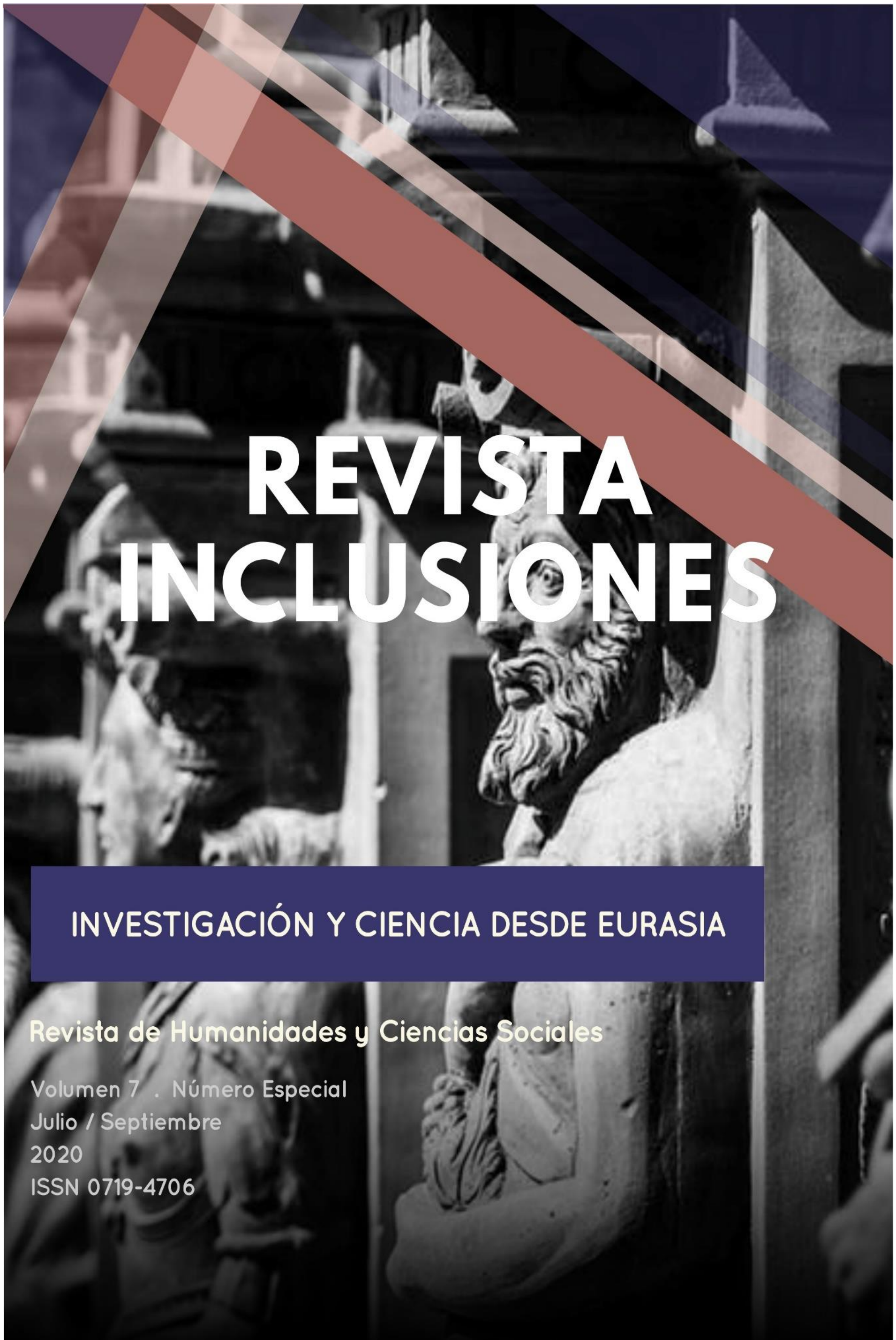

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DEVELOPMENT OF GLOBAL ORGANIC GRAIN MARKET IN THE CONTEXT OF ENERGY EFFICIENCY OF PRODUCTION

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Abstract

The paper explores the economic aspects of the development and operation of the organic grain product subcomplex in the European Union and the USA. The index method is used to provide statistical analysis of the structure of crop areas, yields, gross grain production and market outlook. Specific consideration is given to the production of various types of organic grain, namely, wheat, barley and corn.

Keywords

Organic grain – Index analysis – Fisher – Laspeyres and Paasche formulas

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Introduction

Organic production is a priority of agricultural development in the European Union (EU), Australia, the USA and some countries of Latin America. In Austria, Estonia and Sweden, organic farming accounted for more than 15% of the total crop areas in 2016. Organic products make up almost a quarter of the consumer basket in countries with high income levels. The range of products is diverse, including cereals, bread and bakery products, fruit and vegetable products, meat and dairy products, wine, dried fruit, baby food, cosmetics, animal feeds, etc.[1]

Meanwhile, a considerable share of investment in the organic agriculture system is associated with organic grain production. In Russia, cereals and bread and bakery products account for 25% of all organic consumption, and given the observed growth in popularity of this market segment, stable demand can be expected for organic grain processing products.

Literature review

Many researchers globally have studied the aspects of economic efficiency of organic production.

