	0.0	-56.00	0.00
<b>In terms of grain</b>	<b>34.3</b>	<b>1.5</b>	<b>49.7</b>	<b>1.1</b>	<b>+44.89</b>	<b>-26.67</b>
<b>Exports total</b>	<b>9,659</b>	<b>934</b>	<b>6,968</b>	<b>250</b>	<b>-27.86</b>	<b>-73.23</b>

Source: Exports of cereals, legumes, and flour from Ukraine (2024)

There are no funds to support the development of business entities in agriculture in the 2023 budget of Ukraine. Therefore, if necessary, the state can provide grants, loans, or compensation to business entities.

For the purpose of small business development, the following grant programmes from international donor organisations are worthy of note.

1. Competition for women entrepreneurs “Created by Women – 2023” (the opportunity to attract UAH 100,000 for the development of their business).

2. Training of employees in the specifics of social entrepreneurship to expand their business.

3. Additional support for entrepreneurs under the Science & Business – GIST Pitch Days programme to develop innovations in the amount of USD 5,000.

4. Compensation from the German Government to MSMEs up to 30% of the cost of investment.

5. Search for business partners in other countries (Rykhlytskyi, 2022).

6. Consultations on a competitive basis from the KSE Graduate Business School on adaptation to war conditions.

7. “International Organisation for Migration – implemented for war-affected micro and small enterprises (up to UAH 4.5-20 thous.).

8. “Comprehensive Programme for Support and Development of Agriculture” is aimed at entrepreneurs in the field of organic production. Entrepreneurs in the Lviv region will receive up to UAH 150 thous.

9. “Own business – 2023” – support for micro and small businesses in the amount of UAH 50-250 thous. (Rykhlytskyi, 2022).

10. In terms of the E-work grant programme, in 2023, it is planned to receive up to UAH 8 million in non-refundable grants to start or develop small businesses under the “Own Business” programme.

11. USAID Competitive Economy – 25 grants are being implemented to support small and medium-sized processing enterprises (up to UAH 75-150 thous.); 30 grants to improve the human resources potential of businesses (UAH 35-150 thous.); small and medium-sized farming enterprises (up to UAH 40 thous.); entrepreneurs in Poltava, Sumy, Kyiv, Chernihiv regions).

The USAID-Agro (US Agency for International Development) Agricultural and Rural Development Programme is designed to last until 2024, with a total cost of \$35 million, and aims to support 3,000 producers from regions of the country affected by the Russian-Ukrainian war. According to the USAID programme, UAH 367 million was provided to small businesses in 2023 to finance support projects: processing of grains, oilseeds, and legumes to improve access to facilities for post-harvesting, processing of grains, oilseeds, and legumes into food, industrial, feed products, biofuels; productivity of processing facilities; quality control at various stages of processing; production of value-added products for domestic consumption and export; expert and technical support; diversified production of bioethanol or solid biofuels from grain processing waste; expansion of the range of production by 25%; and number of jobs; sales by 10% in the first year and production by 20%; ensuring food security (USAID will provide UAH 367 million..., 2023). The USAID-Agro project “Strengthening the capacity of demonstration farms to ensure food security in Ukraine” is also being implemented (Agriculture Resilience Initiative – Ukraine..., n.d.).

The Agriculture Resilience Initiative (AGRI) project is active. The cost is USD 100 million; the purpose is to strengthen the mechanisms for exporting agricultural products. Since the beginning of the war, Corteva Agriscience has allocated more than USD 2 million to the development of small-scale farming (including seed). The educational and grant programme TalentA (practice of doing agricultural business in a crisis) was implemented for 180 farmers (The leadership of Corteva Agriscience..., 2023).

In 2023-2024, the project “Emergency Project for Inclusive Support for the Recovery of Agriculture in Ukraine (ARISE)” is planned to be implemented. Within the framework of this project, Ukrainian agriculture could receive UAH 700 million. The funds are allocated for grant assistance to small entrepreneurs (land users; also, those who specialise in breeding goats, sheep, cows); financial support for the programme “Affordable Loans 5-7-9%” for agricultural production (Ukraine has initiated the attraction..., 2023).

Businesses have received 74,000 loans worth UAH 240.5 billion since the launch of the government's Affordable Loans 5-7-9% programme. Small businesses can receive: a loan for investment purposes to restore production facilities for up to 5 years; a technical assistance loan; a targeted loan; or a state subsidy. In 2022, under this State Programme "Affordable Loans 5-7-9%" The Resolution of the Cabinet of Ministers of Ukraine No. 916 dated 29 July (Resolution of the Cabinet of Ministers of Ukraine No. 916..., 2022) extended loans to businesses for the sowing campaign (at 0% interest) in the amount of UAH 95.5 billion for up to 12 months, with UAH 24.722 billion received under state guarantees (80%).

As of the beginning of October 2023, 213 entrepreneurs received loans totalling UAH 1 billion. Banks have issued 20,600 loans worth UAH 73.5 billion to businesses since the beginning of 2023 alone. 50% of entrepreneurs operate in agriculture (Business received UAH 240.5 billion..., 2023). Since the beginning of 2023, 11.1 thousand business entities in agriculture have received loans in the amount of UAH 56.2 billion. However, only 8.6 thousand businesses were financed under the state programme "Affordable Loans 5-7-9%" for UAH 33.3 billion (Agravery, 2023). In total, 38,892 loan agreements totalling UAH 150.9 billion were concluded under the state programme "Affordable Loans 5-7-9%" during wartime, of which UAH 34.79 billion were loans to agricultural producers (Last week, banks issued €0.9 billion..., 2023).

For small businesses, the total amount of the grant "Development of Small and Medium-Sized Enterprises: Economic Integration of Internally Displaced Persons and Business Recovery" is up to EUR 20 thous. The grant is provided by the German Government. One-time limits are up to EUR 4,500. In May 2022, the first competition was held; in October 2022, the second; and in spring 2023, the third competition was held for different regions of the country (War-affected small businesses..., 2023).

Another platform for helping small businesses is the Keep Going project. It is planned to provide EUR 50 million in impulse financial and information support to small business owners (Strykun, 2022). Business entities registered in the State Agrarian Register can receive non-refundable assistance. The amount of this assistance is UAH 3,100 per hectare of cultivated land. However, the maximum amount of this assistance cannot exceed UAH 372 thous. (Small agricultural producers can..., 2022).

The study of the theoretical and methodological foundations for the survival of small businesses engaged in the production of cereals, legumes, and sunflower seeds in wartime is a widespread problem. Research assessments confirm that small businesses are the most adapted to functioning in a crisis. The issues of development of small businesses and agricultural production are discussed in various interpretations in scientific publications.

The authors of the present study support the position of N. Abu Hasan *et al.* (2022), who proved the importance of introducing digital technologies into the business models of small businesses. Admittedly, this will increase long-term productivity and sustainability, competitiveness, and innovation attractiveness. Furthermore, the implementation of the Agile Business Process Management concept will allow small businesses to implement fundamental

changes in the market environment and respond more effectively and mobilise to market changes, fully unleashing their potential as a business process management mechanism (Bitkowska *et al.*, 2022).

Lack of funding is one of the main issues for business in agriculture. Implementing mechanisms for cooperation and integration of business entities will help them survive. The specific features of the impact of extreme and socio-economic conditions of life on the processes of transformation of business entities from the perspective of V. Kyfyak *et al.* (2022) deserves attention. Researchers also focus on the implementation of government programmes to support business entities in agriculture, specifically, tax and financial sector programmes, and deregulation mechanisms (all business inspections were cancelled, except for price checks for socially important goods; declarative system of business operation; declarative principle of customs operation) (Nehrey & Trofimtseva, 2022).

The comprehensive methodology for assessing the efficiency (economic, technological, social, environmental, intellectual) of business in agriculture, the competitiveness of farms and the innovative development of business entities recommended by M. Parkhomets & L. Uniat (2022) should be supported. The study found that business entities currently use limited marketing potential; the prospects for transforming marketing towards revenue growth are reduced; there are no effective marketing strategies in general. Businesses need to change their marketing identity and the profitability of their operational and all activities. It is vital to cover trends in the turbulence of the business environment and the transformation of marketing under the influence of military operations (Shkoda & Savych, 2022).

The conclusions on the effectiveness, efficiency, and profitability of the development of business entities in agriculture during 2008-2023 were confirmed by scientists D. Krysanov & O. Varchenko (2023). The processes of investing in the development of business entities and agricultural production are characterised by variable dynamics. The agrarian crises of 2008-2023, which resulted in higher selling prices, did not affect investment in the development of business entities. O. Shust's (2023) research substantiates the decrease in the number of small businesses in agriculture by 8% (7% have completely stopped their production in crop production, and 1% in livestock production). In 2022-2023, small entrepreneurs in agriculture reported a sharp decline in income from crop production (70%) and livestock production (60%). The study found that small businesses in the areas affected by the hostilities had virtually no access to finance. Due to the reassessment of current credit risks, lending by banks has effectively ceased. It was established that USD 73 billion are the needs of small and medium-sized enterprises alone (Vynogradnya & Burdonos, 2023).

The study reveals the position on the essence of the system of state financial support (the use of various forms, types, means, methods, tools to create a favourable environment for increasing their competitiveness) for small and medium-sized businesses (Vyhovska *et al.*, 2023). The system of monitoring and state financial control over the use of state aid granted to business entities is imperfect. Some legislative acts on the forms and types of support for

business entities are contradictory. Targeted support for enterprises is not publicly available. A simplified taxation system for small businesses ensures the stability of their development and facilitates the implementation of agribusiness (Feduniak *et al.*, 2023).

It is also worth agreeing with the results of developing the structure of technological, organisational, environmental factors of the effective activity of small businesses based on supply chain technology as intermediaries and considering the positions of the theory of innovation diffusion and technologies for organising the market environment (Abdul Rahman & Abdul Rahim, 2023). The capital equipment of 100 ha of agricultural land has a positive impact on the profitability per 100 ha of agricultural land in the context of business entities of different specialisations. The models built by Y. Klius *et al.* (2023), the specialisation models can be used to form the structure of marketable products. The study found that the expansion of the area of land plots under lease by 2025 will lead to an increase in their total volume by 0.245 thous. ha. The purchase (sale) of additional land plots by business entities leads to an increase in the value of land plots by UAH 0.006 thous., and the growth of the volume of land exchanged leads to an increase in their value by UAH 0.377 thous. (Kurbatska *et al.*, 2023). The need to develop a comprehensive approach to changing the processes of efficient use of land and resource potential and production in the post-war period of development of agriculture and the agro-industrial complex was agreed.

During the study, the specific features of the extensive and inefficient way of rapeseed production development were revealed. The economic efficiency of rapeseed production and processing can be improved by increasing the yield and fat content of seeds; using the best seed hybrids adapted to concrete environmental and growing conditions; applying innovative technologies for growing and harvesting rapeseed; strict adherence to the recommended requirements for the control of rapeseed diseases, pests, and weeds (Parkhomets *et al.*, 2023). In 2023-2035, Ukraine can provide a harvested area of 2,250-2,810 thous. ha of rapeseed; rapeseed yield – 3.2-4 t/ha; seed sales – 5,100-9,140 thous. tonnes, or 1.9-3.4 times more than the current level. Yield, oil content of the seeds, and the capacity of the processing plant have the greatest impact on the economic efficiency of rapeseed production and processing. Innovative technologies for rapeseed production and harvesting should be introduced to develop small farmers.

Studies of the specific features of the market environment of business entities have revealed the need for priority investment incentives to increase the production of organic food and the development of primary and advanced processing of agricultural raw materials; they have also focused on the technical and technological modernisation of the production base and environmentally oriented nature management (Penkova & Kharenko, 2023). It was established that farmers have adapted best to functioning in wartime conditions and have retained their positions in the market environment. The authors of the present study support the need to attract investment in the development of small businesses in agriculture and support farmers with a system of credit and innovation cooperation (Skydan *et al.*, 2023). The volume and possibilities of

self-financing of small businesses depend on the level of income of the enterprise and the incentives provided by the state in terms of tax exemption for the income of the enterprise reinvested in innovative development. It is necessary to use a cooperative financing model for farms and private households, which allows for cost optimisation and innovation (Sus *et al.*, 2023).

The study proves that an adaptive approach to functioning under martial law is associated with the development of strategies for reflecting the impact of the crisis by a small business entity (Kravchenko *et al.*, 2023). In 2022-2023, business entities faced the following operational problems: disruptions in logistics, fuel and lubricants supply, and energy security; untimely agricultural work; bombing of grain fields; unsystematic fertiliser supplies, etc. (Pryshliak *et al.*, 2023).

The parameters of the economic crisis impose new requirements for the development of an effective system for the survival of small businesses and the adaptation of their economic mechanism to extreme conditions. Small entrepreneurs in agriculture were able to adapt to the crisis more quickly. The following obstacles to the development of small businesses in agriculture are as follows: the focus of programmes on supporting large producers; low level of information and advisory support; risky business start-ups; and low liquidity of production.

## ► Conclusions

An analytical assessment of the economic activities and specific features of the development of small businesses engaged in the production of cereals, legumes, and sunflower in wartime has confirmed their special socio-psychological and economic significance. Compared to large business entities, small businesses suffered the least losses from the hostilities. It was substantiated that the problems of rural employment can be solved through the development of small agricultural and non-agricultural entrepreneurship.

It was found that due to the compactness of production and mobile management system, small businesses are most adapted to functioning in the market environment in wartime. It was substantiated that an increase in the volume of production of cereals, legumes, and sunflower by small businesses by UAH 1 million leads to an increase in net profit by UAH 0.491982 million. The following factors have a negative impact on the development of small businesses engaged in the production of cereals, legumes, and sunflower seeds: complicated logistics; insufficient attraction of investments and financial and credit resources; lack of a holistic policy of integrated rural development; limited opportunities for the application of advanced technologies; low level of technical and technological support; weak motivation for innovation; insufficient awareness of producers about the benefits of establishing family farms.

Further research should clarify the strategic vectors of development of small businesses in the production of cereals, legumes, and sunflower in accelerating the post-war development of the country's economic system. The study also focused on the need to develop regional programmes for the development of small businesses and their cooperative associations of various specialisations for the period

up to 2030 and state support for starting their business, spreading financial and socio-economic literacy, protecting property rights, employment of rural producers, and increasing the export potential of businesses producing cereals, legumes, and sunflower.

#### ► Acknowledgements

None.

#### ► Conflict of Interest

The authors of this study declare no conflict of interest.

