Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 24, Issue 3, 2024
PRINT ISSN 2284-7995, E-ISSN 2285-3952

TRITICALE - AN ALTERNATIVE CEREAL FOR FOOD INDUSTRY IN THE WORLD, EU-27 AND ROMANIA

Dorina BONEA

University of Craiova, Faculty of Agronomy, 19, Libertatii Street, Dolj County, Romania, Phone/Fax: +40 251 418 475, E-mail: dorina.bonea@edu.ucv.ro; dbonea88@gmail.com

Corresponding author: dbonea88@gmail.com

Abstract

In the context of global food security and the intensification of sustainable agriculture, triticale has become a relevant alternative cereal in food industry. In this paper, the status of triticale crop in the world, EU-27 and Romania was analyzed based on the data provided by the FAOSTAT platform for cultivated area, production quantity and yield. The results showed that in 2022, worldwide, the area cultivated with triticale was 3,616.7 thousand ha, the production quantity was 14,157.9 thousand tons, and the yield 3,914 kg/ha. In the same year, the EU-27 held 71.5% of the world cultivated area, producing 79.6% of the world production of triticale and obtaining a yield of 4,362 kg/ha, higher by 11.4% compared to the world yield. The main producers of triticale, by production, both in the world and in the EU-27 were Poland, Germany and France. Romania occupied the 10th place in the world and the 6th place in the EU-27 in terms of cultivated area (57 thousand ha), as well as the 8th place in the EU-27 in terms of production (192.4 thousand tons). In order to increase the amount of triticale-based food products, it is necessary to develop and use high-quality varieties that meet market demands, but also the development of new processing technologies.

Key words**:** *cultivated area, production quantity, triticale, yield*

INTRODUCTION

Wheat, rice and maize are the most widely grown and consumed traditional grains in the world, providing a large part of human nutrition requirements, but when food security is considered there is a need to increase the production of alternative, non-traditional cereals. Currently, improving the compatibility between environmental management and food security is a worldwide emergency due to climate change, rapid population growth, and the current consumer preference for healthier foods.

Triticale is one of the alternative, non-traditional cereals that offer promising solutions to these challenges/problems, through its good environmental adaptability and nutritional composition. According to [24], triticale market size will grow from USD 554.22 million in 2023 to USD 640 million by 2028.

Triticale (x *Triticosecale* Witt.) from the Poaceae (Gramineae) family is an amphiploid obtained from the artificial hybridization between tetraploid wheat (*Triticum aestivum*) and rye (*Secale cereale*). The first hybrid between these two species was obtained in 1875 by the botanist Wilson (Scotland), but it was sterile. Later, in 1888, through spontaneous chromosome doubling, Rimpau (Germany) developed the first viable hybrid between these species, and in 1968, the first commercial variety was released in Hungary. Therefore, European countries can be considered the pioneers in the creation and breeding of this species [1].

In Romania, in 1927, the first wheat-rye hybrids were described by Saulescu, and the first octoploid form of triticale was obtained by Priadcencu in 1939, but a breeding program for triticale was initiated in 1971 at ICCPT Fundulea [12].

By creating this species, the researchers combined the most valuable traits of wheat (baking quality, early maturity, large number of ears in the ear, large number of grains in the ear and high grain weight) with the valuable traits of rye (resistance to drought, heat, diseases, pests, and high utilization capacity of poorly productive soils) [11, 12, 18].

According to the specialized literature, the chemical composition and nutritional

properties of triticale vary significantly due to the rather large number of genotypes.

The unique nutritional value of triticale grains is due to a higher content of proteins and essential amino acids (especially lysine), total carbohydrates, macro elements (i.e. potassium and phosphorus) [2], phytoestrogen, alkylresorcinols and vitamins [7], compared to wheat and rye grains.

In terms of exchangeable energy content, on average, triticale exceeds wheat and rye by 14% and 23%, respectively, and the consumption of these fiber-rich triticale grains can reduce the risk of weight gain and, consequently, help reducing cardiovascular disease and controlling type 2 diabetes [15].

In a previous study carried out on eight Polish varieties of triticale, [7] reported the following chemical composition in triticale grains: protein 11.8% - 15.2%, lipids 1.9% - 2.4%, starch 60.8% - 67.6%, ash 1.6% - 2%, lignin 2.1% - 3.2%, dietary fibber 11.7% - 13.6%, total phenolic content 1.3 - 1.6 mg GAE/g, insoluble non-starch polysaccharides 7.7% - 9.1% and soluble non-starch polysaccharides 1.5% - 2.8%. A better mineral balance, higher lysine content and a better protein digestibility make triticale a suitable substitute or supplement for other cereals in food or feed [2]. Although the main destination of triticale grains is the use in animal nutrition, many previous studies have indicated that it can also be used in human nutrition (bakery, malt, pastry, crackers, macaroni, soups, bars of cereals, etc.) [5, 8, 16, 28].