The list includes A. G. Paptsov[2]
N. D. Avarskii[3]

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[2] A. G. Paptsov, "Rynok kormovogo zerna Kitaya: razvitie i perspektivy", Ekonomika selskokhozyaistvennykh i pererabatyvayushchikh predpriyatii num 8 (2009): 68-69; A. G. Paptsov; G. E. Bykov y A. N. Osipov, "Transnatsionalnye kompanii v zernovom khozyaistve Rossii", Ekonomika selskogo khozyaistva Rossii num 9 (2015): 39-44; A. G. Paptsov; R. R. Araslanov y I. P. Gotovtseva, Development of the Russian grain export capacity in conditions of world consumption growth. Materialy mezhdunarodnoi nauchnoi konferentsii molodykh uchenykh i spetsialistov, posvyashchennoi 150-letiyu so dnya rozhdeniya V. P. Goriachkina, 2018 (pp. 314-316). 2018; A. G. Paptsov; V. Nechaev y P. Mikhailushkin, "Towards to a single innovation space in the agrarian sector of the member states of the Eurasian economic union: a case study", Entrepreneurship and Sustainability Issues Vol: 7 num 1 (2019): 637-648; A. G. Paptsov y V. V. Maslova, "Finansovo-ekonomicheskaya ustoichivost APK v usloviyakh importozameshcheniya: Rossiiskie realii i opyt ES", APK: Ekonomika, upravlenie num 1 (2016): 81-89; A. N. Stavtsev; A. S. Lankin y D. S. Natarov, "Indeksnyi analiz tendentsii na evropeiskom rynke organicheskoi produktsii i perspektivy ego razvitiya v Rossii", Ekonomika selskogo khozyaistva Rossii num 7 (2018): 93-97; N. K. Dolgushkin y A. G. Paptsov, Strategicheskie napravleniya razvitiya rynka organicheskoi produktsii Rossii. Monograph in two parts. Part 2. Under the general editorship of the academicians of the RAS. Moscow: Krasnogorskii poligraficheskii kombinat, OOO, 2019 y G. Paptsov y N. D. Avarskii, Strategicheskie napravleniya razvitiya rynka organicheskoi produktsii Rossii. Monograph in two parts. Part 2. Under the general editorship of the academician of the RAS A. Moscow: VNIRO Publishing House, 2020.

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A. N. Stavtsev[8]
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D. Morison[10]
J. Willer[11]
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The aforementioned authors focused on the significant theoretical, methodological, research and practical aspects of organic agriculture. However, organic market development is yet to be explored in full and no comprehensive studies can be found on the methods of processing of organic grain. Also, under-researched is the problem of energy efficiency in organic agriculture. This, in our view, lends significant relevance to the subject of this research.

Methods

The statistical references of the research included materials of the Research Institute of Organic Agriculture (FiBL)[20], the Statistical Office of the EU (Eurostat)[21] and the National Agricultural Statistics Service of the US Department of Agriculture (NASS)[22]. The analytical retrospective period included the years from 2010 to 2017.

Traditional economic methods were used, including economic and statistical methods, specifically index analysis and calculations of average annual growth, monographic methods (review of 26 sources, specifical publications of Russian and foreign researchers on the subject for the period from 2003 to 2019), analytical method, the method of graphic analysis (combined graphics and histograms of price index and energy consumption dynamics).

Structurally, the research consists of two parts. The first part is an analysis of the operation and development of the grain industry in the EU and the USA. This specifically includes the statistical analysis of crop areas, yields and gross grain production across a range of organic varieties, such as wheat, barley and corn. Various directions of grain processing are discussed. The second part focuses on energy efficiency in organic

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[21] Statistical office of the European Union. Retrieved from: http://ec.europa.eu/eurostat/data/database
[22] Certified Organic Survey 2016 Summary report released on September 20, 2017 by USDA's National Agricultural Statistics Service (NASS).

agriculture and provides an analysis of energy intensity in production, energy availability and the energy market situation[23].

Results

The organic grain market is showing the strongest development in the countries with the strongest demand growth for this type of products. This primarily applies to the EU and the USA. Higher levels of prosperity, compared to Latin America and Asia, create a stronger focus on quality eco-friendly food[24].

Countries	Years					2017 vs. 2013, %	Annual average growth, %
	2013	2014	2015	2016	2017		
Belgium	–	–	–	14,228	14,045	–	–
Bulgaria	2,366	3,014	3,452	3,264	11,135	4.7 times	147.3
Czech Republic	22,769	24,499	26,561	30,859	28,929	127.1	106.2
Estonia	4,542	6,856	11,180	8,969	9,354	2.1 times	119.8
Greece	12,096	23,906	24,371	34,443	25,973	2.2 times	121.1
Spain	42,737	38,570	39,070	37,229	43,987	102.9	100.7
Croatia	7,426	4,493	11,664	19,459	17,416	2.3 times	123.8
Italy	×	211,955	277,636	501,988	620,559	–	143.1
Latvia	11,666	13,106	17,578	17,555	17,970	154.0	111.4
Lithuania	20,202	22,351	36,093	41,917	64,537	3.2 times	133.7
Hungary	39,555	30,369	32,633	37,446	39,259	99.3	99.8
Poland	12,052	15,935	17,313	18,671	17,645	146.4	110.0
Romania	74,285	13,7474	127,231	11,055	104,454	140.6	108.9
Slovenia	611	1,314	1,205	1,461	1,676	2.7 times	128.7
Slovakia	19,528	17,946	19,309	22,742	23,125	118.4	104.3
Finland	12,980	14,900	12,400	7,600	11,100	85.5	96.2
UK	42,559	45,806	42,830	39,361	30,459	71.6	92.0
Sweden	72,700	101,800	109,200	108,300	143,700	197.7	118.6
Serbia	304	798	2,859	3,967	6,018	–	210.9
Turkey	169,287	217,843	247,355	283,824	322,858	190.7	117.5

Source: developed and calculated by the authors based on Eurostat data[25]

Table 1

Production of organic wheat in EU countries, tonnes

According to the Eurostat, wheat production under eco-friendly technologies has risen considerably. Apart from the undoubted leaders, such as France and Germany, organic grain production is also a big focus in the Czech Republic, Italy, Romania, Sweden, Turkey, Slovakia and several other European countries.