#### ► References

- [1] Abdul Rahman, N.A., & Abdul Rahim, Z. (2023). Determinants Influencing supply chain technology adoption towards the performance of micro, small, and medium enterprises in Malaysia. In *Kedah international conference on social science and humanities: Materials of the 2nd international conference on business, finance, management and economics (BIZFAME)* (pp. 25-30). Malaysia: UiTM Kedah. doi: 10.21834/e-bpj.v8iSI15.5093.
- [2] Abu Hasan, N., Abd Rahim, M., Ahmad, S.H., & Meliza, M. (2022). Digitization of business for small and medium-sized enterprises (SMEs). *Environment-Behaviour Proceedings Journal*, 7(19), 11-16. doi: 10.21834/ebpj.v7i19.3270.
- [3] Agriculture Resilience Initiative – Ukraine (AGRI – Ukraine). (n.d.). Retrieved from <https://www.usaid.gov/ukraine/agriculture-resilience-initiative-agri-ukraine>.
- [4] Bitkowska, A., Dziembek, D., & Gzik, T. (2022). Towards cloud agile business process management. *Communications of the IBIMA*, 2022(2022), article number 821632. doi: 10.5171/2022.821632.
- [5] Business received uah 240.5 billion in affordable loans since the start of the “Affordable loans 5-7-9%” program. (2023). Retrieved from <https://www.me.gov.ua/News/Detail?lang=uk-UA&id=8edfc081-cdc9-421c-8173-e74b9cc3c58b&title=BiznesOtrimav240-5>.
- [6] Exports of cereals, legumes, and flour from Ukraine. (2024). Retrieved from <https://minagro.gov.ua/investoram/monitoring-stanu-apk/eksport-z-ukrayini-zernovih-zernobobovih-ta-boroshna>.
- [7] Feduniak, I., Habor, W., & Litvinov, V. (2023). Components of the financial and legal mechanism for ensuring the development of small enterprises in the agrarian sphere of economy. *Efficient Economy*, 5. doi: 10.32702/2307-2105.2023.5.67.
- [8] Filling out the simplified financial reporting of a small business entity (forms No. 1-MS, No. 2-MS). (2019). Retrieved from <https://interbuh.com.ua/ua/documents/oneanalytics/15035/400>.
- [9] In Ukraine, 41.7 million tons of cereals and oilseeds were harvested. (2023). Retrieved from [https://www.ukrinform.ua/rubric-economy/3767653-v-ukraini-namolotili-417-miljona-tonn-zernovih-ta-olijnih-kultur.html#google\\_vignette](https://www.ukrinform.ua/rubric-economy/3767653-v-ukraini-namolotili-417-miljona-tonn-zernovih-ta-olijnih-kultur.html#google_vignette).
- [10] Kaliuha, Y., & Hryshchuk, H. (2023). Internal control of production activity in small enterprises: Domestic and international practice. *University Economic Bulletin*, 57, 51-57. doi: 10.31470/2306-546X-2023-57-51-57.
- [11] Klius, Y., Vasyurenko, L., Manukhina, M., Melnik, M., Tatsii, I., & Spivak, S. (2023). Adaptive modeling of the size of the resource base as a measure of activity efficiency management of agricultural enterprises. *Financial and Credit Activity: Problems of Theory and Practice*, 2(49), 219-227. doi: 10.55643/fcaptop.2.49.2023.4027.
- [12] Kravchenko, S., Malik, M., Shpykuliak, O., & Malik, L. (2023). Supporting the development of family farming in wartime conditions. In *Scientific directions of research in educational activity: Materials of the VI international scientific and practical conference* (pp. 54-56). Osaka. doi: 10.46299/ISG.2023.1.6.
- [13] Krysanov, D., & Varchenko, O. (2023). Variability of primary production of the agricultural sector of Ukraine: Investment priorities and future forecasts. *Bulletin of Agricultural Science*, 10(847), 76-86. doi: 10.31073/agrovisnyk202310-11.
- [14] Kurbatska, L., Sitkovska, A., Tesliuk, Yu., Lukianova, V., & Yavorska, T. (2023). Factors influencing the effective use of land and resource potential in Ukrainian agricultural businesses. *Scientific Horizons*, 26(4), 119-135. doi: 10.48077/scihor3.2023.119.
- [15] Kusnandar, K., Setyowati, N., & Wida Riptanti, E. (2023). Creating an innovative culture in agribusiness of micro, small and medium-sized enterprises. *Agricultural and Resource Economics: International Scientific E-Journal*, 9(2), 205-222. doi: 10.51599/are.2023.09.02.09.
- [16] Kyfyak, V., Verbivska, L., Alioshkina, L., Galunets, N., Kucher, L., & Skrypnyk, S. (2022). The influence of the social and economic situation on agribusiness. *WSEAS Transactions on Environment and Development*, 18, 1021-1035. doi: 10.37394/232015.2022.18.98.
- [17] Last week, banks issued €0.9 billion in available loans, according to the Ministry of Finance. (2023). Retrieved from <https://www.ukrinform.ua/rubric-economy/3771740-banki-minulogo-tizna-vidali-09-milarda-dostupnih-kreditiv-minfn.html>.
- [18] Law of Ukraine No. 2524-IX “On Official Statistics”. (2022, August). Retrieved from <https://zakon.rada.gov.ua/laws/show/2524-20#Text>.
- [19] Law of Ukraine No. 996-XIV “On Accounting and Financial Reporting in Ukraine”. (1999, July). Retrieved from <https://zakon.rada.gov.ua/laws/show/996-14#Text>.
- [20] Litvak, O., & Litvak, S. (2023). Implementation of the circular economy model in the agricultural sector of Ukraine. *Baltic Journal of Economic Studies*, 9(2), 146-156. doi: 10.30525/2256-0742/2023-9-2-146-156.
- [21] Lopes, J.M., & Gomes, S. (2022). Innovative and sustainable business strategies: The case of portuguese SMEs. *IBIMA Business Review*, 2022(2022), article number 714613. doi: 10.5171/2022.714613.

- [22] Mohamad Fauzi, S.N., Ghazali, P.L., Rohim, R.A., & Abdul Razak, R. (2023). Weighting risk factors for start-up businesses in small and medium enterprises: A qualitative approach and ATLAS ti procedure. In *Kedah international conference on social science and humanities: Materials of the 2nd international conference on business, finance, management and economics (BIZFAME)* (pp. 61-70). Malaysia: UiTM Kedah. doi: 10.21834/e-bpj.v8iSI15.5072.
- [23] Nehrey, M., & Trofimtseva, O. (2022). Analysis of the agriculture sector of Ukraine during the war. *Bulletin of V.N. Karazin Kharkiv National University Economic Series*, 102, 49-56. doi: 10.26565/2311-2379-2022-102-06.
- [24] Official web-site of the State Statistics Service of Ukraine. (n.d.). Retrieved from <http://www.ukrstat.gov.ua>.
- [25] Parkhomets, M., & Uniiat, L. (2022). Methodological and methodical principles efficiency research of innovative development of agricultural business enterprises in conditions of competition. *Innovative Economy*, 1, 23-30. doi: 10.37332/2309-1533.2022.1.3.
- [26] Parkhomets, M., Uniiat, L., Chorny, R., Chorna, N., & Hradovyi, V. (2023). Efficiency of production and processing of rapeseed for biodiesel in Ukraine. *Agricultural and Resource Economics: International Scientific E-Journal*, 9(2), 245-275. doi: 10.51599/are.2023.09.02.11.
- [27] Penkova, O., & Kharenko, A. (2023). Marketing analysis of the functioning environment of agrarian enterprises. *Ukrainian Black Sea Region Agrarian Science*, 27(2), 28-40. doi: 10.56407/bs.agrarian/2.2023.28.
- [28] Pryshliak, N., Dankevych, V., Tokarchuk, D., & Shpykuliak, O. (2023). The sowing and harvesting campaign in Ukraine in the context of hostilities: Challenges to global energy and food security. *Polityka Energetyczna – Energy Policy Journal*, 26(1), 145-168. doi: 10.33223/epj/161794.
- [29] Resolution of the Cabinet of Ministers of Ukraine No. 916 “On Amending the Resolutions of the Cabinet of Ministers of Ukraine dated January 24, 2020, No. 28, and July 14, 2021, No. 723”. (2022, July). Retrieved from <https://zakon.rada.gov.ua/laws/show/916-2022-%D0%BF#Text>.
- [30] Rykhliitskyi, V. (2022). *Business grants: How and where to obtain non-repayable financial assistance for entrepreneurship*. Retrieved from <https://www.epravda.com.ua/publications/2022/08/17/690436/>.
- [31] Sahachko, Yu., Smihunova, O., & Podolska, O. (2023). Prospects for the formation of investment support for the technological growth of the agricultural sector of the Ukrainian economy in the post-war period. *Ukrainian Black Sea Region Agrarian Science*, 27(3), 62-70. doi: 10.56407/bs.agrarian/3.2023.62.
- [32] Shkoda, T., & Savych, O. (2022). Transformation of marketing in wartime and postwar. *Baltic Journal of Economic Studies*, 8(5), 209-216. doi: 10.30525/2256-0742/2022-8-5-209-216.
- [33] Shust, O. (2023). Organizational and economic aspects of the functioning of subjects of the agrarian sector of Ukraine in the conditions of the introductions of martial law. *Innovative Economy*, 2, 5-12. doi: 10.37332/2309-1533.2023.2.1.
- [34] Skydan, O., Dankevych, V., Garrett, R.D., & Nimko, O. (2023). The state of the agricultural sector in Ukraine during wartime: The case of farmers. *Scientific Horizons*, 26(6), 134-145. <https://doi.org/10.48077/scihor6.2023.134>.
- [35] Small agricultural producers can apply for assistance from the EU – here's how to do it. (2022). Retrieved from <https://www.ukrinform.ua/rubric-economy/3564881-mali-agrovirobniki-mozut-podat-zaavku-na-dopomogu-vid-es-ak-ce-zrobiti.html>.
- [36] Strykun H. (2022). *Keep Going – a platform to support micro and small businesses*. Retrieved from <https://platforma-msb.org/keep-going-platforma-dopomogy-mikro-ta-malomu-biznesu/>.
- [37] Sus, T., Suduk, N., Yemets, O., Movchun, S., & Tsiupa, O. (2023). Innovative development of the agricultural sector: Financing models and assessment of the impact of financing at the regional level. *Financial and Credit Activity Problems of Theory and Practice*, 2(49), 181-193. doi: 10.55643/fcaptop.2.49.2023.4021.
- [38] The leadership of Corteva Agriscience briefed the Minister of Agrarian Policy of Ukraine on investment directions. (2023). Retrieved from <https://www.agravery.com/uk/posts/show/kerivnictvo-corteva-agriscience-rozpovilo-pro-napramki-investicij-ministru-agrarnoi-politiki-ukraini>.
- [39] The Ministry of Agrarian Policy and Food increased this year's forecast for grain and oilseed crops to 76.7 million tons. (2023). Retrieved from <https://www.ukrinform.ua/rubric-economy/3746704-minagropolitiki-zbilsilo-prognoz-cogoricnogo-vrozau-zernovih-ta-olijnih-do-767-miljona-tonn.html>.
- [40] Ukraine has initiated the attraction of international assistance in the field of agriculture from the IFAD. (2023). Retrieved from <https://www.agravery.com/uk/posts/show/ukraina-iniciuvala-zalucenna-miznarodnoi-dopomogi-v-galuz-silskogo-gospodarstva-vid-mbr>.
- [41] USAID will provide 367 million UAH to support the processing of Ukrainian cereals, oilseeds, and legumes. (2023). Retrieved from <https://ports.ua/usaaid-nadast-na-pidtrimku-pererobki-ukra%D1%97nskih-zernovih-olijnih-ta-bobovih-kultur-367-mln-grn/>.
- [42] Vyhovska, N., Vyhovskiy, V., & Tsysar, O. (2023). System of state financial support of small and medium-sized business entities. *Efficient Economy*, 11. doi: 10.32702/2307-2105.2023.11.25.
- [43] Vynogradnya, V., & Burdonos, L. (2023). State support of entrepreneurial activity in modern conditions. *University Economic Bulletin*, 57, 109-113. doi: 10.31470/2306-546X-2023-57-109-113.
- [44] War-affected small businesses will receive grants for recovery from the German Government. (2023). Retrieved from <https://www.kmu.gov.ua/news/postrazhdalyi-vid-viiny-malyi-biznes-otrymaie-hranty-na-vidnovlennia-vid-nimetskoho-uridu>.

## Розвиток суб'єктів малого підприємництва з виробництва зернових, бобових і насіння соняшнику в умовах воєнного часу

### Микола Йосипович Малік

Доктор економічних наук, професор  
Національний науковий центр «Інститут аграрної економіки»  
03127, вул. Героїв Оборони, 10, м. Київ, Україна  
<https://orcid.org/0000-0001-9198-4460>

### Світлана Анатоліївна Кравченко

Доктор економічних наук, професор  
Національний науковий центр «Інститут аграрної економіки»  
03127, вул. Героїв Оборони, 10, м. Київ, Україна  
<https://orcid.org/0000-0001-5541-4495>

### Олександр Григорович Шпикуляк

Доктор економічних наук, професор  
Національний науковий центр «Інститут аграрної економіки»  
03127, вул. Героїв Оборони, 10, м. Київ, Україна  
<https://orcid.org/0000-0001-5257-5517>

### Генріх Олександрович Гудзь

Кандидат економічних наук, асистент  
Київський національний університет імені Тараса Шевченка  
01601, вул. Володимирська, 64/13, м. Київ, Україна  
<https://orcid.org/0000-0003-4931-3350>

► **Анотація.** Суб'єкти малого підприємництва з виробництва зернових, бобових і насіння соняшнику забезпечують потенціал продовольчої безпеки країни та зберігання навколишнього середовища. Мета статті було обґрунтувати соціальні, економічні та концептуальні засади діяльності суб'єктів малого підприємництва з виробництва зернових, бобових і насіння соняшнику в сучасних умовах. За методологічну основу дослідження слугували положення інституціональної економічної теорії та функціонального аналізу. Використано аналіз, графічний, абстрактно-логічні методи та підходи узагальнення результатів. Визначено мотиваційну спрямованість функціонування суб'єктів малого підприємництва з виробництва зернових, бобових і насіння соняшнику та їх місце у процесі виробництва та споживання. В процесі дослідження встановлено, що у 2023 році досягнуто рекордної врожайності зернових культур – 51,8 центнерів на гектар, що обумовлено сприятливими погодними умовами. Обґрунтовано, що витрати на виробництво сільськогосподарських культур збільшилися за рахунок зниження цін на продукцію виробництва (на кукурудзу на -41 %; соняшник на -35 %; пшеницю на -37 %) та зростання вартості майже вдвічі комплексу захисту рослин та палива. Доведено, що в період 2017-2022 рр. 91,79 % варіації чистого прибутку пояснюється варіацією рівня реалізованої суб'єктами малого підприємництва продукції зернових, бобових культур і насіння соняшнику. З'ясовано, що порушення системи збуту продукції суб'єктів малого підприємництва з виробництва зернових, бобових і насіння соняшнику, низький рівень закупівельних цін та значне підвищення цін в зв'язку з воєнними діями на матеріально-технічні джерела виживання та добрива робить виробництво малоефективним. Одним з пріоритетних напрямів регіональної політики залишається розвиток суб'єктів малого підприємництва та сімейного фермерства. Інформаційно-аналітичний матеріал можливо враховувати при розробленні регіональних програм розвитку суб'єктів аграрного підприємництва

