



PROF. WACLAW DABROWSKI  
INSTITUTE OF AGRICULTURAL  
AND FOOD BIOTECHNOLOGY  
STATE RESEARCH INSTITUTE


# Quality of Polish Wheat

## Harvest 2021



Research carried out under Task realized for the order of Ministry of Agriculture and Rural Development: *Analysis of the quality of agricultural raw materials, taking into account the risk of contaminants.*

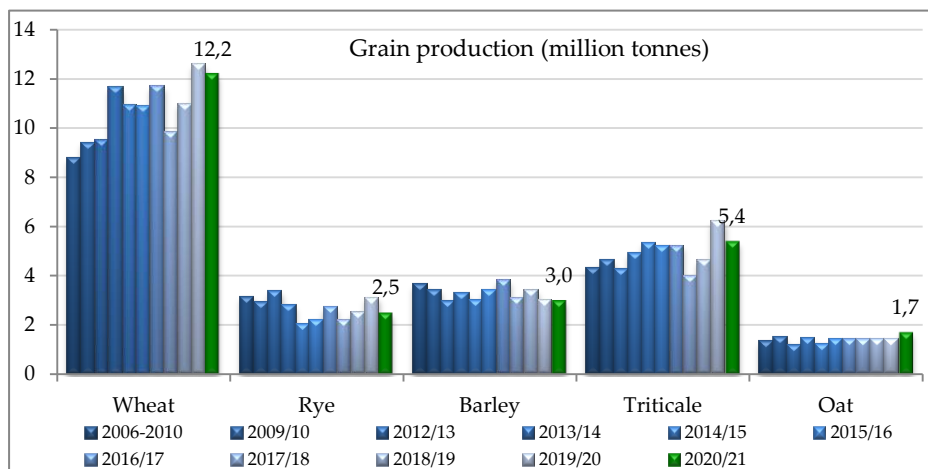


A close-up photograph of two golden wheat spikes. The spikes are in sharp focus, showing the individual grains and the long, thin awns. The background is a soft, out-of-focus blue sky with a hint of orange light, suggesting a sunset or sunrise. The overall tone is warm and natural.

Developed by Anna Szafrńska, D.Sc.  
Prof. Waław Dąbrowski Institute of Agricultural and Food Biotechnology  
– State Research Institute  
Department of Grain Processing and Bakery  
Photo source: pixabay.com  
Warsaw, December 2021

## Wheat harvest according to Statistics Poland

According to Statistics Poland (GUS), main crop production in the year 2021 was on the level of 34.5 mln t, included wheat (12.2 mln t), triticale (5.5 mln t) and barley (3.0 mln t).



Source: Own study based on GUS data.

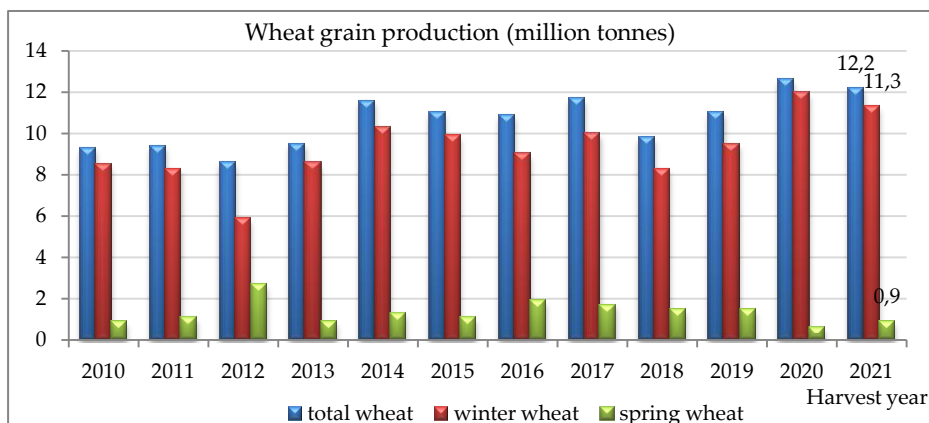
### 2021 HARVEST: A RECORD WHEAT PRODUCTION OF OVER 12 MLN TONNES AND A MEDIUM QUALITY WITH LOW SPECIFIC WEIGHT

