INSTITUTE OF AGRICULTURAL AND FOOD BIOTECHNOLOGY STATE RESEARCH INSTITUTE

Quality of Polish Wheat Harvest 2023

Research carried out under Task realized for the Ministry of Agriculture and Rural Development: *Analysis of the quality of agricultural raw materials with the consideration of the risk contaminants*.

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Wheat harvest according to Statistics Poland

According to the Statistics of Poland (GUS), the main crop production in the year 2023 reached the level of 35.2 mln tonnes, which is 1% lower than last year, which includes wheat (13.0 mln t), triticale (5.3 mln t) and barley (2.8 mln t).

Grain production (mln t)
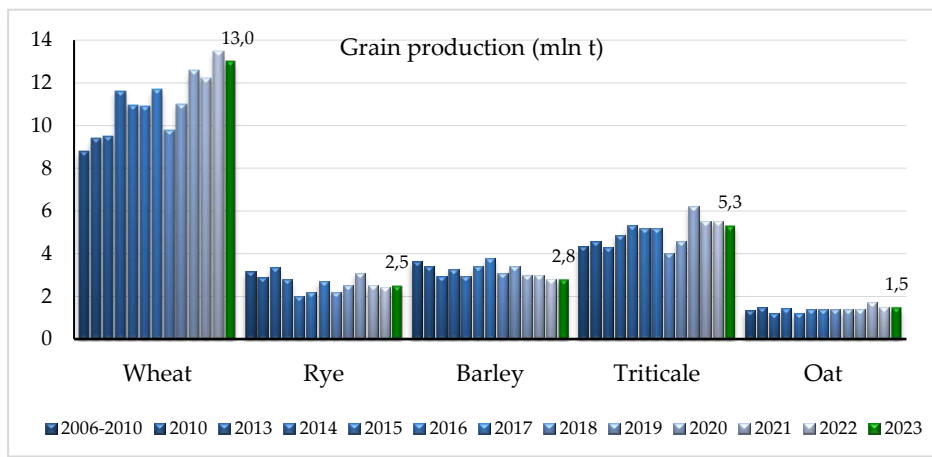
Source: Own study based on GUS data.

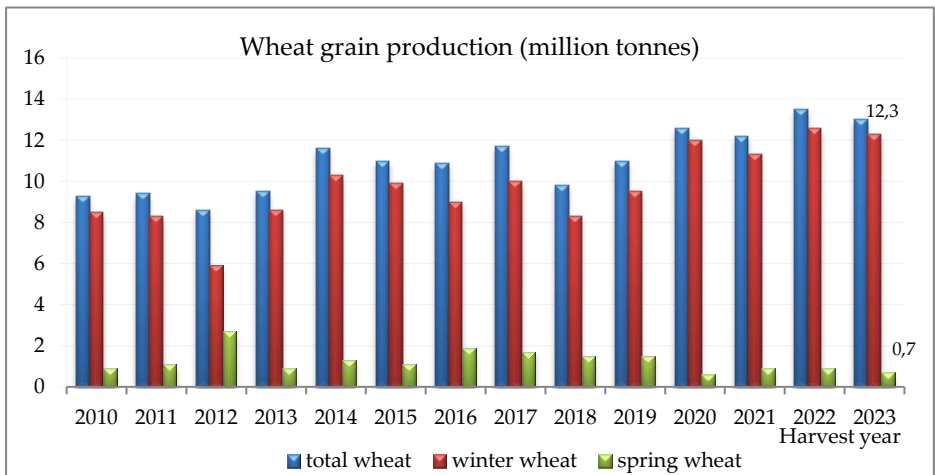**2023 HARVEST: SECOND RECORD WHEAT PRODUCTION OF 13.0 MLN TONNES AND MEDIUM QUALITY WITH LOW PROTEIN CONTENT**

Owing to good growth and development of winter plants in the final stage of growth in autumn of 2022 and slight winter losses of winter cereals (only 0.1% of the sown area of winter cereals was plowed), the yields were particularly high this year. Poland harvested 13.0 mln tonnes of wheat. That means an increase of 17% compared to the average of 2016-2020 (11.1 milion tonnes).