► **Ключові слова:** суб'єкт підприємницької діяльності; адаптація до умов воєнного стану; малі підприємницькі структури; сімейне фермерське господарство; сільськогосподарський кооператив; приватні підприємства



UDC 338.439.5:631.147(477)

## Ukraine in the markets of organic agri-food products of the European Union: Analytics, trends, and prospects

**Liudmyla Smolii\***

PhD in Economic Sciences, Associate Professor

Uman National University of Horticulture

20300, 1 Instytutska Str., Uman, Ukraine

<https://orcid.org/0000-0002-7426-0468>

**Mykola Mostoviak**

Postgraduate Student

Uman National University of Horticulture

20300, 1 Instytutska Str., Uman, Ukraine

<https://orcid.org/0009-0001-9230-820X>

► **Abstract.** The study of the role of the Ukrainian agricultural sector in meeting the demand for organic products in the European Union is vital for understanding and maximising the benefits for Ukraine. This is crucial in the context of the development of the organic market and expanding cooperation with Europe, which indicates the relevance of the problem discussed in the present study. The purpose of this study was to identify the current position, dominant trends, and prospects for increasing Ukrainian organic imports to the European Union. The methodological framework of this study included the general and special methods of scientific cognition: monographic, dialectical, tabular, graphical, abstract and logical, and comparative analysis. The study analysed the vectors and dynamics of development of organic agriculture in the European Union, specifically, identified the growth of domestic and import demand for organic products, expansion of the list of commodity items, the existence of a gap between supply and demand, and high concentration of the commodity structure of imports. The study found the principal factors that ensure Ukraine's leading position among the key importers of organic food: geographical location, increase in domestic production of organic products, improvement of the system of its certification, and establishment of partnerships with the European Union. Ukraine's position in most commodity groups of import demand for organic products has been strengthened: specifically, Ukraine's share of imports has increased, and its structural characteristics have improved in terms of increasing the share of high value-added products. The study highlighted the barriers faced by Ukrainian exporters when entering the European market and acting as a deterrent to expanding the volume and range of exported organic products. The areas for increasing the potential of Ukraine in meeting the demand for organic products in the European Union were outlined. The findings of this study provide valuable information for producers, entrepreneurs, and stakeholders involved in the development of the organic market in Europe and sustainable agriculture. The outlined priorities for the development of organic production in Ukraine can underlie the development of a national programme aimed at increasing the competitiveness of the Ukrainian organic industry in the markets of the European Union

► **Keywords:** organic production sector; agricultural sector; exports; import demand; European Union

► **Suggested Citation:** Smolii, L., & Mostoviak, M. (2024). Ukraine in the markets of organic agri-food products of the European Union: Analytics, trends, and prospects. *Ekonomika APK*, 31(1), 54-63. doi: 10.32317/2221-1055.202401054.

\*Corresponding author



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

## ► Introduction

The growing environmental awareness of consumers in the European Union (EU) is leading to an increase in their interest in healthy eating and sustainable development. This encourages them to prefer organic products, which are considered safer and more environmentally friendly. Growing demand encourages producers to support and develop the organic industry, expand their product range to meet the needs of domestic consumers and reduce dependence on imports. The organic market is showing steady growth and is promising not only for European producers, but also for companies from other countries that adhere to high quality standards and sustainable production principles.

Considering this, the growth of the organic market is recognised as one of the key vectors of the European Green Deal (EGD). The European Commission's Farm to Fork strategy, implemented under the EGD, states that "the organic food market will continue to grow, and organic agriculture needs to be further promoted" (A Farm to Fork Strategy..., 2020). The European Commission's Organic Action Plan for 2021-2027 aims to increase both the demand and supply of organic products.

The active coverage of the problem of developing organic production in scientific sources, as well as its role in ensuring food security and achieving sustainable development goals demonstrates the considerable interest in this issue. The EU is the largest market for organic products, with annual growth. Since the 1990s, the development of organic agriculture has received considerable attention, which has contributed to an increase in the share of organic area in the EU by almost 8.5% compared to the global average of about 1.5% (Willer *et al.*, 2021). Foreign scholars who have investigated this issue argue that the organic sector in the EU has prospects for considerable growth (Rees *et al.*, 2023). Despite the expansion of organic agriculture and the increase in the number of organic producers, according to the results of studies by S. Pedersen *et al.* (2018) and A. Blaće *et al.* (2020), the demand for organic products is growing much faster than domestic production and supply.

At the same time, European scientists are discussing the feasibility of intensifying the expansion of organic areas in the EU member states. While research confirms that consumers are willing to pay a higher price for organic food due to health and environmental benefits, the environmental benefits are increasingly disputed because the lower productivity of organic farming systems may lead to intensification of agriculture on other farmland. This, according to M. Lambotte *et al.* (2023) and M. De Bauw (2022), calls into question the environmental efficiency of organic farming. Considering this, it can be predicted that the share of organic products imported to the EU will only grow.

Ukrainian scientists also pay attention to these trends, as Ukraine holds a key position in the import of organic products to the EU. Thus, V. Butenko *et al.* (2020) discuss the specific features of the development of this market in the European Union. O. Malokhlib (2021) explores the possibilities of Ukrainian producers' participation in the EU markets, considering the requirements of European environmental legislation. The studies of O. Senyshyn (2021)

and T. Grabovska (2019) are based on the investigation of Ukraine's export potential in terms of supplying organic products to the EU. Considering the above, the issues raised are of significant scientific interest and determine the purpose of the present study. The purpose of this study was to investigate the opinions and outline the prospects of the Ukrainian organic industry in meeting the demand for organic agri-food products in the European Union.

## ► Materials and Methods

The study was based on the use of general scientific and special methods of scientific cognition. Based on scientific sources selected on the principle of the highest reliability, objectivity, and relevance, information and provisions were selected that enabled a comprehensive investigation of the issue. The scientific findings and opinions of scientists from the European Union and Ukraine on the main trends in the development of organic exports of agri-food products were investigated using the monographic method. The comparative analysis was used to empirically study the structural and dynamic characteristics of Ukrainian organic exports to the EU; the dialectical method was used to clarify the cause-and-effect relationships between the analysed phenomena. The use of tabular and graphical methods in the study made it possible to demonstrate in a systematic way the dynamics and interrelationships between economic processes and indicators characterising export-import operations, and to identify the existence of functional dependencies between them. By applying these methods, the study clarified Ukraine's position in the import of organic agri-food products to the EU and its changes over time, and improved the ability to visualise and present analytical information. The conclusions were formulated using the abstract and logical method by identifying the essence of the main concepts in the context of the subject under study, identifying logical patterns of development of the organic agri-food market and drawing generalisations and new judgements on this basis.

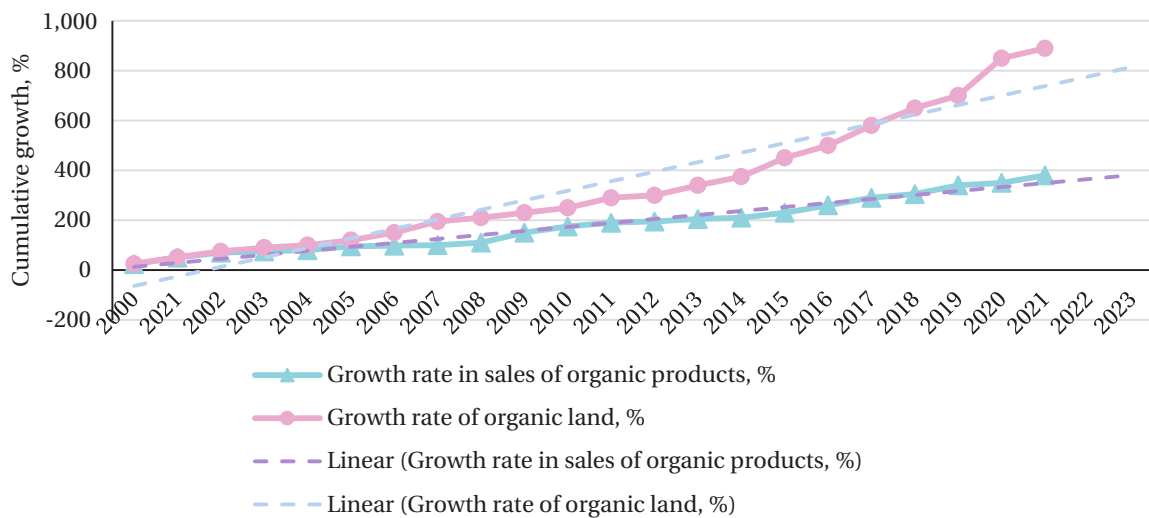
The analytical calculations were based on the Trade Control and Expert System (TRACES), the European Commission's online platform for certification required for the import of animals, animal products, food, non-animal feed, and plant products into the European Union, as well as for trade within the EU and exports from the EU (TRACES NT – European Commission, n.d.). To complete the objectives of this study, data on the total volume of imports of organic products to the EU-27 countries in terms of commodity items and value indicators, including from Ukraine, were used. This made it possible to track the dynamics of import demand for organic products in the EU-27, determine the commodity structure of imports, the share of Ukrainian agri-food products in them, and establish trends in the growth (decline) of such imports in terms of the largest commodity items.

Furthermore, the study used data obtained from the official web portal Diia.Business (Overview of the organic market..., 2021). Specifically, information on the volume of exports of certified organic products by Ukraine by commodity groups, importing countries, destination countries, and types of transport for 2021-2023 was obtained

using the interactive dashboard “Export of Ukrainian organic products” developed by the Business and Export Development Office in partnership with Organic Standard LLC and with the support of Switzerland within the framework of the Swiss-Ukrainian programme “Development of Higher Value Added Trade in the Organic and Dairy Sectors of Ukraine” (Dashboard on export of..., n.d.). The information obtained made it possible to assess Ukraine’s ranking among suppliers of organic agri-food products to the EU in terms of imports, and to identify trends in the reorientation of logistics routes for Ukrainian exports from sea routes to alternative modes of transport: road, rail, and river.

### ► Results and Discussion

The EU-27 market ranks second in the world in terms of consumption of organic products, having increased 5 times over the past 20 years and covering 43% of the market globally in 2022 (Overview of the organic market..., 2021). For a range of organic food products, market demand is growing faster than supply. This is conditioned by the fact that the growth rate of organic land in the EU lags behind the growth rate of organic sales (Fig. 1). The share of organic areas in the total volume of agricultural land in the European Union averages 8.1% (the leaders are Austria (26%), Estonia (22%), and Sweden (20%)) (Overview of the organic market..., 2021).

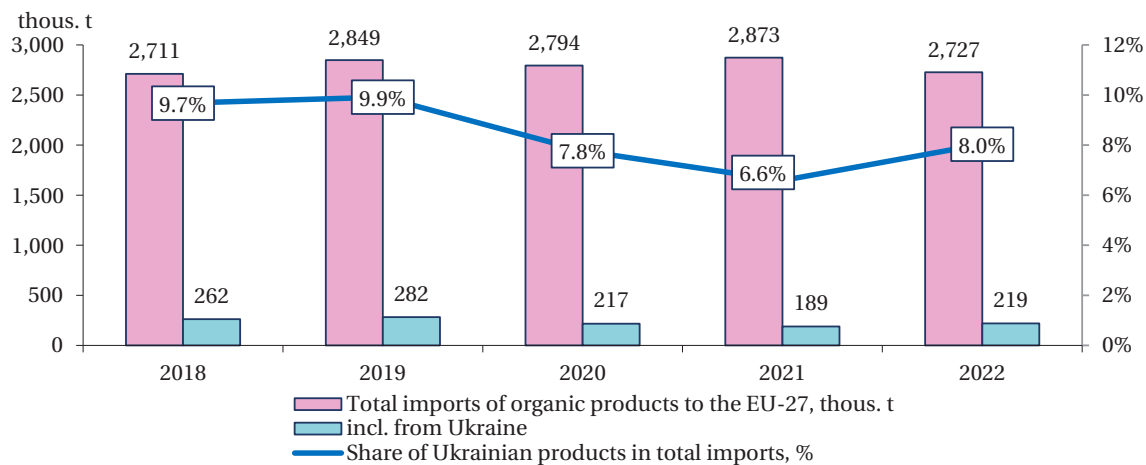


**Figure 1** Growth rate of sales of organic products and organic land in the EU, %

Source: compiled by the authors of this study based on H. Willer (2021)

The gap between supply and demand is partially compensated for by imports of organic agri-food products. In 2022, the EU-27 imported 2.73 million tonnes of organic agri-food products (down 5.1% from 2.87 million tonnes in 2021, but up 0.6% from 2018). The growth of the organic market, which began during the coronavirus pandemic, was restrained by the spread of

inflationary processes in 2022, triggered by the full-scale military invasion of Ukraine by Russia. Lower incomes and rising consumer prices led to a reduction in spending on organic products, resulting in a slight decline in imports. Overall, import demand was relatively stable in 2018-2022, with annual growth of no more than 5% (Fig. 2).

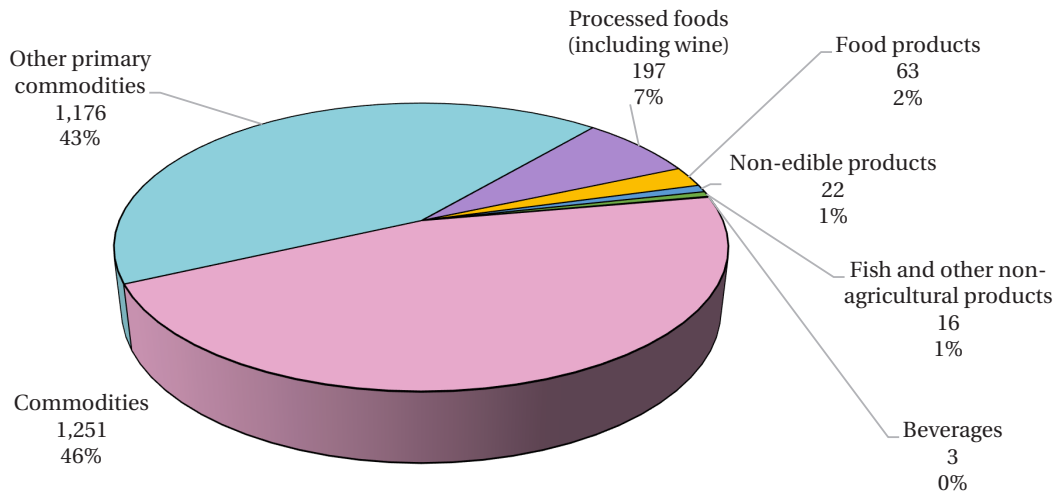


**Figure 2.** Supply of imported organic products to the EU-27 in 2018-2022, thous. t

Source: calculated and constructed by the authors according to TRACES NT – European Commission (n.d.)