Thanks to good growth and development of winter plants in the final stage of growth in autumn 2020 and slight winter losses of winter cereals (only 0.3% of the sown area of winter cereals was plowed), the yields were particularly high this year. Poland harvested 12.2 million tonnes of wheat. That's an increase of 9% compared to the average of 2016-2020 harvest (11.1 million tonnes).

The Statistics Poland (2021) indicated the following unfavourable factors that influenced plant production in the 2020/2021 economic year: cold days in April and May with drops in air temperature near the ground even below -10°C, inhibiting the growth and development of plants; shortage of rainfall in April and May, causing excessive drying of the soil and local extreme climatic phenomena occurring in June and July 2021, such as storms, hailstorms and storms combined with strong winds.

## WHEAT GRAIN PRODUCTION AND YIELD

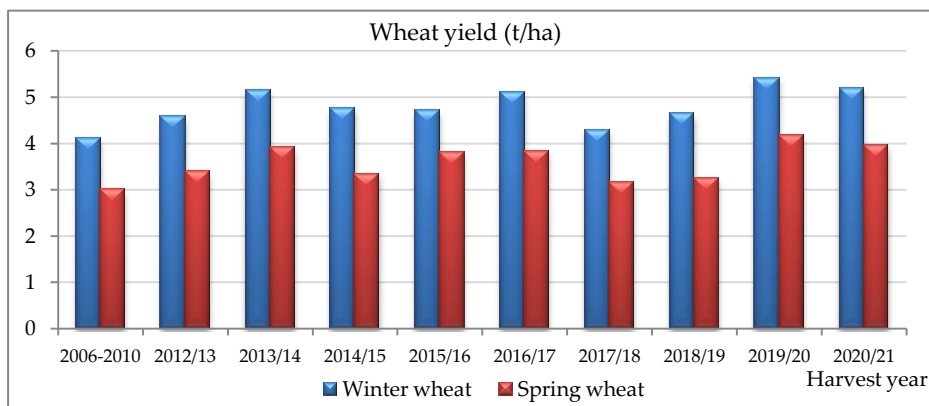
Wheat production in Poland in 2021 r. was 12.2 million tonnes, which is approx. 0.4 million tonnes lower than in previous year, record harvest years. However, this is the second record year of wheat grain production. The 2016-2020 seasons harvest average was 11.2 million tonnes. For comparison, the average harvest on 2006-2010 season was only 8.8 million tonnes.



Source: Own study based on GUS data.

According to Statistics Poland, the harvest of winter wheat was at the second record level 11.3 million tonnes (previous record was in 2020 harvest year 12.0 million tonnes). The average yield was 5.2 t/ha (0.2 t/ha lower than in 2020; 0.5 t/ha higher than in 2019 harvest year and 0.3 t/ha higher than last five year average).

The harvest of spring wheat was 0.9 million tonnes, which are 0.3 million tonnes higher than in 2020 harvest year, but 0.5 million tonnes lower than last five years average. The average yield was 4.0 t/ha (0.2 t/ha lower than in 2020; 0.7 t/ha higher than in 2019 harvest year and 0.3 t/ha higher than last five year average). Compared to the average for 2006-2010 harvest years (3.0 t/ha), there is a clear progress in breeding.



Source: Own study based on GUS data.

## Material

Tested material was 581 wheat grain samples from 2021 harvest. The research was conducted in Department of Grain Processing and Bakery – Prof. Waław Dąbrowski Institute of Agricultural and Food Biotechnology – State Research Institute (IBPRS-PIB). Grain samples were delivered from Agricultural Advisory Centers, grain elevators and milling companies from various climatic and cultivation regions, adopted by the Research Centre for Cultivar Testing (COBORU).