Table 1 shows that the annual average growth rates in the last five years exceeded 5% almost everywhere in the EU. The biggest annual increases of wheat production were

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[23] A. G. Paptsov; G. E. Bykov y A. N. Osipov, "Transnatsionalnye kompanii v zernovom khozyaistve Rossii", Ekonomika selskogo khozyaistva Rossii num 9 (2015): 39-44.

[24] N. D. Avarskii; V. V. Taran; Kh. N. Gasanova; A. N. Osipov; E. A. Silko y V. R. Gumerov, "World Biodiesel Market and Optimal Scenarios for Biodiesel Production and use in Russia", International Journal of Innovative Technology and Exploring Engineering (IJITEE) num 8 Vol: 12 (2019): 4026-4038.

[25] Statistical office of the European Union. Retrieved from: http://ec.europa.eu/eurostat/data/database

registered in Poland, Romania, Sweden, the Czech Republic and Slovakia. The only exceptions were Spain and the UK, registering minor declines in production volumes.

A meaningful observation is also that organic barley production is quite advanced in grain farming in the EU, led by Spain, Italy, Romania, Sweden and Turkey. Remarkably, its production is declining in the UK, Lithuania, Estonia and Slovakia due to rising costs, market influences, adverse weather conditions and other internal and external factors. However, the general observation is that there are signs of a steady trend toward less reliance of the European organic barley market on the importing countries (Table 2).

Countries	Years					2017 vs. 2013, %	Annual average growth, %
	2013	2014	2015	2016	2017		
Belgium	×	×	×	3,204	4,434	×	×
Bulgaria	216	477	158	457	877	4 times	142.0
Czech Republic	7,080	7,790	7,618	6,748	7,199	101.7	100.4
Estonia	3,822	3,914	4,892	3,290	3,820	99.9	100.0
Greece	6,774	15,538	12,883	11,932	68,211	×	178.1
Spain	64,770	59,804	55,957	52,826	62,078	95.8	98.9
France	×	×	×	42,365	62,078	×	×
Croatia	988	3,375	2,480	3,409	4,497	4.5 times	146.1
Italy	×	59,097	54,828	82,325	88,645	×	110.7
Latvia	4,414	6,758	5,785	5,586	5,802	131.4	107.1
Lithuania	6,251	6,549	7,345	4,707	4,424	70.8	91.7
Hungary	3,396	5,387	5,319	2,779	3,964	116.7	103.9
Netherlands	3,297	2,660	3,028	3,385	2,139	64.9	89.7
Poland	3,746	4,021	4,742	5,241	5,299	141.5	109.1
Romania	13,476	34,916	20,259	10,571	10,657	79.1	94.3
Slovakia	3,540	3,082	2,840	2,850	2,714	76.7	93.6
Finland	12,380	13,800	9,400	8,100	10,600	85.6	96.2
UK	50,532	43,026	40,704	45,391	32,723	64.8	89.7
Sweden	53,900	47,100	43,100	44,800	58,600	108.7	102.1
Turkey	27,626	36,987	43,928	45,941	54,092	195.8	118.3

Source: developed and calculated by the authors based on Eurostat data[26]

Table 2
Production of organic barley in EU countries, tonnes

Organic corn production in the EU is limited to a relatively small group of countries. In contrast to wheat and barley, corn production on a meaningful scale is only limited to countries such as Poland, Croatia, Hungary and Romania. The strongest production growth in organic corn is observed in countries such as Poland, Croatia, Hungary and Romania. Thus, over the past five years, organic corn production grew by a factor of 3.2 in Poland, 5.4 in Croatia and by more than 30% in Hungary and Romania[27].

[26] Statistical office of the European Union. Retrieved from: http://ec.europa.eu/eurostat/data/database
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On the other hand, the Netherlands has almost withdrawn from organic corn production, and a considerable pace of decline is observed in Croatia and Serbia. Such moderate engagement in organic corn production in European countries is due to lower market interest in this crop compared to wheat and barley. Traditional corn-producing regions, such as the USA and Latin America, show a stronger interest in organic corn (Table 3).

Countries	Years					2017 vs. 2013, %	Annual average growth, %
	2013	2014	2015	2016	2017		
Belgium	–	–	–	836	1,766	–	–
Bulgaria	373	2,216	976	955	1,818	4.9 times	148.6
Poland	2,213	2,506	2,376	3,209	7,076	3.2 times	133.7
Czech Republic	2,583	2,280	2,077	2,556	2,316	89.7	97.3
Greece	32,892	42,779	35,688	42,929	55,679	169.3	114.1
Spain	3,676	10,390	2,737	6,494	3,819	103.9	101.0
France	–	–	–	82,861	145,041	–	–
Croatia	3,213	4,286	11,921	18,273	17,295	5.4 times	152.3
Italy	–	44,062	46,561	53,096	56,940	–	108.9
Netherlands	2,889	1,823	1,286	771	839	29.0	73.4
Hungary	14,218	18,520	11,733	14,522	16,515	116.2	103.8
Romania	55,476	95,403	86,581	55,405	67,175	121.1	104.9
Slovakia	7,858	4,315	2,752	4,843	1,444	18.4	65.5
Serbia	14,854	19,708	9,729	2,533	11,002	74.1	92.8
Turkey	28,818	15,891	28,030	25,245	24,851	86.2	96.4

Source: developed and calculated by the authors based on Eurostat data[28]

Table 3

Production of organic corn in EU countries, tonnes

We used the index method to analyse the dynamics of gross production and yields of grain crops in the EU countries. The input reference data was gathered for the group of countries with available statistics on major production indicators of organic wheat, barley and corn (Table 4). The main assessment criteria were aggregate indices calculated in accordance with the Laspeyres, Paasche and Fisher formulas[29].