The volumes of Ukrainian organic products supplied varied substantially, ranging from 189 to 282 thous. t, primarily due to considerable fluctuations in the supply of wheat and other grains. Grain crops, vegetable oils and oilseeds,

sugar, milk powder and butter, unroasted coffee and cocoa, which are classified as commodities, accounted for 46% of imports in 2022. Meat products, fruits, vegetables, dairy yoghurt, and honey accounted for 43% of imports (Fig. 3).

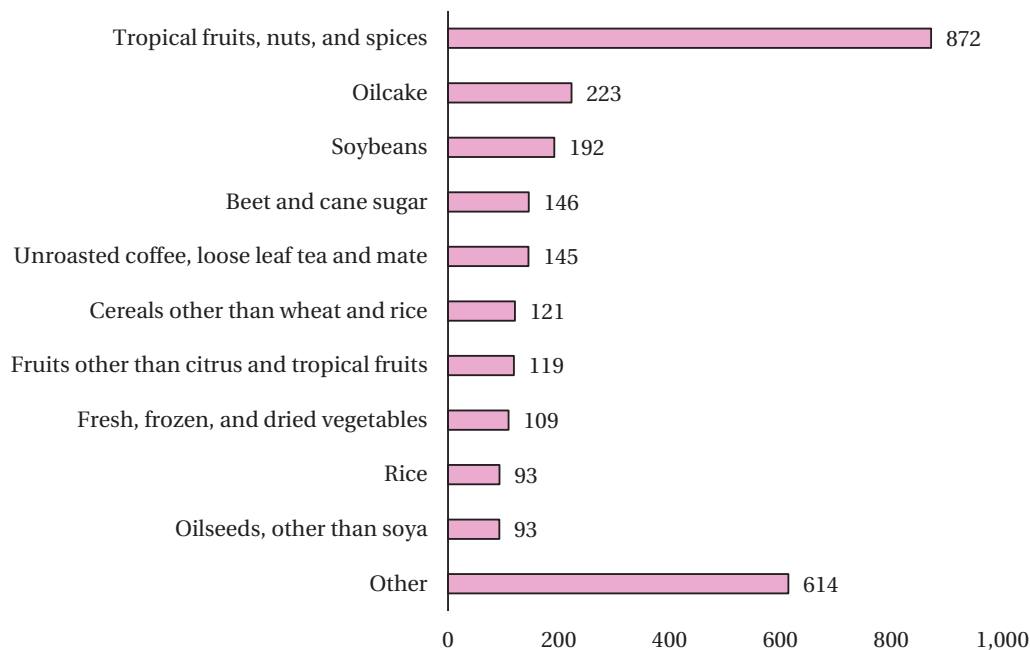


**Figure 3.** Commodity structure of organic imports to the EU-27 in 2022, thous. t (%)

**Source:** calculated and constructed by the authors according to TRACES NT – European Commission (n.d.)

The commodity structure of exports shows that it is highly concentrated – the 8 largest commodity items (with imports of more than 100 thous. t/year) account for almost 72% of the volume, namely: tropical fruits, nuts, and spices (872 thous. t), oilcake (223 thous. t), soya beans

(192 thous. t), beet and cane sugar (146 thous. t), unroasted coffee, loose tea, and mate (145 thous. t), cereals, except wheat and rice (121 thous. t), fruits, except citrus and tropical fruits (119 thous. t) and fresh, chilled and dried vegetables (109 thous. t) (Fig. 4).

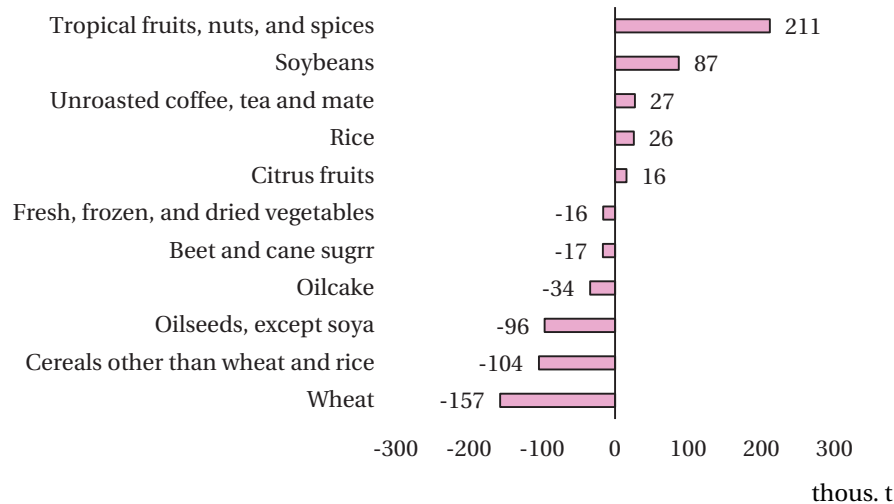


**Figure 4.** Supply of imported organic products to the EU-27 in 2022 by major commodity items, thous. t

**Source:** calculated and constructed by the authors according to TRACES NT – European Commission (n.d.)

In 2018-2022, the increase in imports of organic products in the EU27 was driven by the growth in supplies of tropical fruits, nuts and spices (+211 thous. t) and soybeans (+87 thous. t). The largest decline in imports was

mainly in commodities represented in Ukrainian exports, namely wheat (-157 thous. t), cereals other than wheat and rice (-104 thous. t), oilseeds other than soybeans (-96 thous. t), and oilcake (-34 thous. t) (Fig. 5).



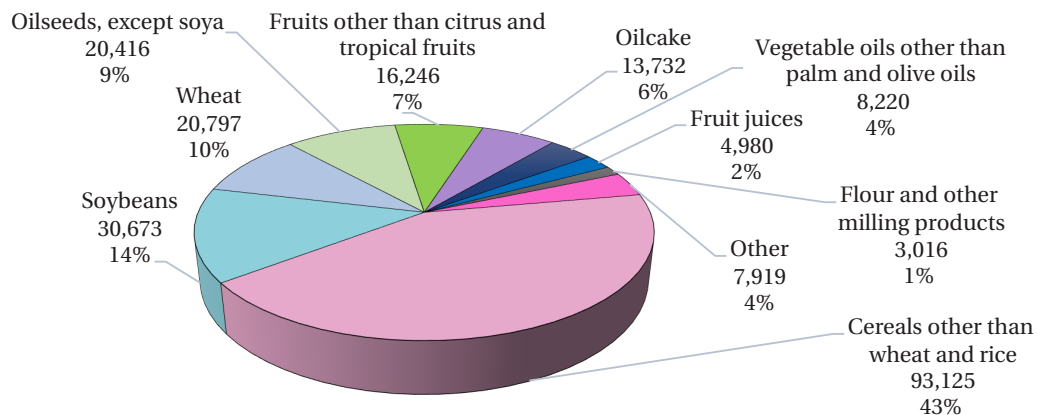
**Figure 5.** Increase (decrease) in the supply of imported organic products to the EU-27 countries in 2018-2022 by major commodity items, thous. t

**Source:** calculated and constructed by the authors according to TRACES NT – Europepe Commissie (n.d.)

In 2022, the ten largest exporting countries to the EU accounted for 65% of organic imports. An analysis by buyer country showed that the Netherlands is the leader among suppliers and importers of organic products, accounting for 36% of imports. Germany, France, and Belgium account for 16%, 10%, and 10% of organic products imported to the EU, respectively. Considerable trading partners in this area are Ecuador, which accounts for 13% of total imports, and the Dominican Republic, which accounts for 9% of imports. China and Ukraine are in roughly the same position, with a share of 8%. Data from the Government Portal (Dashboard on export of..., n.d.) show that Ukraine has become one of the key suppliers of organic agri-food products to the EU, ranking 5th out of 126 countries and 1st among non-tropical countries in terms of supply in 2021. Export trends in 2022 showed a 13% increase in imports of organic products from Ukraine to the European Union and Switzerland compared to 2021, despite the full-scale military invasion of Ukraine by Russia. This was mainly due to an increase in the supply of organic soybeans, wheat, and maize. Generally, Ukraine's role in supplying organic products to the EU markets is vital for both Ukrainian

producers and European consumers who appreciate the benefits of such products.

Ukraine's position in imports to the EU of agri-food products produced in compliance with organic legislation is ensured by a combination of factors. The geographical location of Ukraine and its proximity to the European Union allow for fast and efficient transportation of organic products to this market. Ukrainian producers are actively expanding domestic production and developing their sales markets in the EU, looking for new opportunities and customers to meet growing demand. The product range covers a variety of types, including cereals, meat, milk, fruit, and vegetables. This contributes to the diversification and sustainability of export operations. Furthermore, Ukraine has partnerships with many EU countries, which facilitates cooperation and the development of trade in organic products. Major steps have been taken to improve the certification system for organic products, which helps ensure high quality and compliance with EU standards and is essential for maintaining consumer confidence and increasing competitiveness in the European market. Grains and oilseeds dominate the structure of supplies from Ukraine to the EU market, accounting for 75% of imports in 2022 (Fig. 6).



**Figure 6.** Commodity structure of imported organic products from Ukraine to the EU-27 in 2022, thous. t (%)

**Source:** calculated and constructed by the authors according to TRACES NT – Europepe Commissie (n.d.)

Among commodity items, the highest export growth rates were observed for such products as oilcake (4.3 times in 2018-2022), vegetable oils (2.3 times), nuts (2 times), soybeans (1.3 times), and eggs and honey (1.1 times). In 2018-2022, Ukraine's position in most product groups of the EU's import demand strengthened (Table 1).

Specifically, the most noticeable increase in the share of imports occurred in the segment of cereals other than wheat and rice (+28.0 percentage points to 77.1% in 2022), wheat (+25.4 percentage points to 65.3%), vegetable oils (23.3 percentage points to 49.4%), and oilseeds other than soybeans (+6.8 percentage points to 22.0%).

**Table 1.** Import demand for organic products in the EU-27 in 2018-2022 by main product groups, thous. t

Product group	Imports to the EU-27		incl. from Ukraine			Ukraine's share, %		
	2018	2022	2018	2022	Increment, %	2018	2022	Change, p.p.
Cereals other than wheat and rice	224,792	120,743	110,360	93,125	-16	49.1	77.1	28.0
Soybeans	104,794	191,898	13,269	30,673	131	12.7	16.0	3.3
Wheat	188,847	31,838	75,355	20,797	-72	39.9	65.3	25.4
Oilseeds, except soya	189,053	92,700	28,773	20,416	-29	15.2	22.0	6.8
Fruits other than citrus and tropical fruits	132,493	118,967	12,955	16,246	25	9.8	13.7	3.9
Oilcake	257,056	223,028	2,564	13,732	436	1.0	6.2	5.2
Vegetable oils other than palm and olive oils	9,708	16,648	2,532	8,220	225	26.1	49.4	23.3
Fruit juices	88,206	80,284	5,947	4,980	-16	6.7	6.2	-0.5
Flour and other milling products	19,406	15,227	3,922	3,016	-23	20.2	19.8	-0.4
Tropical fruits, nuts, and spices	660,778	872,234	973	2,914	200	0.1	0.3	0.2
Fresh, frozen, and dried vegetables	125,592	109,298	3,552	2,739	-23	2.8	2.5	-0.3
Other feed and feed ingredients	2,277	1,878	1,094	739	-32	48.0	39.4	-8.7
Eggs and honey	15,825	17,656	320	680	112	2.0	3.8	1.8
Water and soft drinks	1,574	2,081	330	352	7	21.0	16.9	-4.0
Other	690,227	832,724	290	495	71	0.0	0.1	0.0
<b>TOTAL</b>	<b>2,710.628</b>	<b>2,727.206</b>	<b>262,237</b>	<b>219,125</b>	<b>-16</b>	<b>9.7</b>	<b>8.0</b>	<b>-1.7</b>

**Source:** calculated by the authors of this study based on TRACES NT – European Commission (n.d.)

Some reduction in the presence of Ukrainian organic products on EU markets in 2022 is conditioned by the consequences of the military invasion of Ukraine by Russia, which caused considerable losses for the organic industry. The occupation of the territories, destruction of infrastructure, logistical problems, rising fuel and fertiliser prices, and the suspension of retail chains have halted the functioning and development of organic production in Ukraine and, consequently, led to a large-scale reduction in organic production. About 120,000 ha of certified organic land were lost due to occupation or hostilities. In March 2022, 30% of Ukrainian organic operators ceased operations, and 70%, according to a survey conducted by the Organic Ukraine NGO, required financial support (Statement on the situation..., 2022). Thanks to a range of measures taken by Ukrainian and foreign organisations to support organic businesses and meet the most urgent needs to maintain operations and strengthen their positions in the future, the crisis was partially overcome. As a result, 70% of operators have fully or partially continued

production and processing of organic products (Situation in the Ukrainian organic sector..., 2022); the situation continues to adapt to a new reality. The development of alternative logistics routes and the lifting of many existing restrictions on organic exports to the European Union and other countries allow Ukraine's organic sector to continue to hold a significant position in meeting the demand for organic agri-food products on foreign markets. This creates opportunities for Ukrainian producers to find new markets.

At the same time, organic production is one of the key goals of Ukraine's agricultural policy. Within the implementation of the National Economic Strategy for the period up to 2030 (Resolution of the Cabinet of Ministers..., 2021), it is planned to achieve at least 3% of the total area of agricultural land (1.3 million ha) with organic status. However, in 2021, the area of agricultural land under organic production (including land in transition) was 422.3 thous. hectares (1%), and in 2022, due to the Russian military aggression, it was 263.6 thous. ha (0.6%) (Organic

production of Ukraine..., n.d.). This means that to achieve the goals set out in the National Strategy, it is necessary to increase the area of organic land by 5 times in 8 years. Therewith, the Strategic Objective “Optimisation of the sales ecosystem in the domestic and foreign markets” aims to increase exports of organic products to USD 1 billion by 2030 (in 2022 – USD 219 million).

However, even assuming that such ambitious plans are implemented, the target set by the National Economic Strategy may not be sufficient to meet both domestic and external needs, considering the active measures taken by foreign countries to promote organic agriculture and the ever-growing demand for these products. By designating 3% of agricultural land for organic agriculture, Ukraine may face the challenge of producing the large volumes of these products required to meet demand, and thereby risk losing its leading position on the organic market in Europe and globally.