The number and origin of wheat grain samples from the 2021 harvest.

Climatic and cultivation area according to COBORU	Number of tested samples	
	number	percentage of all samples
I	90	15,5
II	37	6,4
III	103	17,7
IV	150	25,8
V	117	20,1
VI	84	14,5



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

## Analytical methods

The following assessment of the technological value of wheat grain were 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-amylase 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 2021 harvest. 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<sup>3</sup>) indicates strong gluten while low sedimentation (<25 cm<sup>3</sup>) indicates weaker gluten.

**Alveograph baking strenght “W”** – acc. to PN-EN ISO 27971:2015-07. Alveograph measure 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 strenght.



## Results

Tested wheat grain samples were characterized by medium and good technological quality – the average protein content is 13.2 % DM; gluten content 24.4%; Zeleny sedimentation index 41 cm<sup>3</sup>; lower specific weight 74.0 kg/hl; falling number 285 s, alveograph baking value “W” 263×10<sup>-4</sup>J.

### 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 (N×5.7) (% DM)	Gluten content (%)	Zeleny sedimentation index (cm <sup>3</sup> )	Alveograph baking strenght “W” (263×10 <sup>-4</sup> J)	Falling number (s)
<b>Average in Poland</b>	<b>74,0</b>	<b>13,2</b>	<b>25,4</b>	<b>41</b>	<b>263</b>	<b>285</b>
range	56,5-86,6	8,6-17,5	<13-35,5	10-64	64-377	62-403
<b>I</b>	<b>75,2</b>	<b>13,6</b>	<b>27,0</b>	<b>46</b>	<b>294</b>	<b>322</b>
range	67,6-81,0	8,9-16,3	<13-35,4	19-57	142-351	94-397
<b>II</b>	<b>72,9</b>	<b>13,9</b>	<b>27,7</b>	<b>46</b>	<b>283</b>	<b>287</b>
range	65,5-80,3	11,0-17,1	19,3-35,3	32-62	224-341	62-403
<b>III</b>	<b>75,4</b>	<b>13,2</b>	<b>27,0</b>	<b>43</b>	<b>273</b>	<b>330</b>
range	65,6-81,6	9,3-17,4	13,1-35,5	12-64	98-359	73-394
<b>IV</b>	<b>71,4</b>	<b>13,9</b>	<b>24,7</b>	<b>42</b>	<b>261</b>	<b>210</b>
range	56,5-80,3	9,7-17,5	<13-33,1	15-58	109-346	62-390
<b>V</b>	<b>75,4</b>	<b>12,1</b>	<b>23,6</b>	<b>36</b>	<b>239</b>	<b>317</b>
range	68,6-86,6	8,6-16,6	<13-33,8	10-62	64-352	159-389
<b>VI</b>	<b>74,5</b>	<b>12,8</b>	<b>24,3</b>	<b>39</b>	<b>248</b>	<b>284</b>
range	66,9-82,8	9,1-16,6	<13-35,4	15-61	114-377	74-398

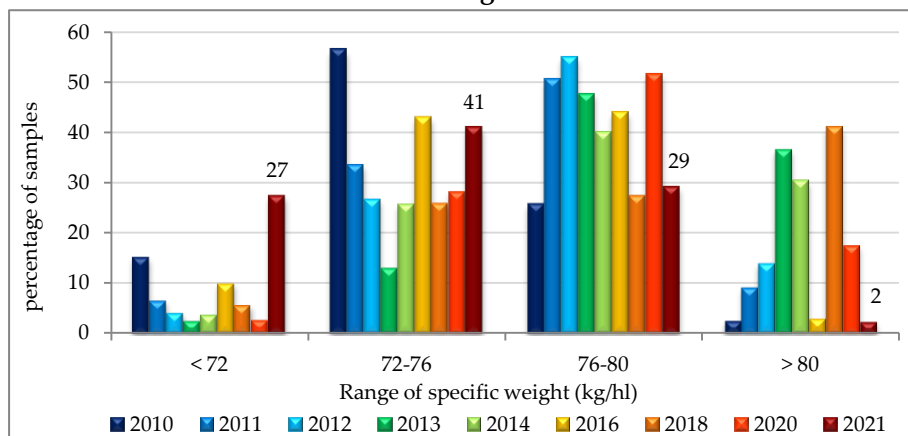
Source: Department of Grain Processing and Bakery, Prof. W. Dąbrowski Institute of Agricultural and Food Biotechnology – State Research Institute, 2021.