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[28] Statistical office of the European Union. Retrieved from: http://ec.europa.eu/eurostat/data/database

[29] A. G. Paptsov; G. E. Bykov y A. N. Osipov, “Transnatsionalnye kompanii v zernovom khozyaistve Rossii”, Ekonomika selskogo khozyaistva Rossii num 9 (2015): 39-44.

Index formula	Index description	
	Index of primary properties	Index of secondary properties
According to the Laspeyres formula	$I_s^L = \frac{\sum s_1 y_0}{\sum s_0 y_0}$	$I_y^L = \frac{\sum y_1 s_0}{\sum y_0 s_0}$
According to the Paasche formula	$I_s^P = \frac{\sum s_1 y_1}{\sum s_0 y_1}$	$I_y^P = \frac{\sum y_1 s_1}{\sum y_0 s_1}$
Fisher index	$I_s^F = \sqrt{\frac{\sum s_1 y_0}{\sum s_0 y_0} \times \frac{\sum s_1 y_1}{\sum s_0 y_1}}$	$I_y^F = \sqrt{\frac{\sum y_1 s_0}{\sum y_0 s_0} \times \frac{\sum y_1 s_1}{\sum y_0 s_1}}$

Table 4
Formulas of aggregate indices

The difference between the numerator and the denominator of the aggregate index of crop areas in organic wheat, barley and corn production according to the Laspeyres formula indicates (Table 5) the absolute change of gross production of organic wheat as a result of the decline in crop areas:

$\Delta w_{(s)} = \sum s_1 y_0 - \sum s_0 y_0$ = 1,311,664 – 1,343,835 = -32,171 tonnes

The difference between the numerator and the denominator of the aggregate index of yields according to the Paasche formula reflects the absolute increase of gross production as a result of higher yields of wheat:

$\Delta w_{(y)} = \sum y_1 s_1 - \sum y_0 s_1$ = 1,554,199 – 1,311,664 = 242,535 tonnes

Index formula	Index description	
	Crop area index	Yield index
According to the Laspeyres formula	0.976	1.197
According to the Paasche formula	0.966	1.185
Fisher index	0.971	1.191

Source: developed and calculated by the authors based on Eurostat data[30]
Table 5
Aggregate indices of gross organic wheat production in the EU

The values of absolute change caused by individual factors add up to the total increase of gross organic wheat production in the analysed set:

$\Delta w = \Delta w_{(s)} + \Delta w_{(y)}$ = 242,535–32,171 = 210,364 tonnes

According to the Laspeyres formula, the expansion of crop areas contributed 24.5 thousand tonnes to the absolute increase in gross production of organic barley (Table 6):

$\Delta w_{(s)} = \sum s_1 y_0 - \sum s_0 y_0$ = 410,384 – 385,907 = 24,477 tonnes

[30] Statistical office of the European Union. Retrieved from: http://ec.europa.eu/eurostat/data/database

Index formula	Index description	
	Crop area index	Yield index
According to the Laspeyres formula	1.063	1.161
According to the Paasche formula	1.100	1.201
Fisher index	1.082	1.181

Source: developed and calculated by the authors based on Eurostat data[31]
Table 6
Aggregate indices of gross production of organic barley in the EU

According to the Paasche formula, yield increase contributed 82.5 thousand tonnes to the absolute increase in production of organic barley:

$\Delta w_{(y)} = \sum y_1 s_1 - \sum y_0 s_1$ = 492,853 – 410,384 = 82,469 tonnes

The values of absolute change caused by individual factors add up to the total change in gross organic barley production in the analysed set:

$\Delta w = \Delta w_{(s)} + \Delta w_{(y)}$ = 24,477 + 82,469 = 106,946 tonnes

The difference between the numerator and the denominator of the aggregate index of crop areas under organic corn according to the Laspeyres formula indicates (Table 7) the absolute decline of gross production of organic corn as a result of the decline in crop areas:

$\Delta w_{(s)} = \sum s_1 y_0 - \sum s_0 y_0$ = 373,020 – 314,528 = 58,492 tonnes

Index formula	Index description	
	Crop area index	Crop area index
According to the Laspeyres formula	1.186	1.111
According to the Paasche formula	1.183	1.109
Fisher index	1.185	1.110

Source: developed and calculated by the authors based on Eurostat data[32]
Table 7
Aggregate indices of gross organic corn production in the EU

According to the Paasche formula, yield increase contributed 40.5 thousand tonnes to the absolute increase in production of organic corn:

$\Delta w_{(y)} = \sum y_1 s_1 - \sum y_0 s_1$ = 413,576 – 373,020 = 40,557 tonnes

The values of absolute change caused by individual factors add up to the total decline of gross organic corn production in the analysed set:

$\Delta w = \Delta w_{(s)} + \Delta w_{(y)}$ = 58,492+40,557 = 99,048 tonnes

[31] Statistical office of the European Union. Retrieved from: http://ec.europa.eu/eurostat/data/database
[32] Statistical office of the European Union. Retrieved from: http://ec.europa.eu/eurostat/data/database

The USA has traditionally been a strategically important player in the market of organic agricultural produce in general and specifically grains.