The Statistics of Poland (2023), indicated the following unfavourable factors which had influenced the plant production in the 2022/2023 economic year: cold days in April and May with drops in air temperature near the ground even below -9 ^{o}C inhibiting the growth and development of plants; shortage of rainfall in spring causing excesive drying of the soil, and local extreme climatic events occuring in June and July 2023, such as storms, hailstorms and storms combined with strong winds.

WHEAT GRAIN PRODUCTION AND YIELD

Wheat production in Poland in 2023 achieved a second record 13.0 mln tonnes, which is approx. 0.5 mln tonnes less than in the previous year. The 2016-2020 seasons harvest average was 11.2 milion tonnes. For comparison, the average harvest in 2006-2010 season was only 8.8 milion tonnes.

According to Statistics Poland, the harvest of winter wheat was at the level of 12.3 million tonnes (in 2020 harvest year - 12.6 milion tonnes). The average yield was 5.4 t/ha (similar level to 2022; 0.4 t/ha higher than last 5 years average). Compared to the average for 2006-2010 harvest years it is 1.3 t/ha higher, which is indicated by a clear progres in breeding.

Source: Own study based on GUS data.

The harvest of spring wheat was on the lower level that in 2022 harvest year with a value of 0.7 million tonnes. The average yield was 4.0 t/ha (0.2 t/ha lower than in 2022 harvest year and 0.1 t/ha higher than in 2021). Compared to the average for 2006-2010 harvest years (3.0 t/ha), there is also a clear progress in breeding.
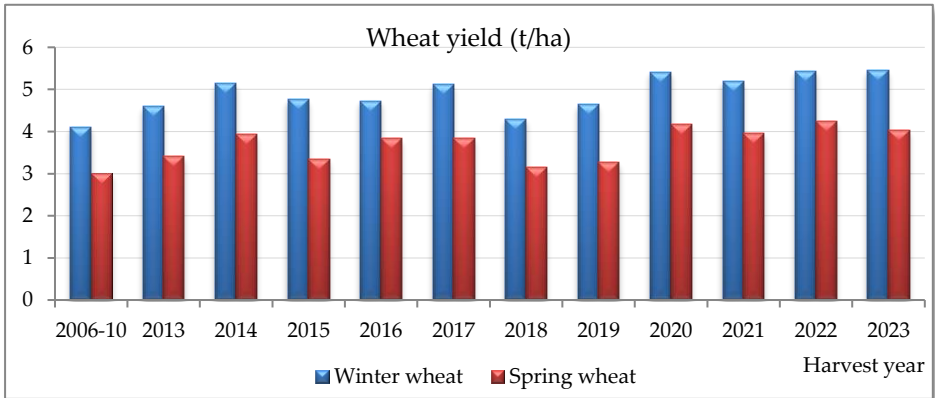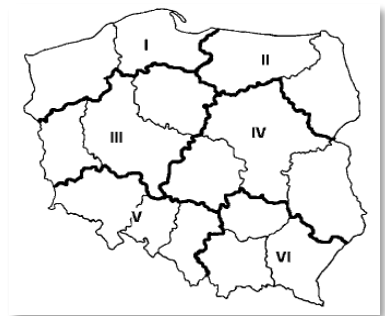
Source: Own study based on GUS data.

Material

Tested material included **476 wheat grain samples** from 2023 harvest year. The research was conducted in the Department of Grain Processing and Bakery – Prof. Wacław Dąbrowski Institute of Agricultural and Food Biotechnology – State Research Institute (IBPRS-PIB). Grain samples were delivered from Agricultural Advisory Centers from various climatic and cultivation regions, adopted by the Research Centre for Cultivar Testing (COBORU).

The number and origin of wheat grain samples from 2023 harvest.

Climatic and cultivation area according to COBORU	Number of tested samples	
	number	**percentage of all samples**
I	70	14,7
II	37	7,8
III	103	21,6
IV	128	26,9
V	86	18,1
VI	52	10,9

Climatic and cultivation area according to Research Centre for Cultivar Testing (COBORU)

Analytical methods

The following assessment of the technological value of wheat grain was performed in IBPRS-PIB:

Specific Weight – acc. to PN-EN ISO 7971-3:2019 – is a measure of density in kilograms per hectoliter (kg/hl). Specific weight may be an indicator of potential milling yield and the general condition of the samples.