Its use on a large scale in the production of bread is hindered by the quantitative and qualitative insufficiency of gluten, which is why triticale flour is indicated especially for the preparation of unleavened dough products, such as crackers and other similar products [10]. However, flour obtained from triticale can be used to obtain good quality bread through new technologies. For example, adding maltodextrins of potato to triticale flour [23], mixing triticale flour with 5% and 10% bran [16], or co-processing several cereals such as triticale, wheat and rye in a ratio of 40:50:10 [14], triticale and oats in a ratio of 90:10 [8], proved to be very promising in obtaining quality bread.

In another study, [7] found that it is possible to obtain quality bread from triticale alone, by using modern varieties suitable for baking. The realization of some improvements in grain plumpness and colour, quantity and quality of gluten, could make triticale more attractive as a food cereal [21].

In addition to its nutritional advantages, the triticale crop stands out compared to wheat through other agronomic traits, namely, resistance to abiotic stresses (drought, heat, cold), biotic stresses (diseases, pests), high productivity, relatively low soil requirements [4, 5, 21, 26], traits that have contributed to increasing its popularity, especially among organically farmers. According to [17], triticale produces 11% more grain yield per acre than wheat and 19% more when grown with less fertilizer. Since the triticale crop germinates and develops quickly covering the land completely, it prevents the development of weeds through the lack of light, and farmers can thus avoid herbicides [10].

In the context of the above, this paper aims to present information regarding the triticale culture as an alternative, non-traditional cereal for the food industry, globally, EU-27 and Romania, highlighting its advantages and the evolution of cultivated area, production and yield.

MATERIALS AND METHODS

This paper was carried out on the basis of data from the FAOSTAT [6] platform and research articles.

The main indicators studied were: the cultivated area, the production quantity and the yield of triticale in the world, EU-27 and Romania. The statistical parameters used, namely, average, standard deviation (STDEV), coefficient of variation (CV), regression equations (y), coefficient of determination (R^2), coefficient of correlation (r) were calculated using the EXCEL program.

RESULTS AND DISCUSSIONS

The world triticale cultivated area, production quantity and yield

In the world, in 1975, 467 ha were cultivated with triticale and the production was 1,200 tons. An impressive growth of the triticale crop was registered in the period 2001-2016, respectively 34.8 times in cultivated area (the largest producing region being Europe with 90.4%) and 79 times in production, compared to the period 1975-1983, when the largest producing region was Oceania with 70.9% [9]. For 2022, the area cultivated with triticale worldwide was 3,616.7 thousand hectares, and the production was 14,157.9 thousand tons. The first ten producers of triticale in the world, by cultivated area and their share were: Poland (34.1%), Belarus (11.2%), France (9.4%), Germany (9%), Spain (7.8%), China (5.5%), Turkey (2.8%), Lithuania (1.7%), Australia (1.7%) and Romania (1.6%).

The top ten triticale producers, by production, and their share were: Poland (38.4%), Germany (13.6%), France (11.4%), Belarus (8.4%), Spain (4.5%), China (2.7%), Turkey (2.3%), Russian Federation (2.2%), Australia (2.1%) and Czechia (1.5%).

The world average of yield was 3,914 kg/ha, the highest yields/ha being obtained by Belgium (6,897 kg/ha), Luxembourg (6,475 kg/ha), Denmark (6,475 kg/ha), Switzerland (6,016 kg/ha), Germany (5,948 kg/ha), Austria (5,686 kg/ha), Sweden (5,673 kg/ha), Netherlands (5,583 kg/ha), Chile (5,556 kg/ha), Czechia (5,117 kg/ha)(Table 1).