The range of US organic agriculture is quite extensive. Organic feed crops are cultivated, specifically perennial hay crops and haylage, but the biggest priorities are organic wheat, barley and corn[33] (Table 8).

Indicators	Crop areas, ha		Yields, tonnes per ha		Gross production, tonnes	
	2015	2016	2015	2016	2015	2016
Barley	20,585	20,758	2.88	2.85	59,199	59,166
Corn	67,571	86,643	6.94	7.49	469,094	649,295
Wheat	122,290	136,303	2.01	2.11	245,394	287,174

Source: developed and calculated by the authors based on USDA data[34,35]

Table 8

Production of organic grain crops in the USA in 2015-2016

According to the NASS, the 2016 levels of gross organic production stood at 650 thousand tonnes for corn, 59 thousand tonnes of barley and almost 290 thousand tonnes of wheat. That said, the considerable growth of production was observed for organic corn and organic wheat. Wheat yields were comparable to the European figures, meanwhile, US producers registered much higher levels for organic corn and organic barley (Table 9).

Indicators	Physical sales volume, tonnes		Revenue, thousand $		Price, $/ton		Price increase, %
	2015	2016	2015	2016	2015	2016	
Barley	47,761	42,183	19,272	16,866	403.5	399.8	99.1
Corn	296,888	462,737	129,067	163,878	434.7	354.1	81.5
Wheat	214,100	243,265	108,625	107,130	507.4	440.4	86.8

Source: developed and calculated by the authors based on USDA data[36,37]

Table 9

Prices for organic grain crops in the USA in 2015-2016

Sales revenues on organic grain in 2016 equalled $289.9 million, including $16.9 million for barley, $163.9 million for corn and $107.1 million for wheat (Table 10).

[33] N. D. Avarskii; V. V. Taran y Zh. E. Sokolova, "Zarubezhnyi opyt formirovaniya organizatsionnykh struktur, reguliruyushchikh razvitie rynkov organicheskoi produktsii", Srednerusskii vestnik obshchestvennykh nauk Vol: 13 num 3 (2018): 154-184.

[34] Certified Organic Survey 2016 Summary report released on September 20, 2017 by USDA's National Agricultural Statistics Service (NASS).

[35] Official website of the US Department of Agriculture USDA. Retrieved from: https://www.usda.gov/

[36] Certified Organic Survey 2016 Summary report released on September 20, 2017 by USDA's National Agricultural Statistics Service (NASS).

[37] Official website of the US Department of Agriculture USDA. Retrieved from: https://www.usda.gov/

Indicators	Individual indices		
	Sales volume index	Price index	Revenue index
Barley	0.999	0.876	0.875
Corn	1.384	0.917	1.270
Wheat	1.170	0.843	0.986

Source: developed and calculated by the authors based on USDA data[38]

Table 10

Individual indices of sales, prices, revenues for organic grain crops produced in the USA

The above indices we calculated indicate that the main trend in organic grain crops in the USA is toward scaling the production volumes with consequent price declines in the domestic market. Moreover, sales volumes were growing in organic corn and organic wheat. However, despite that, declining prices in 2016 led to lower revenues in organic wheat. This trend reflects the response of the US agricultural market to the considerable supply growth in organic grain crops over the past 3-4 years. As long as demand growth is slower, such price fluctuations are a logical consequence. The strategic role of organic grain crops and products contribute to their priority status in ensuring food security both on the global scale and in individual countries[39].

In our view, the most promising directions of organic wheat processing include the production of bread and bakery products, certified organic alcohol, feeds for eco-friendly animal farming and deep processing to produce items such as starch, gluten and dried distillers grains (Figure 1).