Falling number – acc. to PN-EN ISO 3093:2010. This parameter indirectly measures the level of alpha-amlyase activity. Falling number is expressed in seconds. High falling number values (>250 s) indicate low alpha-amylase activity. Sprouted wheat grain is characterized by low falling number values (<150 s).

The remaining qualitative factors (protein content, gluten content, Zeleny sedimentation index, alveograph baking value "W") were determined using the X-Grain (Infracont) whole-grain analyzer using the NIR near-infrared measurement technique with installed calibrations developed for domestic wheat grain. The calibrations were adjusted to the wheat grain samples from the 2023 harvest year. About 30 samples from different regions of Poland were included to check the calibrations.

The analyses were performed by reference methods:

Protein content – acc. to PN-EN ISO 20483. Protein content is an important factor in determining the value of wheat and is used as an indicator in trade and by millers of the suitability of wheat for various products. It is calculated by using coefficient 5.7 and refers to dry matter (DM).

Gluten content – acc. to PN-EN ISO 21415-2:2015-12. Wet gluten is a measure of the quantity of gluten proteins in wheat as determined using the Glutomatic System.

Zeleny sedimentation index – acc. to PN-EN ISO 5529:2010. This parameter characterized the quality of gluten proteins. High sedimentation value (>40 cm^3) indicates strong gluten while low sedimentation (<25 cm^3) indicates weaker gluten.

Alveograph baking strenght "W" – acc. to PN-EN ISO 27971:2015-07. Alveograph measures the rheological properties of flour dough. "W" reflects the amount of energy needed to inflate the dough to the point of rupture and indicates dough strength.

Results

The tested wheat grain samples were characterized by the lowest protein content (average 12.4% d.b.) and gluten content (average 22.6%) in many years. The specific weight (average 76.8 kg/hl) and the falling number (average 291 s) were similar to the long-term average and met the requirements set for grain in consumption purposes.

HARVEST DATA

depended on the climatic and cultivation area acc. to the research of IBPRS-PIB

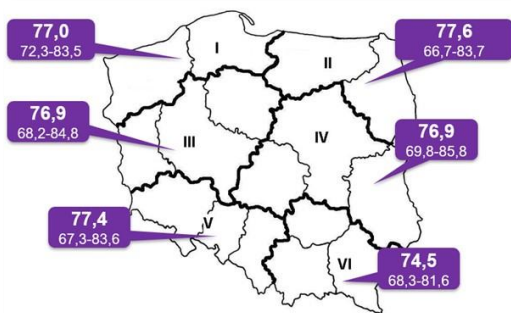| Climatic and cultivation area	Specific weight (kg/hl)	Protein content (Nx5.7) (%s.m.)	Gluten content (%)	Zeleny sedimentation index (cm³)	Alveograph baking strength "W" (×10⁻⁴J)	Falling number (s)
Average in Poland	**76.8**	**12.4**	**22.6**	**35**	**239**	**291**
range	66.7-85.8	8.1-18.1	<13-34.2	10-59	<60-385	62-442
I	**77.0**	**13.2**	**23.1**	**38**	**233**	**234**
range	72.3-83.5	9.7-18.1	14.9-32.1	18-50	105-339	62-355
II	**77.6**	**12.8**	**23.9**	**35**	**248**	**305**
range	66.7-83.7	10.7-15.5	17.6-29.5	19-50	143-351	88-394
III	**76.9**	**13.0**	**24.8**	**38**	**252**	**308**
range	68.2-84.8	10.0-17.4	16.5-33.2	21-59	<60-385	103-442
IV	**76.9**	**12.7**	**23.8**	**37**	**268**	**309**
range	69.8-85.8	8.4-16.5	<13-32.9	14-57	150-352	127-398
V	**77.4**	**10.9**	**19.8**	**28**	**208**	**303**
range	67.3-83.6	9.1-15.0	<13-34.2	14-56	106-353	110-379
VI	**74.5**	**11.3**	**18.9**	**29**	**196**	**260**
range	68.3-81.6	8.1-14.6	<13-29.0	10-48	<64-346	65-358