Table 1. Top ten triticale producers in the world, by cultivated area, production and yield, 2022

Rank	Cultivated area			Production quantity			Yield		
	Country	Thousand ha	Share in the world (%)	Country	Thousand tons	Share in the world (%)	Country	kg/ha	Share in the world (%)
	Total world	3,616.7	100	Total world	14,157.9	100	Total world	3,914	100
1	Poland	1,232.7	34.1	Poland	5,440.3	38.4	Belgium	6,897	176.2
2	Belarus	406.0	11.2	Germany	1,929.7	13.6	Luxembourg	6,475	165.4
3	France	339.7	9.4	France	1,613.7	11.4	Denmark	6,303	161.0
4	Germany	324.4	9.0	Belarus	1,192.9	8.4	Switzerland	6,016	153.7
5	Spain	280.4	7.8	Spain	634.9	4.5	Germany	5,948	152.0
6	China, Mainland	199.7	5.5	China, Mainland	386.1	2.7	Austria	5,686	145.3
7	Turkey	99.6	2.8	Turkey	320.0	2.3	Sweden	5,673	144.9
8	Lithuania	63.1	1.7	Russian Federation	306.9	2.2	Netherlands	5,583	142.6
9	Australia	61.9	1.7	Australia	292.9	2.1	Chile	5,556	141.9
10	Romania	57.0	1.6	Czechia	207.6	1.5	Czechia	5,117	130.7

Source: Own design and processing based on the data from [6].

Although triticale has several advantages compared to wheat and rye, and the demand for healthier food products has favoured the popularization of this species, the worldwide cultivated area and production are still low.

Comparing the value of the studied indicators from 2022 with the values from 2013 (3,807.1 thousand ha, 14,462.3 thousand tons and 3,799 kg/ha, respectively) a slight decrease can be observed, except for yield [6].

[27] believes that expanding the use of triticale in food products by increasing the quality of flour, could lead to an increase in the world's amount of food, especially in the scenario of climate changes and population growth. For this, plant breeders are tasked with identifying and developing new varieties with superior quality to meet market needs [25].

The EU-27 triticale cultivated area, production quantity, and yield

In 2022, the area cultivated with triticale in the EU-27 was 2,585.2 thousand hectares, representing 71.5% of the world area, and the production was 11,276.7 thousand tons, representing 79.6% of the world production. The first ten producing countries in EU-27, by cultivated area and their share were: Poland (47.7%), France (13.1), Germany (12.5%), Spain (10.8%), Lithuania (2.4%), Romania

(2.2%), Hungary (2.1%), Austria (2.1%), Czechia (1.6%) and Sweden (1.1%) (Table 2).
The first ten triticale producing countries, by production quantity and their share were: Poland (48.2%), Germany (17.1%), France (14.3%), Spain (5.6%), Austria (2.6%), Czechia (1.8%), Lithuania (1.8%), Romania (1.7%), Hungary (1.7%) and Sweden (1.4%).
The average yield of triticale in the EU-27 was 4,362 kg/ha, higher by 11.4%, compared to the global level, the highest yields being obtained in Belgium (6,897 kg/ha), Luxembourg (6,475 kg/ha), Denmark (6,303 kg/ha), Germany (5,948 kg/ha), Austria (5,686 kg/ha), Sweden (5,673 kg/ha), Netherlands (5,583 kg/ha), Czechia (5,117 kg/ha), Slovenia (4,864 kg/ha) and France (4,750 kg/ha) (Table 2).
It is surprising that although Poland ranks first both worldwide and at the EU-27 level for cultivated area and production, it is only ranked 15th in the world and 13th at the EU-27 level for yield, with 4,413 kg/ha [6].
The advantage of the expansion of triticale crops in Poland is represented by the high demand for feed cereals on the domestic market, as a result of the expansion of poultry, pig, and cattle farms [13, 25]. Furthermore, in Eastern Poland, where acidic soils and a cold climate predominate, rye has been replaced by triticale in bread production [5].

Table 2. Top ten triticale producers in the EU-27, by cultivated area, production and yield, 2022

Rank	Cultivated area			Production quantity			Yield		
	Country	Thousand ha	Share in the world (%)	Country	Thousand tons	Share in the world (%)	Country	kg/ha	Share in the world (%)
	Total EU-27	2,585.2	100	Total EU-27	11,276.7	100	Total EU-27	4,362	100
1	Poland	1,232.7	47.7	Poland	5,440.3	48.2	Belgium	6,897	158.1
2	France	339.7	13.1	Germany	1,929.7	17.1	Luxembourg	6,475	148.4
3	Germany	324.4	12.5	France	1,613.7	14.3	Denmark	6,303	144.5
4	Spain	280.4	10.8	Spain	634.9	5.6	Germany	5,948	136.3
5	Lithuania	63.1	2.4	Austria	292.9	2.6	Austria	5,686	130.3
6	Romania	57.0	2.2	Czechia	207.6	1.8	Sweden	5,673	130.1
7	Hungary	55.3	2.1	Lithuania	204.6	1.8	Netherlands	5,583	128.0
8	Austria	51.5	2.0	Romania	192.4	1.7	Czechia	5,117	117.3
9	Czechia	40.6	1.6	Hungary	186.5	1.7	Slovenia	4,864	111.5
10	Sweden	28.6	1.1	Sweden	162.5	1.4	France	4,750	108.9

Source: Own design and processing based on the data from [6].