## SPECIFIC WEIGHT

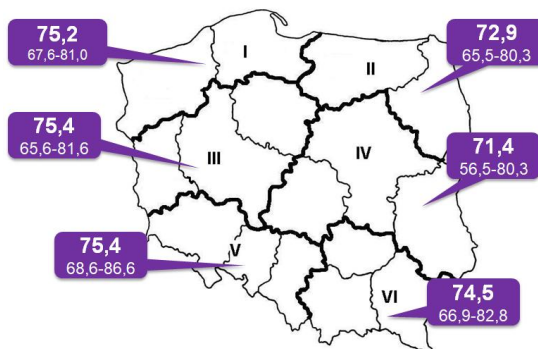
Specific weight was in the range of 56.5 to 86.6 kg/hl. The average (74.0 kg/hl) was significant lower than in the previous 2020 harvest year (average 77.2kg/hl). Only 32% of tested wheat samples were characterized by good milling quality (specific weight above 76 kg/hl). Unsatisfactory level of this parameter – below 72 kg/hl was characterized by 27% of tested samples.

61% of wheat samples met the minimum requirements set for wheat in the EU regulation for public intervention (specific weight above 73 kg/hl).

### 32% of Polish harvest exceeds 76 kg/hl



Percentage of tested samples showing the specific weight within a certain range of values depending of harvest year





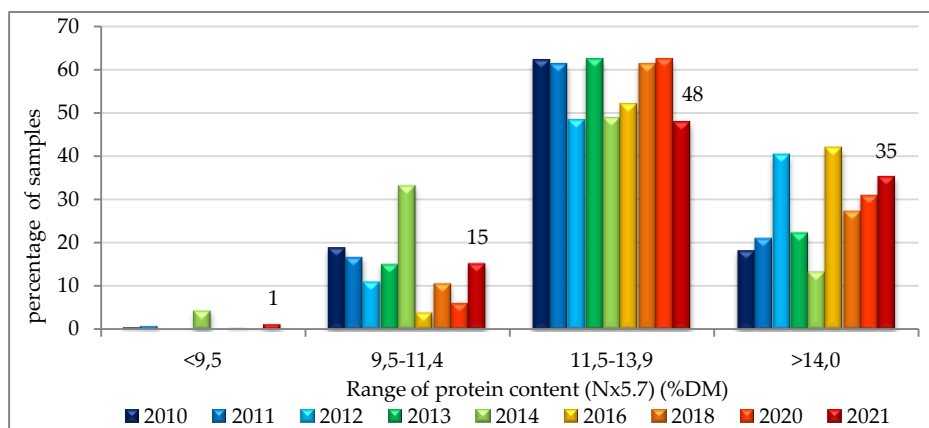
## AN AVERAGE PROTEIN CONTENT OF 13.2% DM

Protein content was in the range of 8.6 to 17.5% (average 13.2%) which is lower than average value in 2012 and 2016 harvest year (13.6%), but still higher than in 2014 harvest year (12.1%). 83% of tested wheat samples were characterized by good baking quality (protein content above 11.5%), and 35% of tested samples – very good baking quality (protein content above 14%). Unsatisfactory level of this parameter – below 9.5% was characterized by only 1% of tested samples.