SPECIFIC WEIGHT

Specific weight was in the range of 66.7 to 85.6 kg/hl. The average (76.8 kg/hl) was slight lower than in the previous, 2022 harvest year (average 77.3 kg/hl) but significantly higher than in 2021 (average 74.0 kg/hl). 63.5% of tested wheat samples were characterized by the good milling quality (specific weight above 76 kg/hl). Unsatisfactory level of this parameter – below 72 kg/hl was characterized by 6.1% of tested samples.

90.1% of wheat samples met the minimum requirements set for wheat in the UE regulation for public intervention (specific weight above 73 kg/hl).

63.5% of Polish harvest exceeds 76 kg/hl
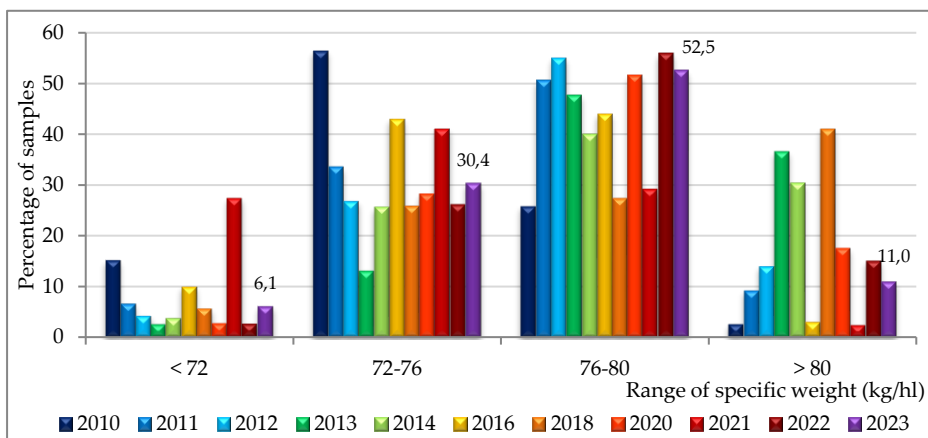
Percentage of tested samples showing the specific weight within a certain range of values depending on the harvest year.

Prof. Wadław Dąbrowski Institute of Agricultural and Food Biotechnology – State Research Institute
Department of Grain Processing and Bakery

LOW AVERAGE PROTEIN CONTENT OF 12.4% DM

Protein content was reported within the range of 8.1 to 18.1% DM, with average of 12.4% DM, which is one of the lowest in a long-time period. 69% of tested wheat samples were characterized by good baking quality (protein content higher than 11.5%), but only 16% showed very good baking quality (protein content higher than 14%). Unsatisfactory level of this parameter – below 9.5% was characterized by 2.5% of tested samples.
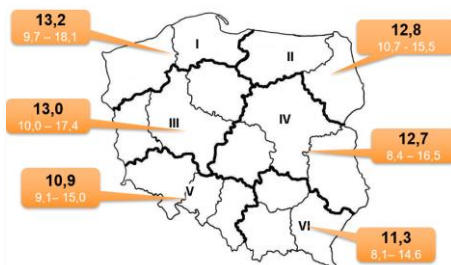
77% of wheat samples met the minimum requirements set for wheat in the EU regulation for public intervention (protein content above 11.0%).