The Romania triticale cultivated area, production quantity, and yield

In 2022, Romania occupied the 10th place in the world in the area cultivated with triticale and the 6th place in the EU-27. In the same year, Romania's contribution to world triticale production was 1.4%, and to EU-27 production it was 1.7% (Tables 1 and 2).
Analyzing the evolution of the area cultivated with triticale in the period 2013-2022, a downward trend was observed with a decrease rate of 33.1%. In 2022, the cultivated area decreased to 57 thousand ha compared to 72.5 thousand ha in 2013 (-21.4%) (Figure 1).
Regarding the evolution of triticale production in the period 2013-2022, a slightly downward trend was observed, with a decrease rate of 6.8%. The lowest production was recorded in 2022 (192.4 thousand tons), 21.5% lower than in 2013 (Figure 2).
For yield, the trend was slightly upward in the analyzed period, the growth rate being 2.3%. The highest triticale yields were recorded in 2017 and 2018 (4,139 kg/ha, respectively 4,272 kg/ha), and the lowest yields in 2020 (3,197 kg/ha) and 2022 (3,376 kg/ha) (Figure 3).
Crop yield is a complex trait influenced by both genetic and agro-ecological factors (drought, heat, agricultural practices, soil, plant protection, etc.) [3].
The first Romanian variety of triticale was released in 1984 by NARDI Fundulea [12], and currently 11 autumn varieties created by NARDI Fundulea are registered in the Official Catalogue [20], the most recently released

being the varieties Zaraza (in 2021) and FDL Ascendent (in 2022).

According to [19], the years 2020 and 2022 were years of extreme drought for Romania. In these extremely dry years in the southern part of Romania (ARDS Teleorman), the new Romanian varieties of triticale managed to exceed the yield reported at the national level (3,197 kg/ha in 2020, and 3,376 kg/ha in 2022, respectively), the variety Zaraza achieving 5,235 kg/ha in 2020 and 6,393 kg/ha in 2022, and the variety FDL Ascendent achieving 4,953 kg/ha, and 6,685 kg/ha, respectively [26]. Also, in the pedoclimatic conditions of central Moldova (ARDS Secuieni), the Zaraza variety achieved 6,689 kg/ha in 2020 and 7,119 kg/ha in 2022 [22].

Therefore, by including these modern varieties in their farms, Romanian farmers could ensure better yields in unfavourable years.

The calculated coefficients of variation were small for all the indicators studied (cultivated area, production and yield of triticale), and they did not vary too much and remained relatively homogeneous (Table 3).

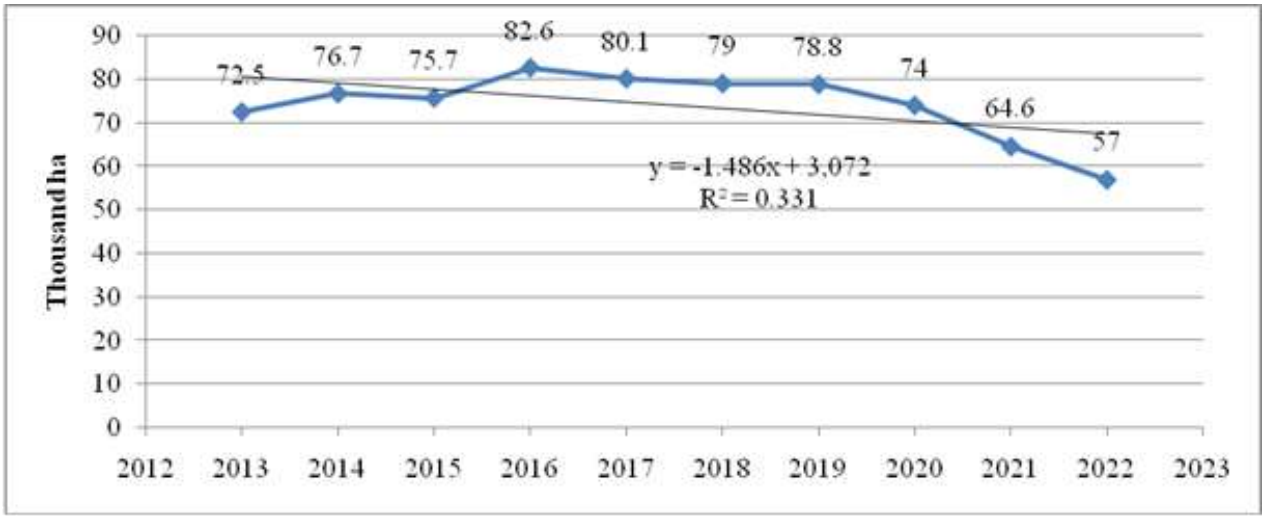

Fig. 1. The evolution of Romania's triticale cultivated area in the period 2013-2022
Source: Own design and processing based on the data from [6].