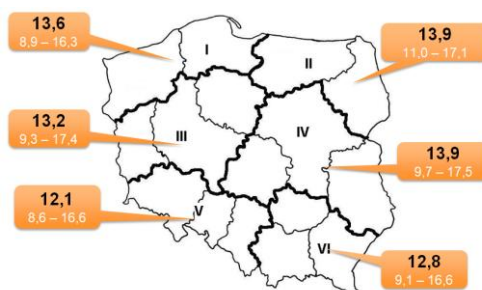
86% of wheat samples met the minimum requirements set for wheat in the EU regulation for public intervention (protein content above 11.0%).

**83% of Polish harvest exceeds 11.5% DM**

**35% of Polish harvest exceeds 14% DM**



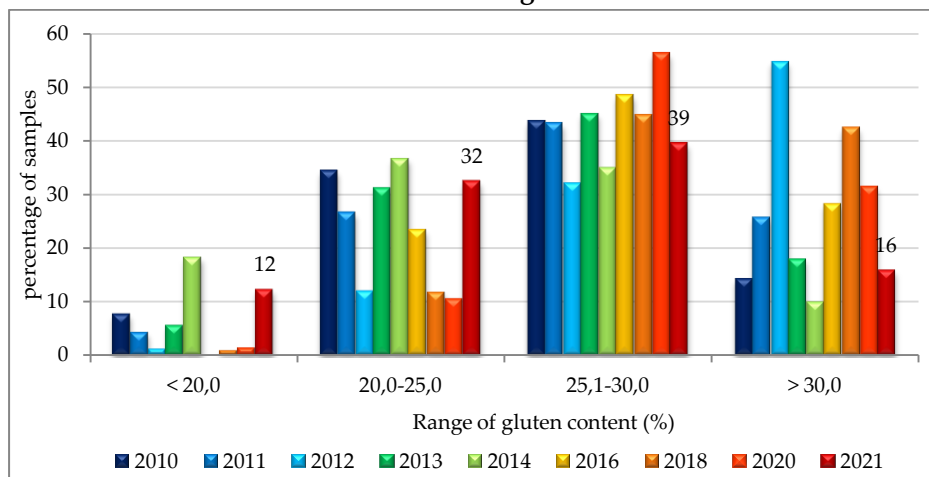
Percentage of tested samples showing the protein content within a certain range of values depending of harvest year



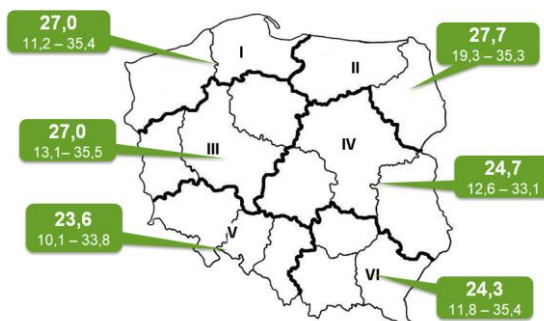
## AN AVERAGE WET GLUTEN CONTENT OF 25.4%

Wet gluten content was in the range of below 13 to 35.5%. Only 55% of tested wheat samples were characterized by good baking quality (wet gluten content above 25%) and 16% by very good baking quality (wet gluten content above 30%). Unsatisfactory level of this parameter – below 20% was characterized by 12% of tested samples. The wheat grain from 2018 and 2012 harvest year were characterized by the highest gluten content (29.4 and 30.3%, respectively), whereas the lowest value was found for 2010 and 2014 harvest year (25.8 and 24.2%, respectively).