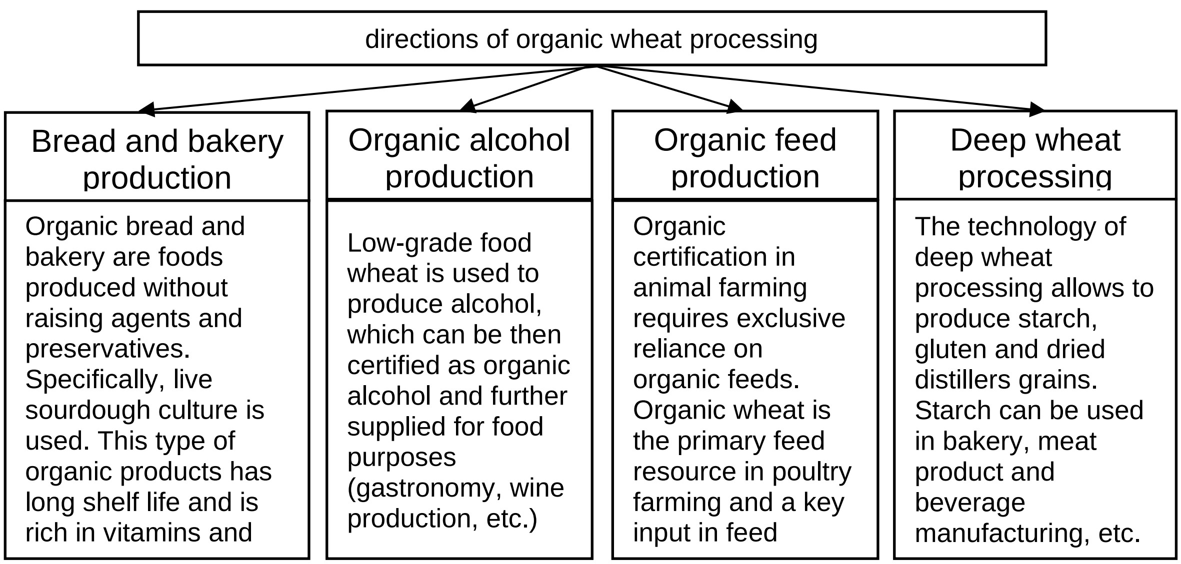

Figure 1

Priority directions of organic wheat processing

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[38] Certified Organic Survey 2016 Summary report released on September 20, 2017 by USDA's National Agricultural Statistics Service (NASS) y Official website of the US Department of Agriculture USDA. Retrieved from: https://www.usda.gov/

[39] N. K. Dolgushkin y A. G. Paptsov, Strategicheskie napravleniya razvitiya rynka organicheskoi produktsii Rossii. Monograph in two parts. Part 2. Under the general editorship of the academicians of the RAS. Moscow: Krasnogorskii poligraficheskii kombinat, OOO, 2019.

Gluten is a natural protein complex derived by the process of separation followed by milling and drying. Technology preserves the health properties of proteins. Wheat gluten is a crucial ingredient in bread and bakery production and meat product manufacturing.

Dried distillers grains with solubles (DDGS) are the by-products of grain distillery, including bran, yeast and gluten. DDGS is a high-protein feed for cattle, pigs and poultry. Such feed is dried for extended storage. However, if it is sold close to the place of production, it is used in the wet form. The main advantage of DDGS is high protein content (up to 40-45%).

High-protein DDGS feeds may well serve for the daily diet of cattle. For pigs and poultry, DDGS may cover up to 20% of the daily diet. Feeding on DDGS can result in higher growth by up to 30%, higher milk cow productivity and increased milk fat content at lower cost[40].

In our view, the most promising directions of organic barley processing include the production of beer, cereals, organic feeds and orzo coffee (barley coffee substitute) (Figure 2).

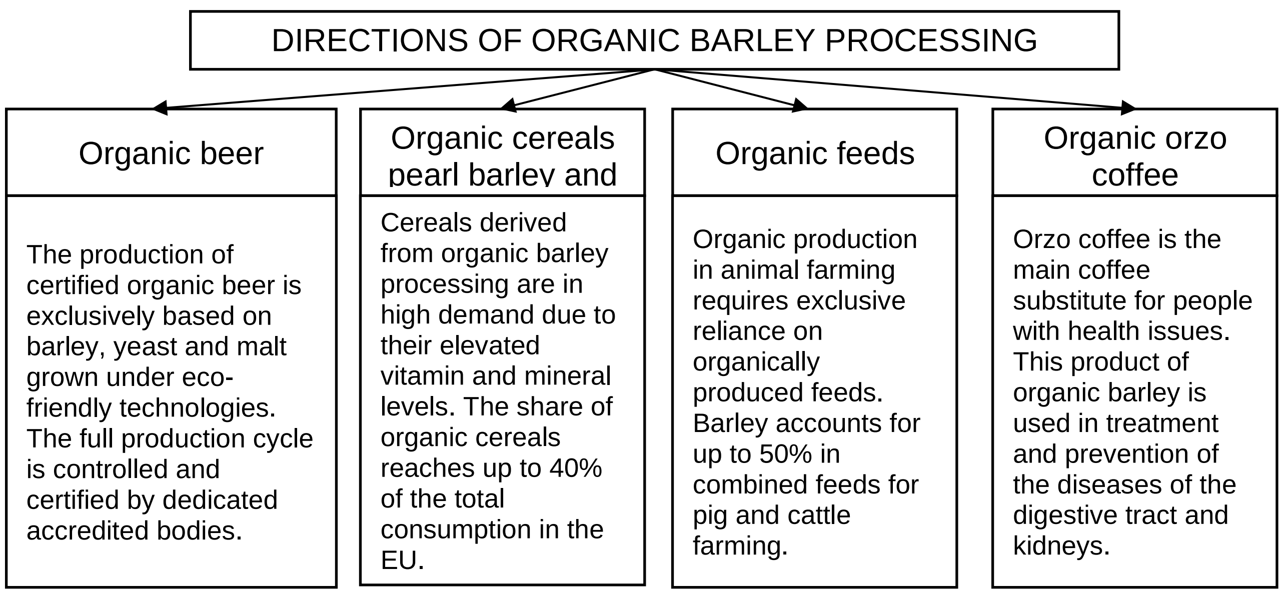


Figure 2
The most promising directions of organic barley processing

For the most part, organic corn output is sold to consumers as canned products. However, as production grows, the issues of organic corn processing gain relevance.

[40] J. Sanders; M. Stolze y S. Padel. (eds.), Use and Efficiency of Public Support Measures Adressing Organic Farming. Study Report. Institute of Farm Economics. Johan Heinrich von Thunen Institute. Federal Research Institute for Rural Areas Forestry and Fisheries. Braunschweig, 2011; N. D. Avarskii; V. V. Taran y Zh. E. Sokolova, “Zarubezhnyi opyt formirovaniya organizatsionnykh struktur, reguliruyushchikh razvitie rynkov organicheskoi produktsii”, Srednerusskii vestnik obshchestvennykh nauk Vol: 13 num 3 (2018): 154-184 y A. G. Paptsov, “Rynok kormovogo zerna Kitaya: razvitie i perspektivy”, Ekonomika selskokhozyaistvennykh i pererabatyvayushchikh predpriyatii num 8 (2009): 68-69.