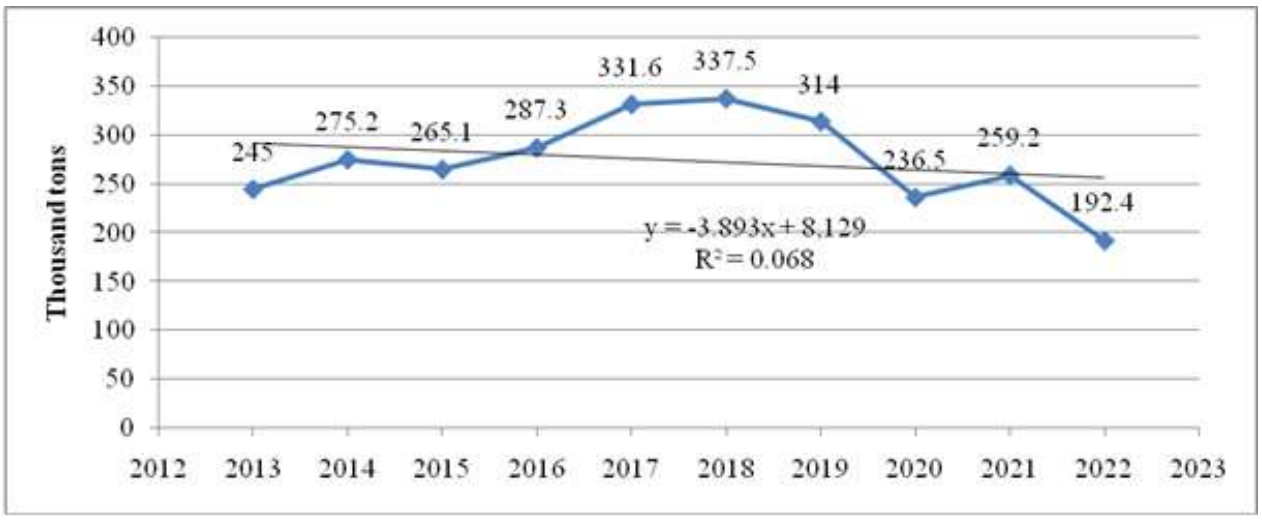

Fig. 2. The evolution of Romania's triticale production quantity in the period 2013-2022
Source: Own design and processing based on the data from [6].

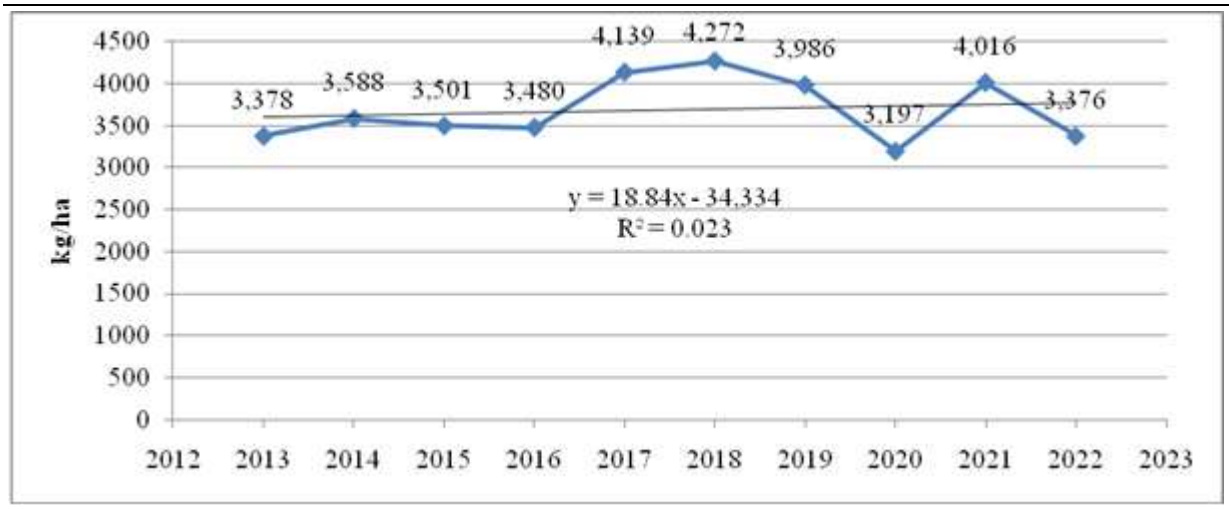

Fig. 3. The evolution of Romania's triticale yield in the period 2013-2022
Source: Own design and processing based on the data from [6].