### 16% of Polish harvest exceeds 30% of gluten content



Percentage of tested samples showing the gluten content within a certain range of values depending of harvest year

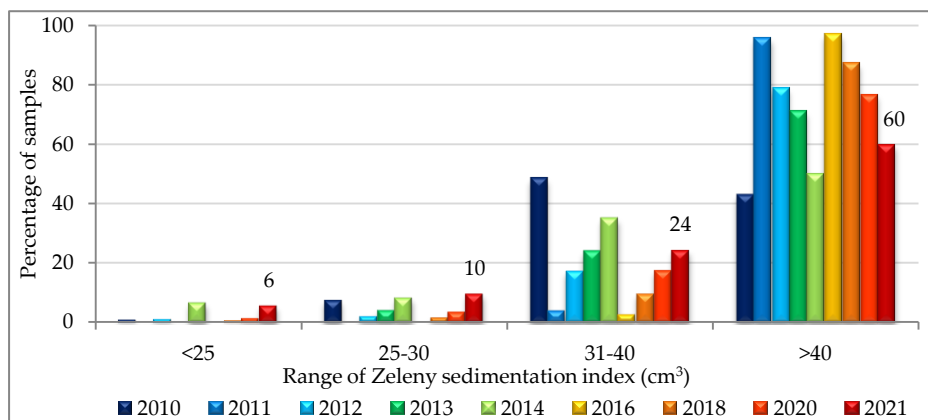


## ZELENY SEDIMENTATION INDEX

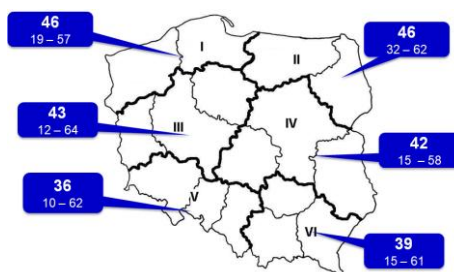
Zeleny sedimentation index was in the range of 10 to 64 cm<sup>3</sup>. The average value (41 cm<sup>3</sup>) classifies the grain from this year's harvest into the group of growing seasons of lower gluten quality. The lowest value of Zeleny index was found for 2010 and 2014 harvest years (39 and 40 cm<sup>3</sup>, respectively), whereas the highest value for 2016 and 2011 harvest (58 and 52 cm<sup>3</sup>, respectively). Only 60% of tested wheat samples were characterized by good baking quality (Zeleny index above 40 cm<sup>3</sup>), but it is still good result in last years. Unsatisfactory level of this parameter – below 25 cm<sup>3</sup> was characterized by 6% of tested samples.

More than 96% of wheat met the minimum requirements set for wheat in the EU regulation for public intervention (Zeleny index above 22 cm<sup>3</sup>).

### 60% of Polish harvest exceeds 40 cm<sup>3</sup>



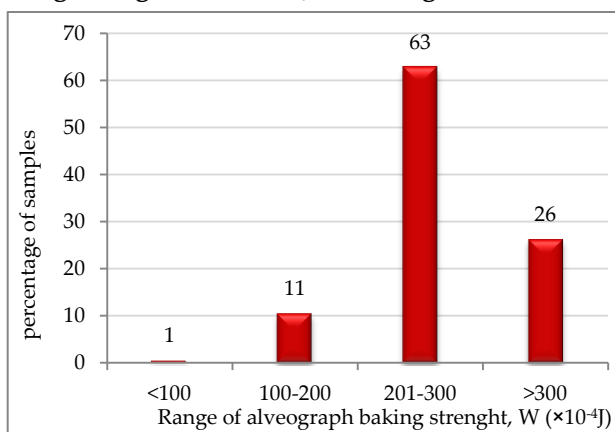
Percentage of tested samples showing the Zeleny sedimentation index within a certain range of values depending of harvest year



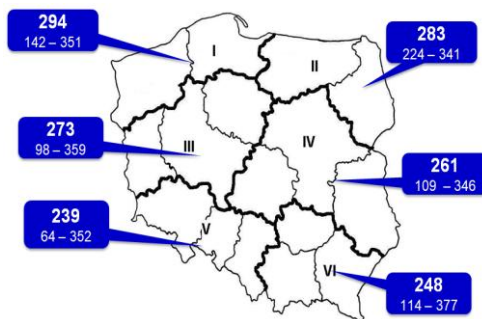
## BAKING STRENGTH, „W”