69.2% of Polish harvest exceeds 11.5% DM
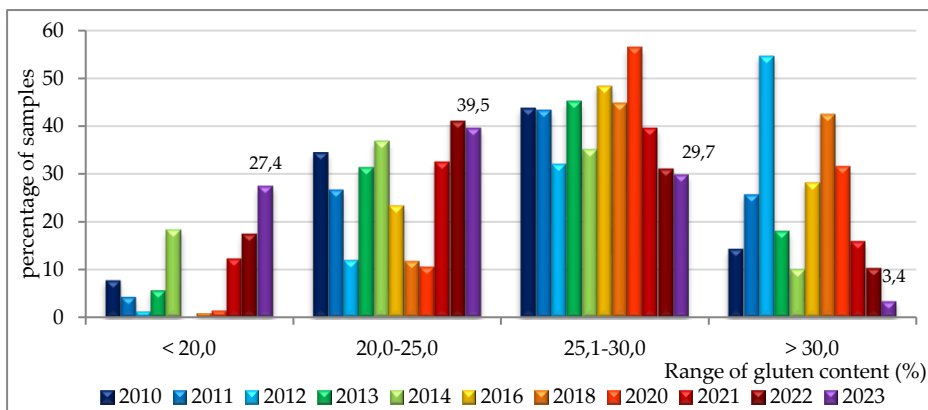**16% of Polish harvest exceeds 14% DM**
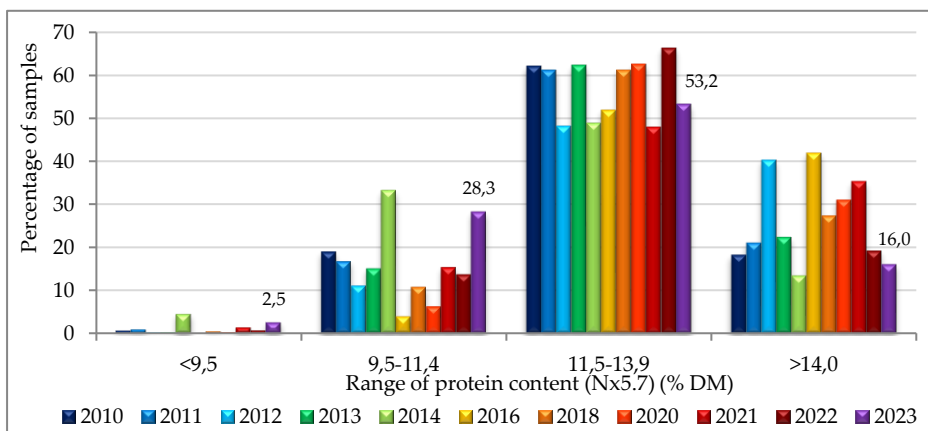
Percentage of tested samples showing the protein content within a certain range of values depending on the harvest year.

LOW AN AVERAGE WET GLUTEN CONTENT OF 22.6%

Wet gluten was with in the range of <13% to 34.2%. Only 33.1% of tested wheat samples were characterized by good baking quality (wet gluten content above 25%) and only 3% by a very good baking quality (wet gluten content above 30%), which are the lowest levels in the presented period of time. Unsatisfactory level of this parameter – below 20% was characterized by 27.4% of tested samples. However, the highest number of samples with gluten content in the range of 20 to 25% indicates their possible usage for biscuit production. The wheat grain from 2018 and 2012 harvest year were characterized by the highest gluten content (29.4 and 30.3%, respectively), whereas till this year the lowest value was found for 2010 and 2014 harvest year (25.8 and 24.2%, respectively).

Percentage of tested samples showing the gluten content within a certain range of values depending on the harvest year.
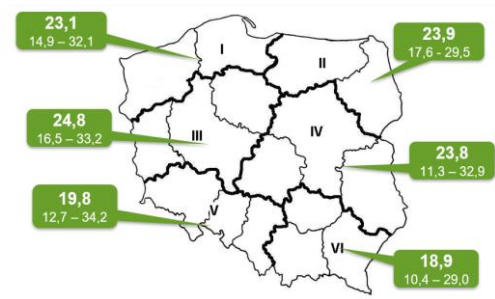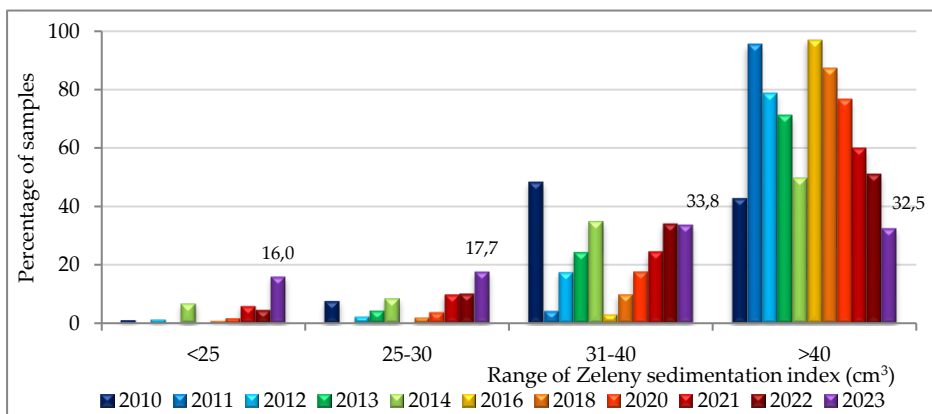
ZELENY SEDIMENTATION INDEX