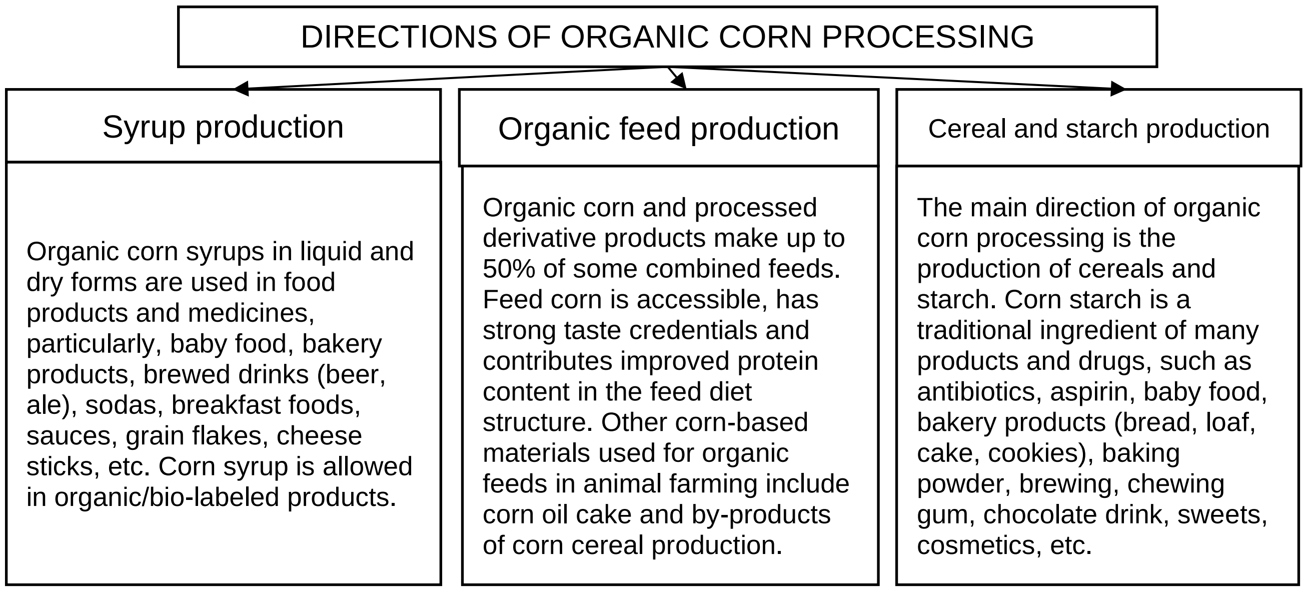


Figure 3
The most promising directions of organic corn processing

As can be seen from Figure 3, the most promising directions include the production of corn syrups, cereals and starches and sales of the by-products of corn processing as organic feeds[41].

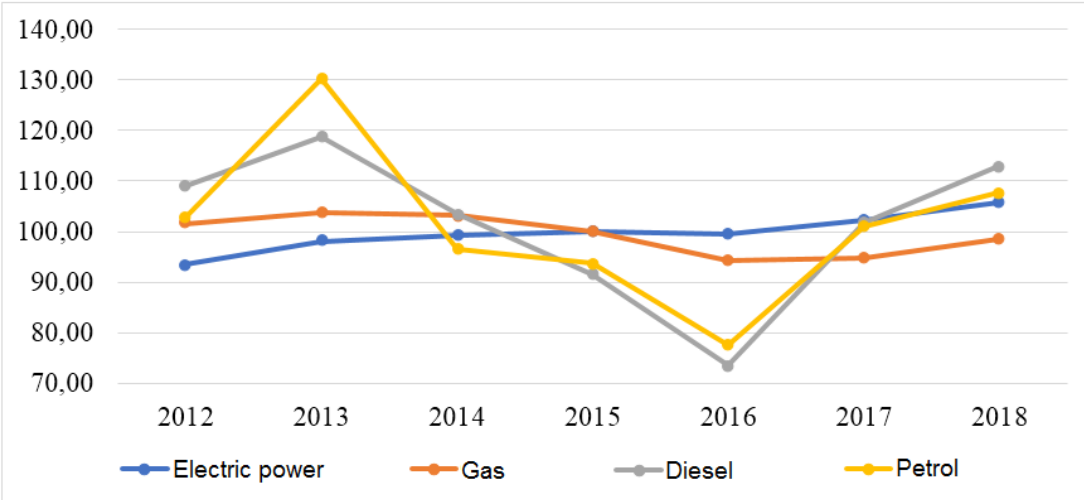
Energy supply is a key criterion of competitiveness, a major productivity driver and a requisite condition of innovation technology adoption at the current stage of agricultural development in the global economy (Table 11).

Indicators	Years							
	2010	2011	2012	2013	2014	2015	2016	2017
GDP energy intensity in the EU, kgoe per 1,000 EUR	141.5	134.5	133.5	131.6	124.6	123.6	122.0	121.0
Growth rate, %	×	95.0	99.3	98.5	94.7	99.2	98.7	99.1

Source: developed and calculated by the authors based on Eurostat data[42]
Table 11
GDP energy intensity in the EU economy

According to the Eurostat, the GDP energy efficiency level in the European economy declined significantly in the past seven years to 121 kgoe per 1,000 EUR in 2017. In our view, this positive trend is primarily due to the adoption of energy-efficient technologies and higher productivity levels (Figure 4).