The EU’s Farm to Fork strategy aims to increase the share of land designated for organic agriculture to 25% of the total agricultural land area (A Farm to Fork strategy..., 2020), which will require the involvement of about 45 million ha (more than the entire agricultural land area of Ukraine). Considering this, increasing the pace and volume of organic production in the country is a promising area of development.

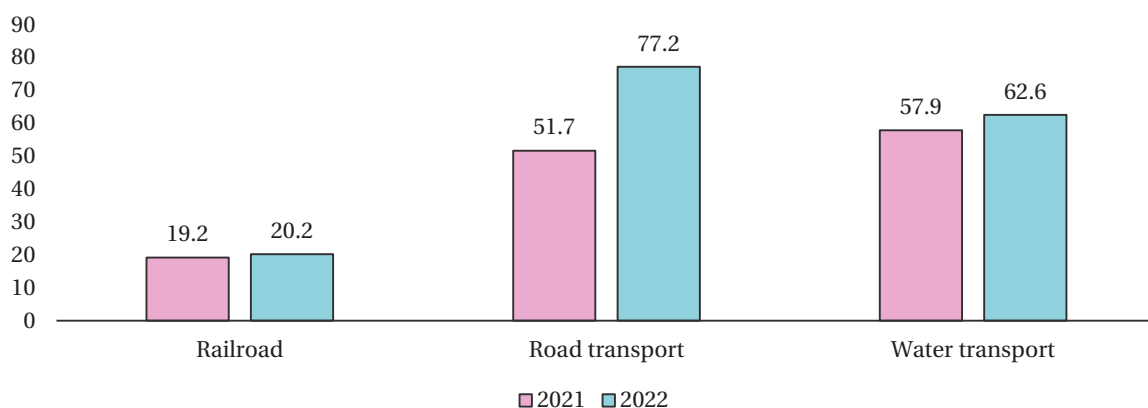
Fulfilling this purpose requires overcoming a range of barriers faced by Ukrainian exporters when entering the EU market, which may open new opportunities. Ukraine is noted as a country that actively exports organic products, entering the European and American markets with a large volume of organic agri-food products. In this context, it is recognised as a substantial player, especially in the wholesale of organic products. However, the majority of food in the EU, including organic food, is sold through wholesale retailers and supermarkets. A certain share is

sold through speciality shops and farmers’ markets, i.e., local distribution channels (Milford *et al.*, 2021). Given the number of organic products available for sale at retail in the European, American and Ukrainian markets, the number of organic products is not that large. This situation can be a favourable prospect both in the domestic and global organic market.

Ukraine’s leadership in exports of organic products to the EU in terms of volume is not identical to its position in terms of value. This is caused by the fact that the products are mainly raw materials and have low added value. However, there have been some positive developments in this area: in recent years, the share of processed organic products in the structure of exported products has been slowly increasing. The list of exported organic products with high added value increased by 100 items in 2021, including sunflower oil, frozen berries, apple juice, honey, amaranth, freeze-dried fruit, fruit pastille, instant meals, essential oils and nectarine juice, baking mixes, apple chips, and dried fruit bars (Halashevskiy *et al.*, 2020).

This can explain the slight increase in the value of exported organic products against the background of a decrease in their volume. According to Organic Standard LLC, in 2020, out of the total value of USD 204 million of exported organic products, USD 77.5 million (61.4 thous. t) was the value of products with higher added value (Analysis of the Ukrainian..., n.d.).

Adaptation to the current reality is also taking place in the area of transporting organic products exported to the EU. The problem of seaports being blocked is gradually being addressed by using alternative logistics routes, specifically by increasing the use of rail or road transport. Due to this, as well as the reorientation to transportation through river ports instead of seaports, Ukrainian exporters managed to increase the volume of organic exports in 2022 compared to 2021 for all types of transportation (Fig. 7).



**Figure 7.** Exports of Ukrainian organic products to the EU and Switzerland in 2021 and 2022 (January to August), thous. t  
**Source:** compiled by the authors of this study based on data from TRACES NT – European Commission (n.d.)

The problem is still the rising cost of logistics, for all types of transport. To solve this problem, the possibility of creating and operating infrastructure in importing countries is being considered, which could partially help overcome this and other logistical problems.

Another challenge for Ukrainian organic exporters is the growing level of competition from European

producers. There is a growing focus on local production, which is reducing demand for organic products from Ukraine. Organic products from Ukraine have a reputation of good quality, but once import duties and taxes are paid, the products may no longer be competitive in terms of price. Cost and delivery times can be a weakness for Ukrainian exporters compared to local suppliers.

A constraint to expanding the volume and range of exported organic products is the high cost of certification to ensure strict compliance with EU norms and standards. The majority of Ukrainian producers have been certified according to EU standards, as well as the US National Organic Programme (NOP), Canadian Organic Standard (COR), private organic standards of Bio Suisse (Switzerland), Naturland (Germany) and Bioland (Germany), JAS (Japan) and KRAV (Sweden) (Analysis of the Ukrainian..., n.d.), which involved considerable costs. The organic status of a product can only be established through a certification system controlled by the European Commission. In some EU member states, there has been noteworthy progress in covering organic production with certification. Specifically, in Switzerland, certified organic production covers 20.4% of agricultural land (Area under organic farming, n.d.). In comparison, in Ireland and France, such conditions are used on only 2.6% and 7.7% of agricultural land, respectively (Leduc *et al.*, 2023). Consumers in the EU have a prominent level of trust in certified organic products, but there are some differences by country. Thus, for instance, in Italy and Poland, preference is given to products certified by EU bodies; in Great Britain and Germany, national certification bodies enjoy a higher level of trust (Murphy *et al.*, 2022).

In Ukraine, the system of certification and standardisation of organic products is still in its infancy. The Law of Ukraine "On the Fundamental Principles and Requirements for Organic Production, Circulation and Labelling of Organic Products" (Law of Ukraine No. 2496-VIII..., 2018), which is based on the IFOAM International Standard (IFOAM Standard, n.d.), as well as the provisions of Council Regulation (EC) No. 834/2007 (Council of the European Union..., 2007), sets out the principles and requirements for legal support of organic production, circulation, and labelling of organic products. In 2022, the government revised the organic legislation in the context of adapting it to Regulation (EU) 2018/848 of the European Parliament and of the Council (Regulation (EU) 2018/848..., 2018) on organic production and labelling of organic products, which came into force on 1 January 2022. The Action Plan for the Harmonisation of the Legal Framework for the Functioning of the Agro-Industrial Complex of Ukraine and the EU (Order of the Ministry of Agrarian Policy..., 2018) prescribes measures to implement 44 acts of EU law (Ignatenko, 2021).

New challenges and unresolved issues facing exporters make it difficult to maintain Ukraine's current position in the markets for agricultural organic products and to strengthen it in the future. Considering the new reality and operating conditions of organic producers, the targets set out in the National Economic Strategy for the period up to 2030 in terms of production and export of safe and healthy agricultural and food products need to be reviewed and adjusted. The European Commission has adopted an Action Plan for the Development of Organic Production for 2021-2027 aimed at achieving the European Green Deal. This document envisages the implementation of the following areas: increased consumption, increased production, and further development of the sector's sustainability

to ensure its balanced growth (Communication from the commission..., 2021). To create a roadmap for achieving the indicators set out in the National Economic Strategy for the development of the organic sector, it would be advisable to develop Ukraine's own national programme, which would focus, among other things, on strengthening the presence and competitiveness of Ukrainian organic products in the markets of the European Union.

### ► Conclusions

A study of the current state of exports of Ukrainian organic agri-food products found that Ukraine is one of the key exporters of these products to the EU and is among the top five suppliers. Against the backdrop of the European organic market growth (annual growth of about 5% in 2018-2022), the supply of organic products is characterised by strengthening of Ukraine's position in most product groups of the EU import demand, providing a 13% increase in 2022 alone compared to the previous year. The high concentration of the commodity structure of organic products exported to the EU is typical for all exporting countries in general (the 8 largest commodity items account for 72% of the volume) and for Ukraine specifically (two commodity items cover 75% of the volume). This is facilitated by factors such as a good geographical location, a wide range of organic products, and the establishment of partnerships with many EU countries. The raw material nature of imports stays (46% of the volume of supplies in quantitative terms), but the share of products with higher added value is gradually increasing. The pace of growth of Ukrainian organic products in the EU markets slowed slightly due to the full-scale military invasion of Ukraine by Russia in 2022 (by 1.7 percentage points compared to 2018), but latest trends show a gradual recovery of the organic sector – 70% of operators have resumed production and processing. Increasing the use of road and rail logistics routes as an alternative for transporting organic products partly helps to solve the problem of blocking sea transport. This was facilitated by the considerable work done to support the development of organic production and export activities in this sector, which was implemented by both foreign and Ukrainian organisations and structures. At the same time, the new reality requires a review of previously approved priorities and target indicators considering the emergence of new and exacerbating problems in the export of organic products to the EU, in particular, the system of standardisation and certification needs to be improved. The development of a programme for the development of organic production and a clear action plan to improve the competitiveness of Ukraine's organic sector in foreign markets, specifically the European Union, based on the identified priority vectors, may be the subject of further research.

### ► Acknowledgements

None.

### ► Conflict of Interest

The authors of this study declare no conflict of interest.

### ► References

- [1] A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. (2020). Retrieved from [https://organicinfo.ua/wp-content/uploads/2021/05/EU-Farm-to-Fork-Strategy-UA\\_fin.pdf](https://organicinfo.ua/wp-content/uploads/2021/05/EU-Farm-to-Fork-Strategy-UA_fin.pdf).

- [2] Analysis of the Ukrainian organic sector for 8 months since the start of the full-scale war in Ukraine. (n.d.). Retrieved from <https://export.gov.ua/industry/review/67>.
- [3] Area under organic farming. (n.d.). Retrieved from [https://ec.europa.eu/eurostat/databrowser/view/sdg\\_02\\_40/default/table?lang=en](https://ec.europa.eu/eurostat/databrowser/view/sdg_02_40/default/table?lang=en).
- [4] Blaće, A., Čuka, A., & Šiljković, Ž. (2020). How dynamic is organic? Spatial analysis of adopting new trends in Croatian agriculture. *Land Use Policy*, 99, article number 105036. doi: 10.1016/j.landusepol.2020.105036.
- [5] Butenko, V., Baidala, V., & Toiunda, A. (2020). Trends in the development of the organic products market. *Economics and Business Management*, 11(4). doi: 10.31548/bioeconomy2020.04.002.
- [6] Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions regarding the plan of measures for the development of organic production. (2021). Retrieved from <https://dspace.organic-platform.org/xmlui/handle/data/512>.
- [7] Council of the European Union (EC) No 834/2007. (2007). Retrieved from <https://eur-lex.europa.eu/eli/reg/2007/834/oj>.
- [8] Dashboard on export of Ukrainian organic products. (n.d.). Retrieved from [https://export.gov.ua/740-eksport\\_ukrainskoi\\_organichnoi\\_produktsii](https://export.gov.ua/740-eksport_ukrainskoi_organichnoi_produktsii).
- [9] De Bauw, M., Franssens, S., & Vranken, L. (2022). Trading off environmental attributes in food consumption choices. *Food Policy*, 112, article number 102338. doi: 10.1016/j.foodpol.2022.102338.
- [10] Grabovska, T. (2019). *Organic agriculture policy of Ukraine is the way to the European standards* (Monograph, Polissia National University, Kyiv, Ukraine).
- [11] Halashevskiy, S., Korohod, O., & Prokopchuk, N. (2020). Catalog of ready organic food products. In *Organic processing and trade 2020: Materials of the VII international conference* (pp. 1-47). Kyiv: Organic Ukraine.
- [12] IFOAM Standard. (n.d.). Retrieved from <https://www.ifoam.bio/our-work/how/standards-certification/organic-guarantee-system/ifoam-standard>.
- [13] Ignatenko, I. (2021). Prospects for the development of organic agriculture in Ukraine in the process of EU integration. *Legal Position*, 3(32), 70-74. doi: 10.32836/2521-6473.2021-3.13.
- [14] Lambotte, M., De Cara, S., Brocas, C., & Bellassen, V. (2023). Organic farming offers promising mitigation potential in dairy systems without compromising economic performances. *Journal of Environmental Management*, 334, article number 117405. doi: 10.1016/j.jenvman.2023.117405.
- [15] Law of Ukraine No. 2496-VIII "On the Basic Principles and Requirements for Organic Production, Circulation, and Labeling of Organic Products". (2018, July). Retrieved from <https://zakon.rada.gov.ua/laws/show/2496-19#Text>.
- [16] Leduc, G., Billaudet, L., Engstrom, E., Hansson, H., & Ryan, M. (2023). Farmers' perceived values in conventional and organic farming: A comparison between French, Irish and Swedish farmers using the Means-end chain approach. *Ecological Economics*, 207, article number 107767. doi: 10.1016/j.ecolecon.2023.107767.
- [17] Malokhlib, O. (2021). Current issues of development of organic production in Ukraine in the context of European integration. *Law and Society*, 5, 100-109. doi: 10.32842/2078-3736/2021.5.14.
- [18] Milford, A.B., Lien, G., & Reed, M. (2021). Different sales channels for different farmers: Local and mainstream marketing of organic fruits and vegetables in Norway. *Journal of Rural Studies*, 88, 279-288. doi: 10.1016/j.jrurstud.2021.08.018.
- [19] Murphy, B., Martini, M., Fedi, A., Loera, B.L., Elliott, C.T., & Dean, M. (2022). Consumer trust in organic food and organic certifications in four European countries. *Food Control*, 133(Part B), article number 108484. doi: 10.1016/j.foodcont.2021.108484.
- [20] Order of the Ministry of Agrarian Policy and Food of Ukraine No. 313 "On the Approval of the Action Plan for Aligning Ukrainian Legislation with EU Law in the Agro-Industrial Complex". (2018, June). Retrieved from <https://ips.ligazakon.net/document/FN044053>.
- [21] Organic production of Ukraine for 2016-2022 (land certified). (n.d.). Retrieved from <https://organicinfo.ua/infographics/organic-land-2016-2022/>.
- [22] Overview of the organic market in Europe. (2021). Retrieved from <https://export.gov.ua/industry/review/51>.
- [23] Pedersen, S., Aschemann-Witzel, J., & Thøgersen, J. (2018). Consumers' evaluation of imported organic food products: The role of geographical distance. *Appetite*, 130, 134-145. doi: 10.1016/j.appet.2018.08.016.
- [24] Rees, C., Grovermann, C., & Finger, R. (2023). National organic action plans and organic farmland area growth in Europe. *Food Policy*, 121, article number 102531. doi: 10.1016/j.foodpol.2023.102531.
- [25] Regulation (EU) 2018/848 of the European Parliament. (2018). Retrieved from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L.2018.150.01.0001.01.ENG&toc=OJ%3AL%3A2018%3A150%3ATOC>.
- [26] Resolution of the Cabinet of Ministers of Ukraine No. 179 "On the Approval of the National Economic Strategy for the Period Until 2030". (2021, March). Retrieved from <https://www.kmu.gov.ua/npas/pro-zatverdzhennya-nacionalnoyi-eko-a179>.
- [27] Senyshyn, O. (2021). Organic potential of Ukraine in the system of organic production of European countries. *Economic Scope*, 171, 22-31. doi: 10.32782/2224-6282/171-4.
- [28] Situation in the Ukrainian organic sector after 5 months of the russia's full-fledged invasion. (2022). Retrieved from <https://organicinfo.ua/en/news/statement-july2022/>.
- [29] Statement on the situation in the Ukrainian organic sector. (2022). Retrieved from <https://organicinfo.ua/news/organic-appeal/>.