Zeleny sedimentation index was in the range of 10 to 59 cm^3. The average value (35 cm^3) classifies the grain from this year's harvest in the group of growing seasons of the lowest gluten quality. The lowest value of Zeleny index was found for 2010 and 2014 harvest years (39 and 40 cm^3, respectively), whereas the highest value for 2016 and 2011 harvest (58 and 52 cm^3, respectively). Only 32% of tested wheat samples were characterized by good baking quality (Zeleny index above 40 cm^3), which is required for baking purposes. It is the worst result in the last years. Unsatisfactory level of this parameter – below 25 cm^3 was characterized by 16% of tested samples.

92% of wheat met the minimum requirements set for wheat in the EU regulation for public intervention (Zeleny index above 22 cm^3).

**32.5% of Polish harvest exceeds 40 cm^3**

Percentage of tested samples showing the Zeleny sedimentation index within a certain range of values depending on the harvest year.
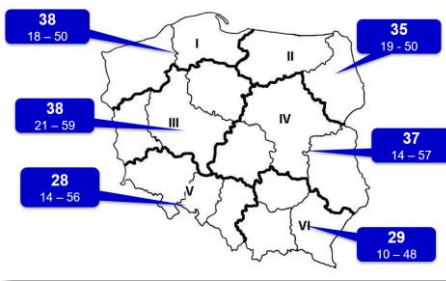
BAKING STRENGTH, „W"

The baking strength was in the range of below 60 to 385×10^{-4}J. Only 15% of tested wheat samples were characterized by baking strength above 300×10^{-4}J, which indicates the potential use of grain for the production of flour for baking purposes, e.g. hamburger buns, pizza, frozen dough ("W" in the range $300-400 \times 10^{-4}$J), or as an improver for flour obtained from weaker wheat („W" above 400×10^{-4}J). 62% of tested wheat samples were characterized by baking strength „W" within the range of 201 to 300×10^{-4}J, which indicates the possibility of its use in the production of bread, toasted bread, and „crescent" type bread. However, 22% of tested wheat grain samples had baking strength „W" within the range of 100 to 200×10^{-4}J, which indicates its potential use for biscuits, small confectionery bread, and baguettes production.

**Medium baking strenght of 239×10^{-4}J on average**
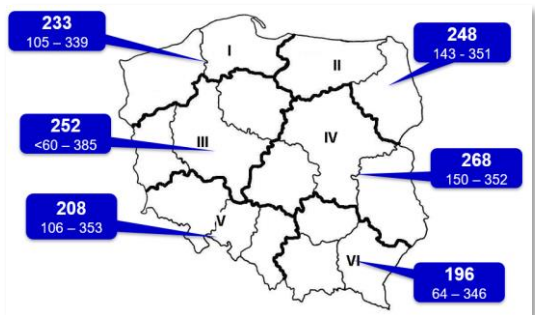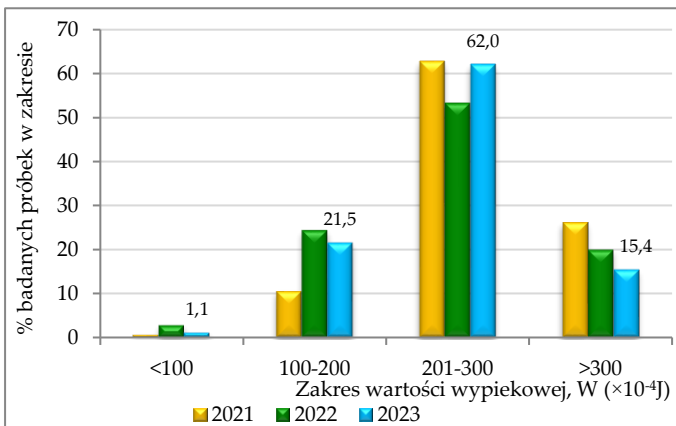
LOW ALPHA-AMYLASE ACTIVITY