The baking strength was in the range of 64 to  $377 \times 10^{-4} \text{J}$ . Only 26% of tested wheat samples were characterized by baking strength above  $300 \times 10^{-4} \text{J}$ , 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  $300\text{--}400 \times 10^{-4} \text{J}$ ), or as an improver for flour obtained from weaker wheat („W” above  $400 \times 10^{-4} \text{J}$ ). 63% of tested wheat samples were characterized by a baking strenght „W” in the range of 201 to  $300 \times 10^{-4} \text{J}$ , which indicates the possibility of its use in the production of bread, toasted bread and „crescent” type bread. Only 11% of tested wheat grain samples had a baking strenght „W” in the range of 100 to  $200 \times 10^{-4} \text{J}$ , which indicates its potential use for biscuits, small confectionery bread and baguettes production.

### Good baking strenght of $263 \times 10^{-4} \text{J}$ on average



Percentage of tested samples showing the baking strenght, „W” within a certain range of values

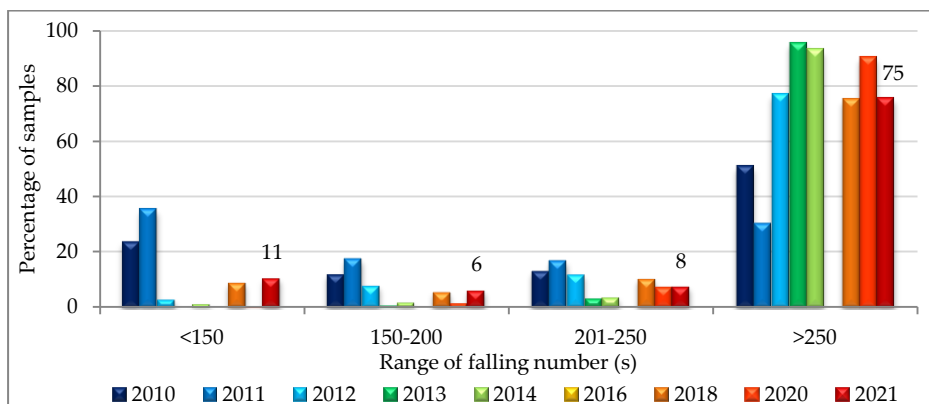


## LOWER FALLING NUMBERS IN LUBLIN PROVINCE

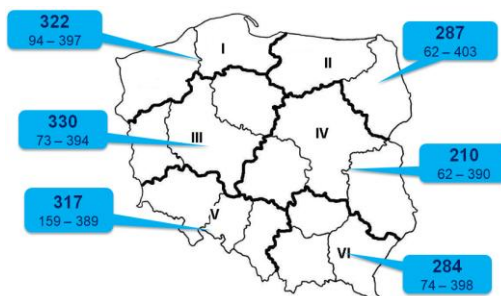
The Hagberg Falling Number (FN) was in the range of 62 to 403 s. The grain from this year's harvest was characterized by an unfavourable - the third lowest average value of the parameter in the last few years. 75% of tested wheat samples were characterized by FN above 250 s, which indicates low alpha-amylase activity. In comparison – 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 11% of tested samples – most of them in Lublin Province. In 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).

81% of wheat met the minimum requirements set for wheat in the EU regulation for public intervention (Falling Number above 220 s).