- [30] TRACES NT – Europese Commissie. (n.d.). Retrieved from <https://webgate.ec.europa.eu/tracesnt/directory/publication/establishment/index#!/search?sort=country.translation>.
- [31] Willer, H., Travnicek, J., Meier, C., & Schlatter, B. (Eds.). (2021). The world of organic agriculture 2021. Retrieved from <https://www.fao.org/family-farming/detail/en/c/1378841/#:~:text=Statistics%20and%20Emerging%20Trends,at%20least%203.1%20million%20farmers.>

## Україна на ринках органічної агропродовольчої продукції країн Європейського Союзу: аналітика, тренди та перспективи

### Людмила Василівна Смолій

Кандидат економічних наук, доцент  
Уманський національний університет садівництва  
20300, вул. Інститутська, 1, м. Умань, Україна  
<https://orcid.org/0000-0002-7426-0468>

### Микола Іванович Мостов'як

Аспірант  
Уманський національний університет садівництва  
20300, вул. Інститутська, 1, м. Умань, Україна  
<https://orcid.org/0009-0001-9230-820X>

► **Анотація.** Дослідження ролі українського агропромислового сектору в забезпеченні потреби в органічній продукції в країнах Європейського Союзу є значущим для розуміння та максимізації переваг для України. Це особливо важливо в контексті розвитку органічного ринку та поглиблення співпраці з Європою, що вказує на актуальність розглянутої у статті проблеми. Метою роботи було визначення існуючих позицій, домінуючих тенденцій та перспектив збільшення українського імпорту органіки до країн Європейського Союзу. Методологічною основою дослідження стало використання загальнонаукових та специфічних методів: монографічного, діалектичного, табличного, графічного, абстрактно-логічного та методу порівняльного аналізу. Проаналізовано вектори та динаміку розвитку органічного сільського господарства в Європейському Союзі, зокрема, виявлено зростання внутрішнього та імпортного попиту на органічні продукти, розширення переліку товарних позицій, наявність розриву між попитом та пропозицією, високу концентрацію товарної структури імпорту. Виділено основні чинники, що забезпечують провідне становище України серед ключових імпортерів органічного продовольства: географічне розташування, збільшення обсягів внутрішнього виробництва органічної продукції, вдосконалення системи її сертифікації, налагодження партнерських стосунків з країнами Європейського Союзу. Встановлено посилення позицій України по більшості товарних груп імпортного попиту на органічну продукцію: зокрема, зростання частки України в імпорті, а також поліпшення структурних характеристик в частині збільшення питомої ваги продукції з високою доданою вартістю. Виокремлено бар'єри, що постають перед українськими експортерами при виході на ринок Європи та виступають стримуючим фактором розширення обсягів та асортименту експортованої органічної продукції. Окреслено напрями підвищення потенціалу України в забезпеченні потреби в органічній продукції в Європейському Союзі. Результати дослідження надають важливі відомості для виробників, підприємців та стейкхолдерів, зацікавлених в розвитку ринку органічних продуктів в Європі та сталого сільського господарства. Окреслені пріоритети розвитку органічного виробництва в Україні можуть стати підґрунтям для формування національної програми, спрямованої на підвищення конкурентоспроможності української органічної галузі на ринках країн Європейського Союзу

► **Ключові слова:** сектор органічного виробництва; агропромисловий сектор; експорт; імпортний попит; Європейський Союз



UDC 338.43

## Albania's agricultural economy: Transformation, opportunities and challenges for modern agricultural enterprises

Elti Shahini\*

Postgraduate Student

Simon Kuznets Kharkiv National University of Economics

61166, 9A Nauky Ave., Kharkiv, Ukraine

<https://orcid.org/0009-0004-8299-4236>

► **Abstract.** The European agricultural market is currently in a state of uncertainty – climate change, military operations on arable land and the partial blocking of traditional grain export routes have changed the usual food security balances and brought the world closer to the risks of global hunger. The study aimed to provide recommendations for the development of the Albanian agricultural sector, considering the current situation and the historical background of the country's agriculture. Using such methods as statistical analysis, induction, classification, comparison and synthesis, the dynamics of development of both the Albanian economy as a whole and the specifics of its agricultural sector in the period from 1992 to 2022 were investigated. Modelling and generalisation methods were also used. The study obtained and analysed statistical information from previous years on such a basic economic indicator as gross domestic product and studied the dynamics of agricultural field crop production and the structure of their crops. Separately, the volume of Albania's foreign trade in the agro-industrial complex was analysed in terms of imports of agricultural products, exports, and the balance of these two indicators. The elasticity of private farms was assessed and steps to reform the national assortment policy were proposed. These recommendations were developed considering the Albanian specifics of the relatively small average land area of rural households. In addition, the result of the work is the development of proposals for joint farming and the creation of a national unique trade advantage in the agricultural sector, which will have an economic effect in foreign markets. The practical significance of the study lies in an objective assessment of the current economic situation in the Albanian agro-economy and the development of several recommendations that may be useful to representatives of the Ministry of Agriculture and Rural Development of Albania

► **Keywords:** agriculture; land fragmentation; unique selling proposition; private farms; market niche; medicinal plants

### ► Introduction

In the current environment of instability in the European food market, the food independence of each country is becoming extremely important. Therefore, Albania should reassess the capabilities of its agriculture and integrate into the updated balance of supply and demand for agricultural products – both at the European level and in the context of the threat of global hunger.

According to the international platform Statista, the share of Albania's agricultural sector in gross domestic product (GDP) is around 19% (Albania: Distribution of gross..., n.d.). Despite state-level support for the agricultural sector in recent years and agricultural land occupying about a quarter of the country's area, the share of agricultural products has remained almost unchanged from 2013

to 2023. At the same time, the European Commission notes the outflow of human capital from rural areas, lack of skills in quality product promotion, and limited average land-holdings – ten times smaller than in the European Union (EU) – among the challenges faced by Albania's agricultural sector (Agriculture in the enlargement countries, n.d.).

The problems and achievements of the local agro-industrial complex have repeatedly been the subject of research by the Albanian scientific community. For instance, Z. Sinaj *et al.* (2023) analysed the impact of state aid and the level of remuneration of employees in the industry in the process of identifying ways to improve the efficiency of agricultural enterprises in Albania. As such, to increase the productivity of agricultural enterprises in the country,

► **Suggested Citation:** Shahini, E. (2024). Albania's agricultural economy: Transformation, opportunities and challenges for modern agricultural enterprises. *Ekonomika APK*, 31(1), 64-72. doi: 10.32317/2221-1055.202401064.

\*Corresponding author



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

it was proved that significant mechanisation of production and the spread of forced irrigation technologies for arable land are needed.

Important analyses of the issue in the context of climate change and the global sustainable development movement were conducted by A. Maho *et al.* (2023). After analysing long-term statistics on climate indicators such as temperature and precipitation in the Albanian region of Korça, the authors made recommendations for changes in crop cultivation technology. In particular, since it has been proven that adjusting the sowing dates directly affects the modification of the phenological periods of plants, a whole calendar of more suitable periods for each crop was created.

In general, solving any technical problems of the agro-economy loses its meaning if the basic contradictions in the land market are not eradicated. L. Mukli (2022) investigated the challenges faced by the country in the egalitarian land reform inherited from post-communist Albania. Considering the farmer as the central economic figure in the organization of land work, the author proved that young non-local farmers are more inclined to sell their land than to use it for its intended purpose, as they see no prospects in this business.

Thus, in addition to purely economic factors, the land market in Albania is also influenced by traditional practices. E. Zhllima *et al.* (2023), in their study of gender gaps in land ownership and inheritance, determined that societies in small provincial towns often disregard legal grounds for ownership, violate women's rights, and rely on customary laws. Such archaism hurts both the social and economic development of the village.

M. Osmani *et al.* (2022) also devoted their study to the failures of Albania's economic policy concerning agricultural policy. Analysing examples of unsuccessful government intervention in resource allocation, the authors noted the rather low socialisation of Albanian villagers and their lack of skills in unbiased collective activity. The authors suggest that the way out of this situation is to accelerate the process of Albania's integration into the EU.

I. Tomorri *et al.* (2022) also believe that Albania's future lies in increasing its competitiveness in international markets. In their opinion, it is necessary to introduce value chains in rural areas with the distribution of functions according to the conveyor principle. This measure should create strong market linkages between individual actors and stimulate an increase in the productive base of smallholders.

Thus, the issues of land reform and the economics of the agricultural sector in Albania have been widely studied in the scientific community, but without considering the challenges to global food security that occurred in 2022-2023. These challenges include, in particular, the large-scale war in Ukraine, the fight against terrorism in the Middle East, epidemic threats. The study aims to formulate economic recommendations on the key areas of development of Albania's agro-industrial complex and modern agricultural enterprises.

### ► Materials and Methods

In the process of conducting this study, such methods as statistical analysis, classification and synthesis were used.

Moreover, the comparison method was used to compare Albania's performance over the years in terms of such an important economic indicator as gross domestic product. These data were considered in the dynamics, which made it possible to obtain a more objective and informative assessment of the country's economic development. As part of the theoretical study, the analysis method was also used to assess the agro-economic indicators of the previous five years, including the volume of vegetable production, considering the share of each crop, the area sown with field crops and the yield per hectare. Separately, the data on the structure of crops in the period from 2018 to 2022, the last year for which there are currently processed and systematised statistics, were systematised and combined using the synthesis method.

The impact of the COVID-19 pandemic and the subsequent quarantine restrictions in 2020 and 2021 on food exports and imports from and to Albania was also assessed. Using the analysis method based on data obtained from the portal of the Albanian Institute of Statistics, the general trend of the trade balance for the two years of forced isolation of producers and consumers, as well as for comparison, for the two previous years (2018-2019) and one subsequent year (2022), as the finalised statistics for 2023 are not yet available.

The materials used for this study included, in addition to the above, operational and archival data from The World Bank, the Ministry of Agriculture and Rural Development of Albania, current laws and regulations, in particular, Law No. 9817 "On Agriculture and Rural Development" (2007), as well as the annual reference publication Albania in figures (n.d.). Furthermore, by applying the induction method, data on key competitors in the region were identified and summarised for such crop groups as olives, grapes, and cereals. The analysis method was used to assess the prospects of the relevant areas of the Albanian agro-industrial complex in the competition and the expected result in terms of increasing the economic benefits of the country's agricultural activities.

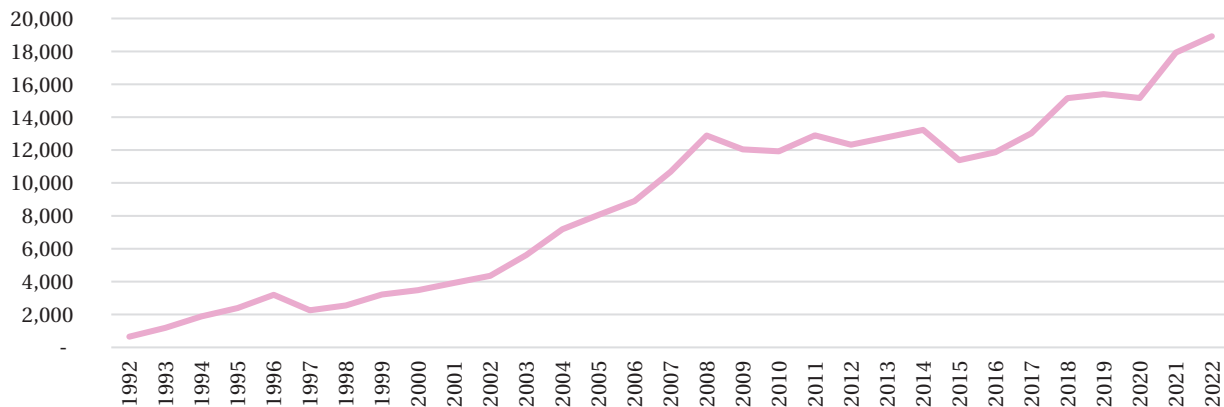
The key problems and obstacles faced by the Albanian agricultural economy were identified and listed using the classification method. These include, in particular, the average size of land holdings in private households, the low level of communication between farmers within communities, the lack of quality strategic planning, the deliberate self-removal of local authorities, including elected ones, from solving the problems of local farmers. Furthermore, using the modelling method, based on the data obtained and the relevant conclusions, the further development of the agricultural business in Albania was modelled and described. By analysing the current situation in the European agricultural market, the economic niches that Albanian farmers and professional officials should focus on were identified. Furthermore, using the method of generalisation, recommendations on assortment policy were formulated, considering the potential unique competitive advantages (UCAs) that Albania can take advantage of.

### ► Results

The collapse of the communist system in Albania, which was completed in 1992, and the transition to market

mechanisms have provided an opportunity for the country's economic development. The dynamics of the gross domestic product have changed several times over the

three decades of post-communist development, demonstrating different stages of economic growth in the country. GDP figures by year are shown in Figure 1.