Table 3. Average, standard deviation (STDEV) and variation coefficients (CV) for cultivated area, production and yield of triticale, Romania, 2013-2022

Indicators studied	Average	STDEV	CV (%)
Cultivated area (thousand ha)	74.1	7.8	10.5
Production quantity (thousand tons)	274.4	45.1	16.4
Yield (kg/ha)	3,693.3	374.7	10.1

Source: Own design and processing based on the data from [6].

The regression equations showed that the increase by one hectare of the area cultivated with triticale caused an increase in the production of triticale by 4.61 units, and the increase by one kg/ha in the yield caused an increase in the production of triticale by 0.09 units (Table 4).

The correlation coefficients between cultivated area and production (r = 0.798), as well as between yield and production (r = 0.800), were positive and significant, showing that triticale production was influenced by both cultivated area and yield. A positive but weak correlation coefficient was recorded between cultivated area and yield (r = 0.281), expressing an insignificant relationship.

Based on the coefficients of determination, it was established that 64% of the variation in triticale production was caused by the yield variation; also 63.7% of the variation in triticale production was determined by the variation in cultivated area (Table 4).

Table 4. Regression equations and correlation coefficients between the indicators characterizing production of triticale

Indicators studied	Regression equation (y)	Determination coefficient (R^2)	Correlation coefficient (r)
Production quantity and cultivated area	y = 4.614x – 67.54	R^2 = 0.637	r = 0.798**
Yield and cultivated area	y = 13.49x + 2,693	R^2 = 0.079	r = 0.281^{ns}
Production quantity and yield	y = 0.096x – 81,54	R^2 = 0.640	r = 0.800**

**- significant positive at 0.01 level; ns - non-significant
Source: Own design and processing based on the data from [6].

Table 5 presents the average values (2013-2022) of cultivated areas, productions and yields for the main small-grain cereals grown in Romania. Comparing the cultivated areas and productions at the national level, it can be seen that triticale occupied the 4th place among small grain cereals, after wheat, barley and oats. Even though these values are much lower than for wheat, they are significantly higher than for rice and rye. Also, the average yield obtained by triticale (3,925 kg/ha), which places it in 2nd place among small-grain cereals, reflects the good potential of this alternative cereal.

Table 5. Averages of cultivated areas, production quantities and yields for the main small-grain cereals in the period 2013-2022, Romania

Cereal	Cultivated area (thousand ha)	Production quantity (thousand tons)	Yield (kg/ha)
Wheat	2,127.8	8,726.1	4,101
Barley	460.1	1,718.4	3,750
Oats	145.9	321.6	2,205
Triticale	74.1	274.4	3,925
Rye	10. 7	28.0	2,633
Rice	8.4	37.5	4,467

Source: Own design and processing based on the data from [6].

In the analyzed period 2013-2022, Romania's potential for the export and import of triticale recorded an upward trend as a result of the increase in interest for this species, the highest values being recorded in 2020 (Figure 4).