The Hagberg Falling Number (FN) was in the range of 62 to 442 s. More than 78% of tested wheat samples were characterized by FN above 250 s, which indicates low alpha-amylase activity. In comparison – better results and over 90% of tested grain samples of 2013 and 2014 harvest were characterized by a FN above 250 s. Unsatisfactory level of this parameter – below 150 s was characterized by 5.3% of tested samples. In the previous years, only in 2010 and 2011 harvests, the greater part of grain (23 and 35%, respectively) was characterized by high alpha-amylase activity (FN<150 s).

87% of wheat met the minimum requirements set for wheat in the EU regulation for public intervention (Falling Number above 220 s).
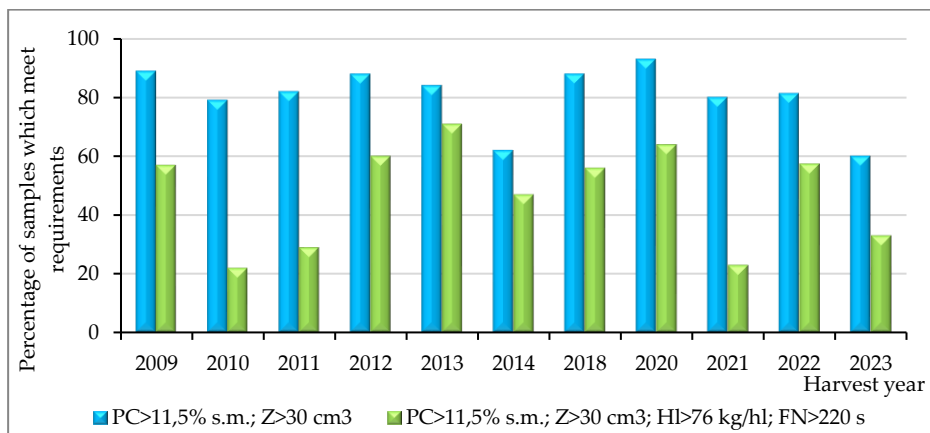
78% of wheat above 250 s
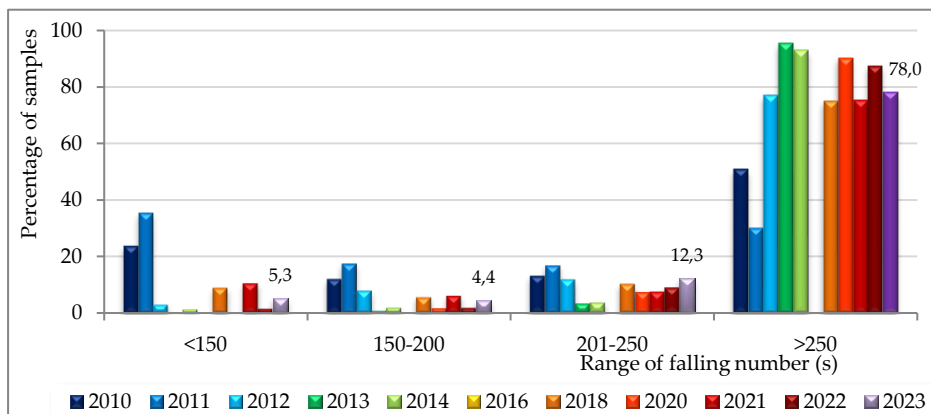
Percentage of tested samples showing the falling number within a certain range of values depending on the harvest year.
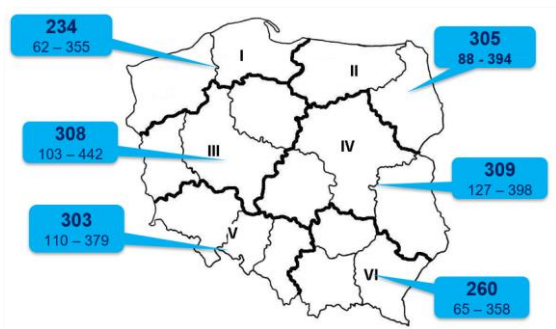
## Criteria for evaluating the baking and milling value of grain.