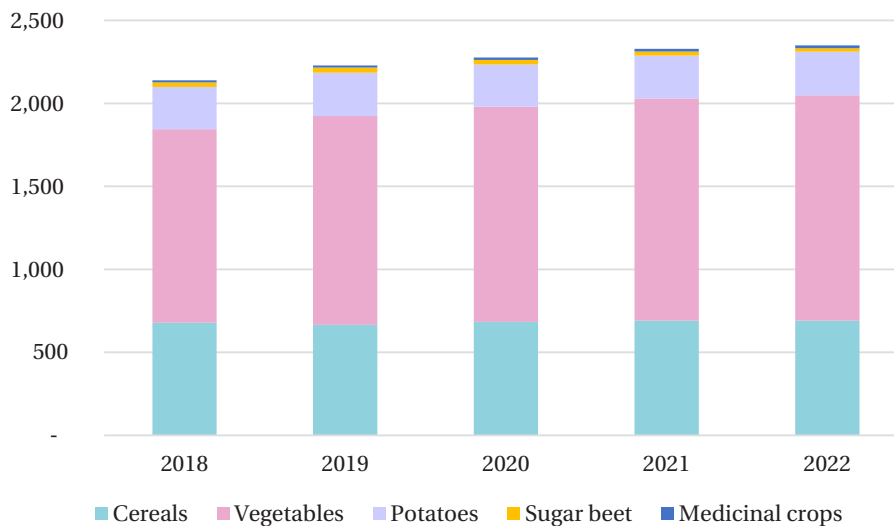


**Figure 1.** Albania's GDP by years, million USD

**Source:** compiled by the author based on the data from GDP (current US\$) – Albania (n.d.)

According to the chart, after the collapse of the USSR and the end of the so-called “socialist bloc”, Albania's economy was in a catastrophic state, with GDP in 1992 amounting to only USD 652 million. However, thanks to its domestic potential and the assistance of developed European economies, the country managed to demonstrate strong growth in the following years, which continued until 2008. In the period from 2008 to 2016, there was a certain stabilisation of economic indicators and slight fluctuations in GDP. However, starting in 2017, a noticeable economic recovery resumed, and over the

next six years, the gross domestic product grew by almost one and a half times. Since the share of agriculture in Albania's economy is consistently around 19%, it can be concluded that the agricultural sector has seen a similar growth of 146% in six years (Albania: Distribution of gross..., n.d.). It becomes clear which categories of agricultural products accounted for this growth after analysing the key indicators of agricultural development from the Ministry of Agriculture and Rural Development of Albania. In particular, the volume of field crop production by year is shown in Figure 2.

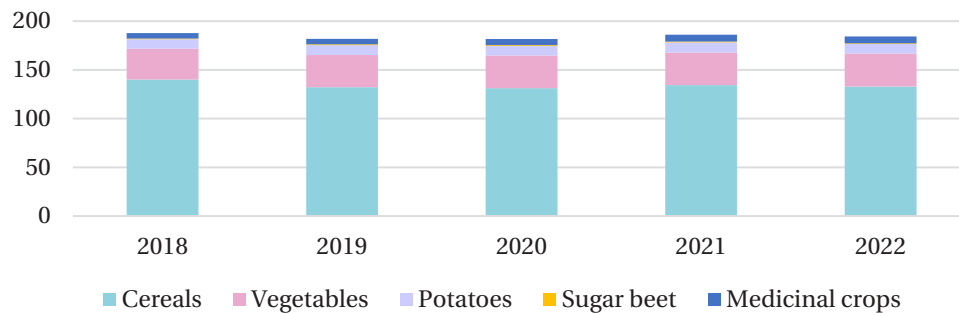


**Figure 2.** Production of agricultural field crops, thousand tonnes

**Source:** compiled by the author based on Agriculture and fishery (n.d.)

As can be seen from the histogram above, each of the main categories of field crops is seeing an increase in production volumes, which ultimately leads to an increase in the total figure. The success of the Albanian agro-industrial complex in growing medicinal crops deserves special attention – although the difference between 12.5 thousand tonnes in 2017 and 16.43 thousand

tonnes in 2022 is not very noticeable concerning the total production of field crops, this category is growing by 31%, which is a very high figure. To understand whether the increase in agricultural output is due to quantitative or qualitative growth, it is also necessary to analyse the dynamics of the amount of sown area for these crops. This is shown in Figure 3.



**Figure 3.** Structure of field crops, thousand ha

**Source:** compiled by the author based on Agriculture and fishery (n.d.)

Analysing the structure of field crops in the context of production indicators, it is possible to conclude that the Albanian agricultural sector has chosen a more progressive, intensive path of development and additional yields and profits are not due to the addition of new arable land, but to a more efficient and technological approach. It is worth considering changes in agriculture through the prism of foreign economic activity.

Since no country can provide itself with its domestic production of the entire existing range of agricultural products, certain products will inevitably be purchased abroad. Accordingly, in this case, not only absolute exports, and imports but also their balance is an important indicator of the economic viability of the industry. The relevant indicators for Albania are shown on Figure 4 and Table 1.



**Figure 4.** Albania's foreign trade in the agricultural sector, million Albanian leks

**Source:** compiled by the author based on International trade in goods (n.d.)

**Table 1.** Albania's foreign trade in the agricultural sector, million Albanian leks

Year	2018	2019	2020	2021	2022
Import	106,508	110,365	110,927	130,017	149,225
Export	32,334	35,374	39,050	44,469	51,715
Balance	-74,174	-74,991	-71,877	-85,548	-97,510
Share of exports in foreign trade	30%	32%	35%	34%	35%

**Source:** compiled by the authors based on International trade in goods (n.d.)

As can be seen, despite the growth in imports of agricultural products into the country, the balance of supplies abroad and to Albania has remained almost unchanged over the past five years, with a ratio of approximately 1 to 3. An important aspect of this study of Albania's foreign economic activity is the fact that the trends in agricultural trade between 2018 and 2022 were not affected by the COVID-19 pandemic, which was active in the middle of this period. As can be seen from the graph in Figure 4, imports and exports have an almost linear positive trend, with no deviations in 2020 and 2021. This fact concludes

that the agricultural sector is not heavily affected by the restrictions imposed by the coronavirus pandemic and that due to its specific nature, agriculture remains a consistently profitable industry with guaranteed effective demand even in times of forced isolation in society.

Attempts to develop Albania's unique agricultural trade offer that would allow it to compete in the region have not yet had the desired result, due to the relatively small amount of arable land, which, in turn, is objectively limited by the size of the country itself. For example, Albania's olive production, according to the Institute of

Statistics, varies between 130-160 thousand tonnes, while market leaders Spain and Greece supply 8 and 3 million tonnes on average per year, respectively – 50-20 times more. The situation with grapes is similar: in 2022, Albania was able to grow and supply 211 thousand tonnes of this product to the market, ranking only 38th in the world ranking, according to the Food and Agriculture Organisation of the United Nations (Crops and livestock products, n.d.). At the same time, the leaders of the European ranking, Italy and Spain, supplied 8 and 6 million tonnes respectively in 2022, which is again 40-30 times more. As for grains, the production volumes of countries with huge arable land – France and Ukraine – which are leaders on the continent, leave Albania no chance of at least regional influence in the cereal market.

However, the search for opportunities to strengthen its influence on the European agricultural market continues. In particular, in recent years, medicinal and aromatic plants have become increasingly popular in the world, and Albania is one of the leading countries in the production of this still relatively exotic category. According to experts, the production of medicinal and cosmetic plants by Albanian enterprises already generates about EUR 18 million for the budget. At the same time, it is important to understand that growing and shipping low-processed raw materials is a fairly simple option that does not unlock even a small fraction of the industry's potential. The economic effect will be multiplied by building a systematic production of essential oils from medicinal and aromatic plants – and this is where Albania, with some help from national or European programmes, could become a leader and a true trendsetter. The potential for elasticity of private farms is evidenced by the following facts, for example, in greenhouses in just two prefectures – Berat and Fier – almost 80% of all vegetables were grown in 2022, and pomegranate production increased by 45.13% in just one year across the country, and by as much as 214% in Vlora prefecture (Albania in figures, n.d.). This demonstrates the willingness and ability of Albanian farmers to develop in the right direction, and it is only necessary to set this benchmark for them and implement a support programme.

The current situation at the level of individual small and medium-sized rural households is quite complex. As mentioned above, Albania is the anti-rating leader in terms of the average size of private plots, at 1.26 hectares. To generate a guaranteed systemic income from such an area, it is necessary to unite small households into joint management and introduce proven technologies for efficient land use. However, the vast majority of Albanian household owners are not ready for radical change, and communication within the community is traditionally limited. This is a particular concern in the context of the industry's future qualitative transition to the so-called "Agriculture 4.0" format, which will be based on the three principles of sustainable intensification – people, production, and planet – and which is inevitable according to professional futurists. At the same time, the fragmentation of Albanian society, which has persisted throughout the thirty years of post-Soviet development, negatively affects the realisation of the potential in the agricultural sector. In addition, among the chronic problems of the

Albanian agricultural sector, experts also note the lack of skills in promoting their products among ordinary farmers, limited access to cheap credit, extremely poor availability of modern equipment and technologies and, consequently, low labour productivity. In addition, as already mentioned, the rural sector in Albania is traditionally characterised by a low level of both vertical and horizontal cooperation, which significantly reduces the social capital of potential joint projects.

The responsibility for this state of affairs lies primarily with the government, which has failed to ensure the required level of agricultural management and to create conditions for the effective operation of the agro-economy for three decades. It is the government that should guarantee the conditions for the development and transfer of technology, improve the investment attractiveness of the industry, and create the necessary targeted financial support programmes for farmers. Such financial support can be either in the form of subsidising prices for certain crops or in the form of cancelling export duties on certain products to stimulate their sales in foreign markets. Thus, the solution to the problems and challenges faced by small and medium-sized farms in Albania lies in good governance. Responsible non-governmental organisations that have the necessary powers and credibility among farmers can lead the creation of joint farms. These structures can also act as a guarantor of fair distribution of the results of joint labour on conditionally united land plots. However, it is important to consider the social trauma inflicted on Albanians and residents of Eastern Europe by the former communist regime. Any suspicions of land expropriation or the formation of "new collective farms" should be calculated in advance and preventively addressed at the stage of developing the communication strategy. In addition, since the target audience of the project has pronounced signs of a traditional psychological structure, where personal trust is of great importance, it is necessary to involve well-known people as speakers, not political, but rather from artistic and cultural circles – famous artists, pop figures, bloggers popular among middle-aged people.

As a pilot programme for reforming the new agricultural culture, it would be advisable to involve small and medium-sized farmers in the cultivation and processing of medicinal and cosmetic plants – as was found above, this is a relatively free niche in the European market and Albania can occupy it. Extensive information support through popular information channels (state television, radio, YouTube) and the establishment of mobile points of reception and primary processing of raw materials in the regions will demonstrate to farmers effective support from the state and the existence of an agro-industrial development programme. After the successful implementation of the first programme – during one harvesting season – farmers will be convinced of its effectiveness and will begin to trust the state more in further steps to develop the industry, in particular, in projects for joint project use of temporary unification of several small land plots.

In general, when formulating an information policy towards local farmers, it is necessary to recognise the failure of previous attempts to convey intentions and ideas of joint farming to rural communities. The small fragmentation of private land plots in Albania requires a special

approach to creating targeted messages. The key idea of such messages should be to reassure opinion leaders about the guarantees of inviolability of private property and to explain in detail, in language understandable to the target audience, how the procedure for common land use will work and what economic benefits private households will receive from it. Albania's building of its agricultural strategy from scratch will paradoxically give it an advantage over other, more established agricultural markets, as the country's agro-industrial complex will not need to destroy the remnants of the previous one to integrate into the new way of life of the fourth agricultural revolution.

### ► Discussion

As can be seen from the study results, Albania's agro-economy can have a significant impact on the food balance in the modern world, where the risks of global hunger are increasingly being voiced. In general, the development of the agro-industrial complex and the challenges for modern agricultural enterprises are a topic of research by the global scientific community.

For instance, S.O. Araújo *et al.* (2021) considered the possibilities of the fourth mode of agriculture, which was discussed in this paper, as a guaranteed way to meet the needs of the world's population with food. By analysing existing trends in the industry through a semi-automated analysis of numerous scientific publications, the authors presented a project of cloud architecture that could serve to further develop agricultural systems. D.C. Rose *et al.* (2021) conducted a similar study on the conditions of intensification that should bring Agriculture 4.0 closer. They proved that human capital is the most important element of the future agricultural system. The authors suggest investing in it by engaging people in agricultural innovation systems to create a renewed agro-economic system. Similar conclusions were drawn in this paper, as economic benefits from reforms can only be achieved by maintaining contact with farm owners and workers, and by explaining the issues to them in a language they understand.

J. Aschemann-Witzel *et al.* (2021) discussed the future challenges to the food sector and the solutions that can be offered by plant-based foods. After a detailed analysis of global factors and trends that predict the possibility of food shortages on the planet, the strengths, and weaknesses of food companies, including European ones, were identified. As noted in this study, the agricultural market tends to specialise, and only those participants who find their unique niche in time to gain leadership will receive the maximum economic benefit. It is worth noting the view of Albania's agribusiness from the perspective of foreign experts. A group of Czech researchers D. Imami *et al.* (2021) studied the peculiarities of strengthening the vertical coordination of Albanian farmers through the development of agricultural cooperatives, which is the kind of strengthening of ties between individual farms that was discussed in this paper. As such, it was proved that the development of joint projects involving farmers not only reduces the cost of crop production but also helps build mutual trust.

Given the many common factors between the agro-industrial complexes of Albania and Montenegro – geographical, historical, market conditions – the experience

of agricultural market development in this country is quite informative. D. Zejak *et al.* (2021), in search of examples of sustainable management of crop production in rural areas, highlighted the experience of some Montenegrin regions in raspberry cultivation. The optimal growing conditions provided by the mountainous terrain result in high and high-quality yields that allow for the planning of industrial cultivation of this berry in the future. This specialisation in monoculture has much in common with the ideas of systematic cultivation of medicinal plants in Albania proposed in this paper. Excessive fragmentation of land plots, as mentioned above, is also common in other countries of Eastern Europe and Central Asia. M. Gorgan & M. Hartvigsen (2022), who studied the peculiarities of such land distribution, concluded that a coherent national land policy and the introduction of a land bank to consolidate it are needed. The establishment of such an institution could be useful for Albania as well.

M. Biczkowski *et al.* (2021), who studied the impact of agro-economic development programmes on the example of rural Poland, conducted a correlation analysis of the relationship between the number of implemented projects and the economic growth of certain regions (counties). As such, the authors proved that in regions where agriculture is historically deeply rooted, the agro-economy experiences significant growth, while representatives of areas with fewer farms, on the contrary, are looking for alternative ways to earn money in other sectors. Accordingly, it is worth using this experience and not trying to attract people unaccustomed to such work to agribusiness. However, for Albania, the experience of its closest neighbours, the Balkan countries, is more valuable. E. Erjavec *et al.* (2021), who studied agricultural policy in the Western Balkans, formulated the key principles of agricultural policy harmonisation and invented schemes for classifying agricultural policy measures. A similar work, but in the context of promoting the green economy, was carried out by A. Licastro & B.S. Sergi (2021) using the SWOT analysis matrix, which formed the influence of internal and external factors on the development of the agro-industrial complex of four Balkan countries, demonstrating a direct link between the success of a country's European integration and its environmental policy. In the context of its European integration movement, Albania should consider this correlation.

How the cooperation of individual farmers helps to solve economic issues, which was also discussed in this paper, was the subject of a study by O. Gava *et al.* (2021). Using the example of another Balkan country, Bosnia and Herzegovina, the authors proved the successful contribution of joint farming to improving market positions and helping the collective transition to growing a new crop (in this case, berries) to overcome economic problems. The new important challenges facing the agricultural sector, mentioned in this study, were also described by G. Malorgio & F. Marangon (2021). The decline in natural resources caused by human error and unjustified aggressive actions can lead to the collapse of the global economy and a deep crisis. The authors insist that the inclusion of the concept of sustainability in food production and consumption is necessary at this stage, and the uniqueness of the trade offer and the specialisation

of regions in certain crops can guarantee sustainability in the agricultural market.