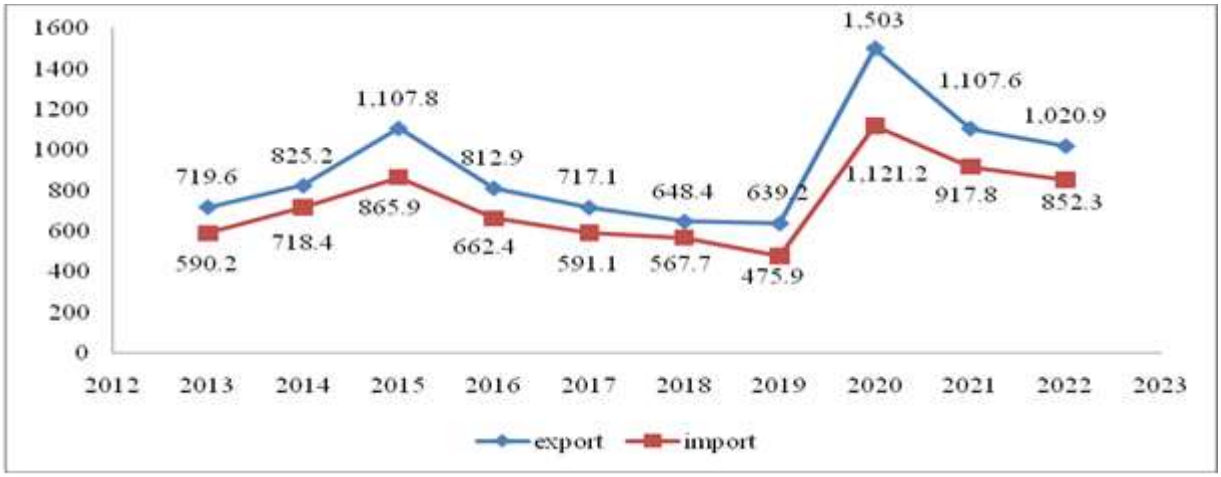

Fig. 4. The import and export of triticale (thousand tons) in Romania in the period 2013-2022
Source: Own design and processing based on the data from [6].

CONCLUSIONS

The data analysis showed that, although the demand for healthier food products has favoured the popularization of this species, the cultivated area and world production are still low.

In 2022, worldwide the area cultivated with triticale was 3,616.7 thousand ha, production quantity of 14,157.9 thousand tons, and yield of 3,914 kg/ha. In the same year, the EU-27 represented 71.5% of the world cultivated area, producing 79.6% of the world production of triticale and obtaining a yield of 4,362 kg/ha, higher by 11.4% compared to the world yield.

The main producers of triticale, by production, both in the world and in the EU-27 were Poland, Germany and France. Romania ranked 10th in the world and 6th in the EU-27 in cultivated area (57 thousand ha), as well as 8th in the EU-27 in production (192.4 thousand tons).

In the period 2013-2022, in Romania, the fluctuation of the cultivated area and the production of triticale from one year to another was small, registering, on average, 74.1 thousand ha and 274.4 thousand tons, respectively.

In order, to increase the amount of triticale-based food products, it is necessary to develop and use high-quality varieties that meet the needs of the market, as well as the development of new processing technologies.

REFERENCES

[1]Ayalew, H., Kumssa, T.T., Butler, T.J., Ma, X.F., 2018, Triticale improvement for forage and cover crop uses in the Southern Great Plains of the United States. Frontiers in Plant Science, 9:1130. doi: 10.3389/fpls.2018.01130.

[2]Biel, W., Kazimierska, K., Bashutska, U., 2020, Nutritional value of wheat, triticale, barley and oat grains. Acta Scientarium Polonorum Zootechnica, 19:19-28.