### 75% of wheat above 250 s



Percentage of tested samples showing the falling number within a certain range of values depending of harvest year



## Criteria for evaluating the baking and milling value of grain

Characteristics of the suitability for baking purposes of wheat from the 2021 harvest compared to grain from the 2009-2020 harvest

	Harvest year								
	2009	2010	2011	2012	2013	2014	2018	2020	2021
PC>11,5%	89	79	82	88	84	62	88	90	80
Z >30 cm <sup>3</sup>									
PC>11,5%	57	22	29	60	71	47	56	69	23
Z >30 cm <sup>3</sup>									
HL >76 kg/hl									
FN >220 s*									

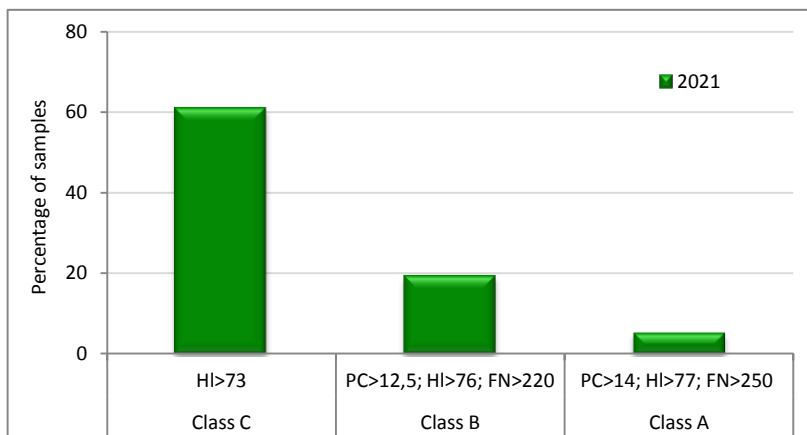
PC- protein content (Nx5.7) (DM); Z –Zeleny sedimentation index; HL – specific weight; FN – Falling Number

80% of grain from 2021 harvest met the requirements for grain for baking purposes (including protein content >11.5% and Zeleny sedimentation index >30 cm<sup>3</sup>) compared to 90% of samples tested in 2020 harvest.

Only 23% of grain from 2021 harvest met both criteria of baking and milling value (included also the specific weight >76 kg/hl and the falling number >220 s).

In presented period of time, the lowest technological value was stated for grain from the 2010 and 2011 harvest – only 22 and 29%, respectively of wheat samples met the requirements for the good baking and milling value of grain. These years were characterized by unfavourable weather condition which cause sprouting of grain and low specific weight.

## Wheat classification according to Agricultural Exchange Market requirement



Explanations: „PC” – protein content (% DM), „HI” – specific weight (kg/hl), „FN” – Falling Number (s)

### HARVEST DATA

#### Average results of selected wheat cultivars acc. to the research of IBPRS-PIB

Wheat cultivar	Specific weight (kg/hl)	Protein content (Nx5.7) (% DM)	Gluten content (%)	Zeleny sedimentation index (cm <sup>3</sup> )	Alveograph baking strenght “W” (263×10 <sup>-4</sup> J)	Falling number (s)
Arkadia	73,0	13,1	24,8	39	251	242
Belissa	71,3	12,0	21,0	33	223	277
Euforia	74,7	13,3	25,3	42	263	311
Hondia	72,0	13,6	26,3	44	263	304
RGT Kilimandżaro	76,2	12,5	24,2	39	245	330
Wilejka	76,7	13,4	26,8	46	289	276

Source: Department of Grain Processing and Bakery, Prof. W. Dąbrowski Institute of Agricultural and Food Biotechnology – State Research Institute, 2021.





**INSTYTUT BIOTECHNOLOGII  
PRZEMYSŁU ROLNO-SPOŻYWCZEGO  
im. prof. Wacława Dąbrowskiego  
PAŃSTWOWY INSTYTUT BADAWCZY**

**ZAKŁAD PRZETWÓRSTWA ZBÓŻ I PIEKARSTWA**

---

ul. Rakowiecka 36, 02-532 Warszawa  
T: +48 22 849 04 03, [zpzip@ibprs.pl](mailto:zpzip@ibprs.pl)  
[www.ibprs.pl](http://www.ibprs.pl)

---