[41] I. A. Tsvetkov; A. V. Belokopytov y M. V. Belokopytov, “Problemy i perspektivy razvitiya proizvodstva organicheskoi selskokhozyaistvennoi produktsii”, Vestnik Rossiiskogo gosudarstvennogo agrarnogo zaochnogo universiteta num 24 Vol: 29 (2017): 76.
[42] Certified Organic Survey 2016 Summary report released on September 20, 2017 by USDA’s National Agricultural Statistics Service (NASS).



Source: developed by the authors based on Eurostat data[43]

Figure 4

Price indices for major energy sources used in agriculture

The energy-saving system in agriculture is based on the efficient use of fuel and energy sources in production processes. In terms of economic efficiencies, energy-saving is a way to ensure agricultural production of proper quality standards at minimum possible cost.

Energy price regulation is especially relevant for cross-sector interaction considerations in agriculture. The advanced growth in energy tariffs caused disruptions to the equivalence of cross-industry exchange. The transition of agricultural human jobs to materialised industrial labour proved an economic disadvantage for most agricultural operations. The market of industrial resources has further lost its appeal for agriculture[44].

Notably, the organic agricultural sector of the EU almost completely relies on energy imports, which means energy prices in monetary terms depend considerably on the outlook of the hydrocarbon market. Specifically, Figure 5 shows that diesel and petrol prices followed oil prices down and fell significantly compared to 2015.

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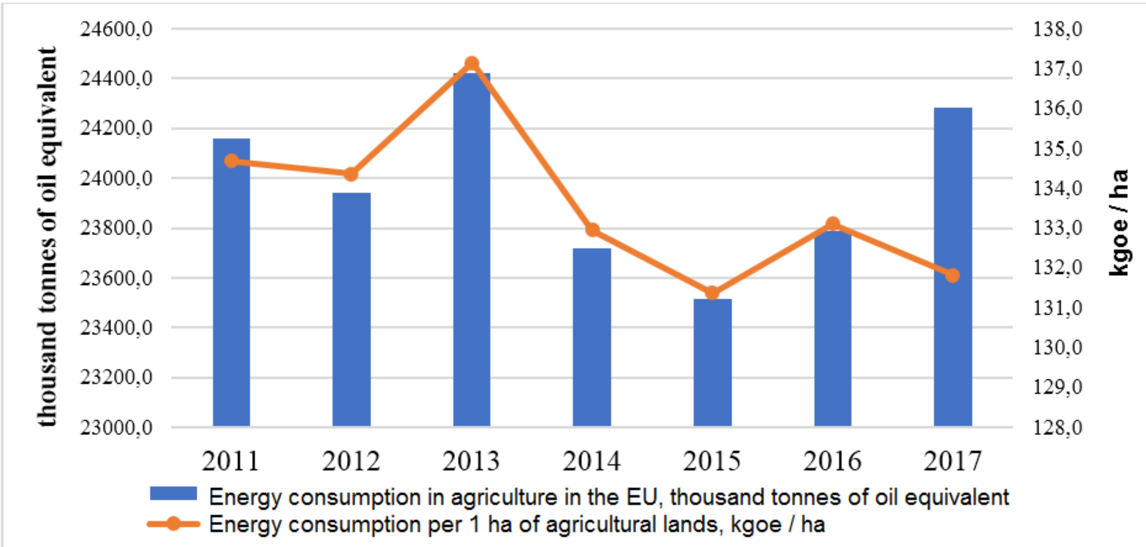
[43] Statistical office of the European Union. Retrieved from: http://ec.europa.eu/eurostat/data/database

[44] N. D. Avarskii; G. E. Bykov; V. G. Bykov y M. E. Novoselov, “Organizatsionno-ekonomicheskie predposylki razvitiya proizvodstva i realizatsii zerna kukuruzy v stranakh BRIKS”, Ekonomika selskogo khozyaistva Rossii num 1 (2017): 92-99; A. G. Paptsov; G. E. Bykov y A. N. Osipov, “Transnatsionalnye kompanii v zernovom khozyaistve Rossii”, Ekonomika selskogo khozyaistva Rossii num 9 (2015): 39-44 y A. N. Stavtsev; A. S. Lankin y D. S. Natarov, “Indeksnyi analiz tendentsii na evropeiskom rynke organicheskoi produktsii i perspektivy ego razvitiya v Rossii”, Ekonomika selskogo khozyaistva Rossii num 7 (2018): 93-97.



Source: developed by the authors based on Eurostat data[45]

Figure 5
Energy consumption in agriculture in the EU

The research shows a rise in agricultural energy consumption in the EU in 2017, while energy intensity in agriculture is generally lower. this is particularly due to energy-efficient technologies and partial transition to alternative energy sources.

Conclusion

Organic grain production in the EU and the USA is now a fully established and efficient direction of agricultural business. The organic grain production cluster, specifically, corn, barley and wheat production, has shown very significant growth recently.

Remarkably, the EU and US markets of organic grain crops are not only driven by local demand and demand from importing countries, but also get support as a result of dedicated government efforts.

Simultaneously, the use of energy-efficient systems and alternative energy sources remains a key problem for organic agriculture globally, primarily due to constantly rising prices for major fuels and energy sources.

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