[3]Bonea, D., Dunăreanu, I.C., 2022, Influence of hybrid and weather conditions on yield, protein and oil contents in grain of maize. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 22(2):137-143.
[4]Draghici, I., Draghici, R., Croitoru, M., 2012, Triticale, alternative plant to wheat crops on sandy soils in Romania. Annals of the University of Craiova - Agriculture, Montanology, Cadastre Series, Vol. XLII (2):93-99.
[5]Faccini, N., Morcia, C., Terzi, V., Rizza, F., Badeck, F.W., 2023, Triticale in Italy. Biology, 12, 1308. https://doi.org/10.3390/biology12101308
[6]FAOSTAT., 2024, Crops and livestock products, https://www.fao.org/faostat/en/#data/QCL, Accessed on 10 February, 2024.
[7]Fras, A., Golebiewska, K., Golebiewski, D., Mankowski, D.R., Boros, D., Szecowka, P., 2016, Variability in the chemical composition of triticale grain, flour and bread. Journal of Cereal Science, 71:66-72.
[8]Fras, A., Golebiewska, K., Golebiewski, D., Wisniewska, M., Gzowska, M., Mankowski, D.R., 2021, Utilisation of triticale (X *Triticosecale* Wittmack) and residual oat flour in bread making. Czech Journal of Food and Science, 39(3):226-233.
[9]Gagiu, V., 2018, Triticale crop and contamination with mycotoxins under the influence of climate change - global study. Journal of Hygienic Engineering and Design, 23:30-45.
[10]Gaspar, I., Butnaru, G., 1985, Triticale - O nouă cerealã [Triticale – a new cereal]. Editura Academiei R.S.R., Bucureşti.
[11]Ittu, G., Saulescu, N.N., Ittu, M., Mustatea, P., 2001. Advances in triticale breeding programme from R.I.C.I.C. Fundulea. Romanian Agricultural Research, 16:1-6.
[12]Ittu, G., Săulescu, N.N., Ittu, M., Mustatea, P., 2007, Realizări în ameliorarea la triticale (x Triticosecale Witt.) [Achievements in triticale breeding]. NARDI Fundulea, LXXV:73-82.
[13]Jaskiewicz, B., Grabinski, J., Ochmian, I., 2019, Intensity of triticale production in different regions of Poland. Proceedings of the 2019 International Conference "Economic Science For Rural Development", No. 51, Jelgava, LLU ESAF, 9-10 May 2019, pp. 137-143.
[14]Kandrokov, R.K., Berezina, N.A., Kusova, I.U., Ryndin, A.A., 2021, Technological properties of wheat-triticale-rye flour. Biomedical Journal of Scientific & Technical Research, 39(3):31372-31378.
[15]Kamanova, S., Yermekov, Y., Shah, K., Mulati, A., Liu, X., Bulashev, B., Toimbayeva, D., Ospankulova, G., 2023, Review on nutritional benefits of triticale. Czech Journal of Food Sciences, 41(4):248-262.
[16]Kaszuba, J., Jaworska, G., Krochmal-Marczak, B., Kogut, B., Kuzniar, P., 2021, Effect of bran addition on rheological properties of dough and quality of triticale bread. Journal of Food Processing and Preservation, 45(1), e15093
[17]Kleist, T., 2023, Triticale to rise in the world of baked deliciousness, https://www.plantsciences.ucdavis.edu/news/hegarty-triticale-rise, Accessed on 5 February, 2024.
[18]Malinas, A., Kadar, R., Deac, V., Rotar, I., Vidican, R., Racz, I., Malinas, C., 2020, Reaction to fertilization of Romanian varieties of winter triticale, under the conditions of Transylvania plain, between the years 2012-2019. Scientific Papers. Series A. Agronomy, Vol. LXIII(1):402-407.
[19]Meteo, Romania, 2024, Announcement: 2022 - The 3rd warmest year in the history of meteorological measurements in Romania] from 17.01.2023, https://www.meteoromania.ro/wp-content/uploads/comunicate/comunicat-an-calduros.pdf Accessed on 5 February, 2024.
[20]Official catalogue of cultivated plant varieties in Romania. 2023, https://istis.ro/image/data/download/catalog-oficial/ordin%20catalog%202023%20cu%20anexa.pdf Accessed on 25 January, 2024.
[21]Pena, R., 2004, Food uses of triticale. In: Triticale Improvement and Production; Mergoum, M., Gómez-Macpherson, H., Eds.; Food & Agriculture Org: Rome, pp. 37-48.
[22]Pintilie, A.S., Leonte, A., Pintilie, P.L., Barcan, M.D., Isticioaia, S.F., 2023, Research on the behavior of some triticale varieties under the conditions of A.R.D.S. Secuieni between 2017 - 2022. Acta Agricola Romanica, Tom 5, no. 51:79-85.
[23]Pycia, K., Jaworska, G., Telega, J., Sudol, I., Kuzniar, P., 2018, Effect of adding potato maltodextrins on baking properties of triticale flour and quality of bread. LWT, 96:199-204.
[24]Research and Markets, 2023**,** Report: Triticale market size & share analysis - growth trends & forecasts (2023-2028). Dublin https://www.researchandmarkets.com/report/triticale?utm_source=CI&utm_medium=PressRelease&utm_code=3kmqmk&utm_campaign=1877668+-+Europe%27s+Triticale+Dominance%3a+Poland+Leads+as+Major+Producer+in+Global+Market&utm_exec=elco286prd, Accessed on 21 February, 2024.
[25]Rozewicz, M., 2022, Yield, grain quality and potential use of triticale in Poland. Polish Journal of Agronomy, 49:9-19.
[26]Voica, M, Delcea, A.M., Tunaru, I., Safta, C.L., Baltatu, M., 2023, Behavior of some winter triticale varieties under pedoclimatic conditions of A.R.D.S Teleorman durig 2020 - 2022. Acta Agricola Romanica, Tom 5, no 51:107-117.
[27]Watanabe, E., Antunes-Arruda, K.M., Good-Kitzberger, C.S., Coelho, A.R,. 2019, Physico-chemical properties and milling behavior of modern triticale genotypes. Emirates Journal of Food and Agriculture, 31(10):752-758.
[28]Zhu, F., 2018, Triticale: Nutritional composition and food uses. Food Chemistry, 241: 468–479.