PC- protein content (Nx5.7) (DM); Z –Zeleny sedimentation index; Hl – specific weight; FN – Falling Number.

63% of grain from 2023 harvest met the requirements for baking purposes (including protein content >11.5% and Zeleny index >30 cm^3) compared to 90% of samples tested in 2020. Only 35% of grain from 2023 harvest met the criteria of baking and milling value (including the specific weight >76 kg/hl and FN >220 s).

In presented period of time, the lowest technological value was reported for grain from the 2010, 2011 and 2021 harvest – only 22; 29 and 23% of wheat samples met the requirements of good baking and milling value of grain because of the unfavourable weather condition which caused sprouting of grain.

Wheat classification according to Agricultural Exchange Market requirements
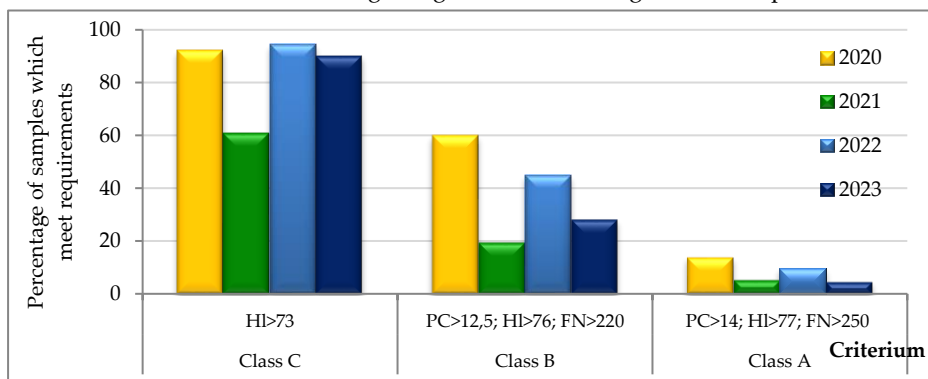
Explanations: „PC" – protein content (% DM), „Hl" – specific weight (kg/hl), „FN" – Falling Number (s).

Quality characteristics of the most popular wheat cultivars during study

Cultivar	Number of tested samples	Protein content (N×5.7) (D.M.)	Gluten content (%)	Specific weight (kg/hl)	Alveograph baking value "W" (×10⁻⁴J)	Falling number (s)
Euforia	52	12,6	23,1	76,9	244	321
Formacja	14	12,0	21,9	76,9	231	328
Fenomen	10	12,7	23,4	77,8	253	272
KWS Donovan	10	12,2	22,5	77,0	241	316
RGT Bilanz	9	12,1	21,4	76,0	226	279
Hondia	8	12,8	24,3	77,3	251	321
Julius	8	12,5	24,3	78,1	264	257
Patras	8	12,7	22,9	**74,1**	251	214
RGT Kilimanjaro	8	12,2	23,3	77,2	259	316
SU Banatus	8	**11,3**	**20,3**	76,1	233	264
SU Dubaj	8	12,4	23,2	77,2	255	337
Wilejka	8	**13,1**	**25,9**	**80,6**	**288**	287
Arkadia	7	11,7	19,7	76,4	208	279
KWS Emil	7	12,1	22,0	76,4	237	288
Ostroga	7	12,3	21,8	75,6	235	259
Belissa	6	12,5	23,5	76,2	246	311
LG Keramik	6	11,6	20,0	76,3	192	279
RGT Specialist	6	11,2	20,6	77,0	225	327
Symetria	6	11,7	20,4	75,4	211	312
Artist	5	11,4	20,0	75,9	194	298

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