The market of medicinal plants, which is proposed in this study to be a specialisation of the agricultural sector in Albania, has many features. K.S. Rao *et al.* (2022) exploring the methods of improving the quality of this specific product category, considered the steps leading to an increase in added value and methods that can increase farmers' profits. I. Taghouti *et al.* (2022), in turn, analysing the global supply chain of medicinal and aromatic plants in the Mediterranean region, identified several problems related to certification and labelling of products, market changes, laboratory testing, and processing of raw materials. Summing up, the authors state that the relative "exoticism" of this market, on the one hand, opens up great opportunities for new leaders, and on the other hand, it contains the risks of a still unbalanced system. The industry's challenges include the lack of a stable institutional and legislative framework, high accountability to national health ministries, and low consumer awareness. All of this should be considered when making the final decision to encourage Albanian farmers to adopt the new assortment policy.

The impact of European regulations on different categories of botanical products on the nomenclature of medicinal and cosmetic plants was studied by A.R. Bilia & M. do Céu Costa (2021). Using the example of five product categories – St. John's wort, valerian, ginkgo, ginseng, and green tea – the authors investigated the complexities of national certification and categorisation of products, which can vary significantly from country to country and, accordingly, affect the profit margin of producers. Thus, the authors identified a systemic problem with the compatibility of rules and working conditions, which should be considered when entering the European market for medicinal plants.

To sum up, the agricultural business is quite promising from an economic point of view, but it has many peculiarities and limitations. Given the fragmentation of the Albanian land market, it is necessary to consider the experience of both the global agricultural sector and neighbouring Balkan countries when formulating its long-term strategy.

## ► References

- [1] Agriculture and fishery. (n.d.). Retrieved from <https://www.instat.gov.al/en/themes/agriculture-and-fishery/agriculture/#tab2>.
- [2] Agriculture in the enlargement countries. (n.d.). Retrieved from [https://agriculture.ec.europa.eu/international/international-cooperation/enlargement/candidates\\_en](https://agriculture.ec.europa.eu/international/international-cooperation/enlargement/candidates_en).
- [3] Albania in figures. (n.d.). Retrieved from <https://www.instat.gov.al/media/12769/albania-in-figures-2022.pdf>.
- [4] Albania: Distribution of gross domestic product (GDP) across economic sectors from 2012 to 2022. (n.d.). Retrieved from <https://www.statista.com/statistics/444090/albania-gdp-distribution-across-economic-sectors/>.
- [5] Araújo, S.O., Peres, R.S., Barata, J., Lidon, E., & Ramalho, J.C. (2021). Characterising the Agriculture 4.0 landscape – emerging trends, challenges and opportunities. *Agronomy*, 11(4), article number 667. doi: 10.3390/agronomy11040667.
- [6] Aschemann-Witzel, J., Futtrup Gantriis, R., Fraga, P., & Perez-Cueto, F.J.A. (2021). Plant-based food and protein trend from a business perspective: Markets, consumers, and the challenges and opportunities in the future. *Critical Reviews in Food Science and Nutrition*, 61(18), 3119-3128. doi: 10.1080/10408398.2020.1793730.
- [7] Biczkowski, M., Jezierska-Thöle, A., & Rudnicki, R. (2021). The impact of RDP measures on the diversification of agriculture and rural development – Seeking additional livelihoods: The case of Poland. *Agriculture*, 11(3), article number 253. doi: 10.3390/agriculture11030253.

## ► Conclusions

Albania's agricultural economy is at a favourable moment for reform, and it is up to the government and ordinary small landowners to take advantage of the changing balance in the European agricultural sector. As the Albanian agro-industrial complex has not been able to build its development strategy for more than thirty years of independence, the country's great agricultural potential, due to its mild climate and coastal location, has not yet been realised.

To overcome this situation, a nationwide programme is needed to explain the current situation and possible prospects to the population. Historically, the mentality of Albanian villagers has been such that, in addition to the physical fragmentation of land, there is a certain social atomisation of society – vertical and horizontal ties in local communities are rather weak and people are not used to implementing joint projects together, even when there is an obvious economic benefit. The state information company could change this attitude and establish transparent and secure mechanisms for the temporary pooling of land plots in a common-use regime with clear algorithms for the distribution of economic benefits from the sale of crops. This project should also focus on a balanced product mix policy and select crops for the reform of the Albanian agro-industrial complex that would become a unique trade offer for the country and take advantageous positions in the solvent foreign economic market of the EU. Such trade items could be medicinal and essential plants, the demand for which is not fully met at this stage.

The launch of such a national project will be able to restart the Albanian agricultural economy and attract additional investments from European partners. A separate competitive advantage of such a reform could be a system of mobile points for receiving raw materials from farmers and their further primary processing. The principles of operation of such mobile stations and the calculation of their profitability could be the subject of further study.

## ► Acknowledgements

None.

## ► Conflict of Interest

None.

- [8] Bilia, A.R., & do Céu Costa, M. (2021). Medicinal plants and their preparations in the European market: Why has the harmonization failed? The cases of St. John's wort, valerian, ginkgo, ginseng, and green tea. *Phytomedicine*, 81, article number 153421. doi: [10.1016/j.phymed.2020.153421](https://doi.org/10.1016/j.phymed.2020.153421).
- [9] Crops and livestock products. (n.d.). Retrieved from <https://www.fao.org/faostat/en/#data/QCL>.
- [10] Erjavec, E., Volk, T., Rednak, M., Ciaian, P., & Lazdinis, M. (2021). Agricultural policies and European Union accession processes in the Western Balkans: Aspirations versus reality. *Eurasian Geography and Economics*, 62(1), 46-75. doi: [10.1080/15387216.2020.1756886](https://doi.org/10.1080/15387216.2020.1756886).
- [11] Gava, O., Ardakani, Z., Delalić, A., Azzi, N., & Bartolini, F. (2021). Agricultural cooperatives contributing to the alleviation of rural poverty. The case of Konjic (Bosnia and Herzegovina). *Journal of Rural Studies*, 82, 328-339. doi: [10.1016/j.jrurstud.2021.01.034](https://doi.org/10.1016/j.jrurstud.2021.01.034).
- [12] GDP (current US\$) – Albania. (n.d.). Retrieved from <https://data.worldbank.org/indicator/NY.GDPMKTP.CD?locations=AL>.
- [13] Gorgan, M., & Hartvigsen, M. (2022). Development of agricultural land markets in countries in Eastern Europe and Central Asia. *Land Use Policy*, 120, article number 106257. doi: [10.1016/j.landusepol.2022.106257](https://doi.org/10.1016/j.landusepol.2022.106257).
- [14] Imami, D., Valentinov, V., & Skreli, E. (2021). Food safety and value chain coordination in the context of a transition economy: The role of agricultural cooperatives. *The Commons Journal*, 15(1), 21-34. doi: [10.5334/ijc.1039](https://doi.org/10.5334/ijc.1039).
- [15] International trade in goods. (n.d.). Retrieved from <https://www.instat.gov.al/en/themes/international-trade/international-trade-in-goods/#tab2>.
- [16] Law No. 9817 “On Agriculture and Rural Development”. (2007, October). Retrieved from <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC083478/>.
- [17] Licastro, A., & Sergi, B.S. (2021). Drivers and barriers to a green economy. A review of selected Balkan countries. *Cleaner Engineering and Technology*, 4, article number 100228. doi: [10.1016/j.clet.2021.100228](https://doi.org/10.1016/j.clet.2021.100228).
- [18] Maho, A., Mero, G., & Papa, G. (2023). *Adapting agroecosystems to climate change to maintain sustainability*. *Journal of Agriculture and Sustainable Rural Development*, 1(1-2), 8-15.
- [19] Malorgio, G., & Marangon, F. (2021). Agricultural business economics: The challenge of sustainability. *Agricultural and Food Economics*, 9, article number 6. doi: [10.1186/s40100-021-00179-3](https://doi.org/10.1186/s40100-021-00179-3).
- [20] Mukli, L. (2022). The farmer and the land market. Case study Orikum area. *Economic Insights – Trends and Challenges*, 11(3), 43-51. doi: [10.51865/EITC.2022.03.05](https://doi.org/10.51865/EITC.2022.03.05).
- [21] Osmani, M., Kolaj, R., Borisov, P., & Arabska, E. (2022). Why agricultural policies fail and two cases of policy failures in Albania. *Agricultural and Resource Economics: International Scientific E-Journal*, 8(2), 86-104. doi: [10.22004/ag.econ.322722](https://doi.org/10.22004/ag.econ.322722).
- [22] Rao, K.S., Haran, R.H., & Rajpoot, V.S. (2022). Value addition: A novel strategy for quality enhancement of medicinal and aromatic plants. *Journal of Applied Research on Medicinal and Aromatic Plants*, 31, article number 100415. doi: [10.1016/j.jarmap.2022.100415](https://doi.org/10.1016/j.jarmap.2022.100415).
- [23] Rose, D.C., Wheeler, R., Winter, M., Lobley, M., & Chivers, C.A. (2021). Agriculture 4.0: Making it work for people, production, and the planet. *Land Use Policy*, 100, article number 104933. doi: [10.1016/j.landusepol.2020.104933](https://doi.org/10.1016/j.landusepol.2020.104933).
- [24] Sinaj, Z., Ramosacaj, M., & Kushta, E. (2023). Performance management assessment in agriculture organisations (using factorial parameters case of Albania). *Scientific Horizons*, 26(1), 102-110. doi: [10.48077/scihor.26\(1\).2023.102-110](https://doi.org/10.48077/scihor.26(1).2023.102-110).
- [25] Taghouti, I., Cristobal, R., Brenko, A., Stara, K., Markos, N., Chapelet, B., Hamrouni, L., Buršić, D., & Bonet, J.A. (2022). The market evolution of medicinal and aromatic plants: A global supply chain analysis and an application of the Delphi method in the Mediterranean area. *Forests*, 13(5), article number 808. doi: [10.3390/f13050808](https://doi.org/10.3390/f13050808).
- [26] Tomorri, I., Keco, R., & Tomorri, K. (2022). Evaluating the impact of small farmer's inclusion in agricultural value chain for sustainable rural development in Albania. *European Journal of Agriculture and Food Sciences*, 4(2), 86-94. doi: [10.24018/ejfood.2022.4.2.483](https://doi.org/10.24018/ejfood.2022.4.2.483).
- [27] Zejak, D., Glisic, I., Spalevic, V., Maskovic, P., & Dudic, B. (2021). Sustainable management of fruit growing in rural areas of Montenegro: The impact of location on the phenological and nutritional properties on raspberry (*Rubus idaeus* L.). *Agronomy*, 11(8), article number 1663. doi: [10.3390/agronomy11081663](https://doi.org/10.3390/agronomy11081663).
- [28] Zhllima, E., Pojani, D., Merkaj, E., & Imami, D. (2023). Unlanded class: Albania's gender gaps in land ownership and inheritance. *Feminist Economics*, 29(2), 32-63. doi: [10.1080/13545701.2022.2125167](https://doi.org/10.1080/13545701.2022.2125167).

## Аграрна економіка Албанії: трансформація, можливості та виклики для сучасних сільськогосподарських підприємств

Елті Шахіні

Аспірант

Харківський національний економічний університет імені Семена Кузнеця

61166, просп. Науки, 9А, м. Харків, Україна

<https://orcid.org/0009-0004-8299-4236>

► **Анотація.** Європейський аграрний ринок наразі перебуває у стані невизначеності – зміна клімату, військові дії на орних землях та часткове блокування традиційних маршрутів експорту зерна змінили звичні баланси продовольчої безпеки та наблизили світ до ризиків глобального голоду. Метою дослідження було надання рекомендацій щодо розвитку аграрного сектору Албанії, враховуючи поточну ситуацію та історичні передумови розвитку сільського господарства країни. За допомогою таких методів, як статистичний аналіз, індукція, класифікація, порівняння та синтез, було досліджено динаміку розвитку як економіки Албанії в цілому, так і специфіку її аграрного сектору в період з 1992 по 2022 роки. Також були використані методи моделювання та узагальнення. У ході дослідження було отримано та проаналізовано статистичну інформацію за попередні роки щодо такого базового економічного показника, як валовий внутрішній продукт, а також вивчено динаміку виробництва сільськогосподарських польових культур та структуру їх посівів. Окремо було проаналізовано обсяги зовнішньої торгівлі Албанії в агропромисловому комплексі в розрізі імпорту сільськогосподарської продукції, експорту та сальдо цих двох показників. Було оцінено еластичність приватних фермерських господарств та запропоновано кроки для реформування національної асортиментної політики. Ці рекомендації були розроблені з урахуванням албанської специфіки відносно невеликої середньої земельної площі сільських домогосподарств. Крім того, результатом роботи є розробка пропозицій щодо спільного ведення сільського господарства та створення національної унікальної торговельної переваги в аграрному секторі, що матиме економічний ефект на зовнішніх ринках. Практичне значення дослідження полягає в об'єктивній оцінці поточної економічної ситуації в агроєкономіці Албанії та розробці низки рекомендацій, які можуть бути корисними для представників Міністерства сільського господарства та розвитку сільських територій Албанії

► **Ключові слова:** сільське господарство; фрагментація земель; унікальна торгова пропозиція; приватні фермерські господарства; ринкова ніша; лікарські рослини

**ЕКОНОМІКА АПК**  
**Науково-виробничий журнал**

**Том 31, № 1**  
**2024**

**Літературний редактор:**  
В. Сова

**Редагування бібліографічних списків:**  
В. Сова

**Комп'ютерна верстка:**  
М. Кришталь

Підписано до друку 30.01.2024  
Формат 60\*84/8  
Ум. друк. арк. 8,6  
Наклад 50 прим.

Видавництво: Національний науковий центр «Інститут аграрної економіки»  
03127, вул. Героїв Оборони, 10, м. Київ, Україна  
E-mail: [info@eapk.com.ua](mailto:info@eapk.com.ua)  
<https://eapk.com.ua/uk>

**EKONOMIKA APK**  
**Scientific and Production Journal**

**Volume 31, No. 1**  
**2024**

**Literary editor:**

V. Sova

**Editing bibliographic lists:**

V. Sova

**Desktop publishing:**

M. Kryshtal

Signed to the print 30.01.2024  
Format 60\*84/8  
Conventional Printed Sheet 8.6  
Circulation 50 copies

Publisher: National Scientific Center "Institute of Agrarian Economics"  
03127, 10 Heroiv Oborony Str., Kyiv, Ukraine  
E-mail: [info@eapk.com.ua](mailto:info@eapk.com.ua)  
<https://eapk.com.ua/en>