

Review

# Buckwheat Breeding and Seed Production in Poland

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## ABSTRACT

The history of buckwheat breeding in Poland is almost 80 years old. “Hruszowska” was the first breeding variety, which was in 1956 entered to The Polish National List of Agricultural Plant Varieties (NLI). In the history of buckwheat breeding programs in Poland, 10 varieties have been registered so far. Additionally, 3 breeding lines have been entered into official tests without a decision on entry to the NLI. During the planned economy period in Poland (until 1989), despite the limited number of varieties, the scale of production of certified buckwheat seeds practically covered the entire demand for sowing material. Currently, the small scale of buckwheat cultivation in Poland, and above all, the lack of buckwheat on the EU list of plant species varieties which are subject to national listing and which seed material may be produced, assessed, and controlled limit the scope of breeding work on buckwheat and make it difficult to obtain profitable seed trade.

## INTRODUCTION

Probable traces of buckwheat in Poland date back to around 400 BC. (Gibert, 1956). Badura's (1999) reports on the presence of remains of *Fagopyrum esculentum* in two archaeological sites dating back to the 6<sup>th</sup>-10<sup>th</sup> century AD and the remains of common buckwheat from the Wolin island dated to the 9<sup>th</sup> century (Alsleben, 1995) may indicate that its cultivation was known in these areas even before the invasions of the Mongol tribes, which is generally accepted as a buckwheat source in Europe. During the wars with the Tatars (13<sup>th</sup> century), buckwheat cultivation was popularized and intensified (Badura, 1999; Koszałka and Strzelczyk, 2015).

## Materials and Methods

The history of buckwheat breeding and cultivation in Poland, the number of registered varieties and variety movement in the The Polish National List of Agricultural Plant Varieties were presented on the basis of a query of archival materials and old prints as well as legal acts related to the subject and current publications.

Cultivars' characteristics were based on literature sources, source data from Research Centre for Cultivar Testing (COBORU), and accession descriptions from the National Center for Plant Genetic Resources: Polish Genebank (KCRZG). The scale of production was presented on the basis of source data from Statistics Poland (GUS)

and FAOSTAT and a query of historical studies. The characteristics of the seed market were made using source data obtained from Plant Health and Seed Inspection Service (PIORiN).

## RESULTS

### Buckwheat production in Poland

The first records of buckwheat cultivation in Poland date back to the 15<sup>th</sup> century (Zemanek et al., 2009). Buckwheat has always been a minor crop. In the agricultural literature of the sixteenth century, it was not recommended to grow it in larger areas but generally in areas after frozen winter crops (Gostomski, 1588). Buckwheat growing was in Poland mostly spread in the 17<sup>th</sup> century, and since then, it has been gradually replaced by oats (Król, 1986). In the interwar period (1920-1939), its cultivation area was about 150 thousand ha, falling three times in the second half of the twentieth century.

Currently, buckwheat is cultivated in Poland in an area of approx. 114,000 hectares, this is 1.6% in the entire sowing structure and slightly more than 1% in the cereal sowing structure (Fig. 1).

The scale of buckwheat production in Poland corresponds to the size of the sown area, due to the seed yield

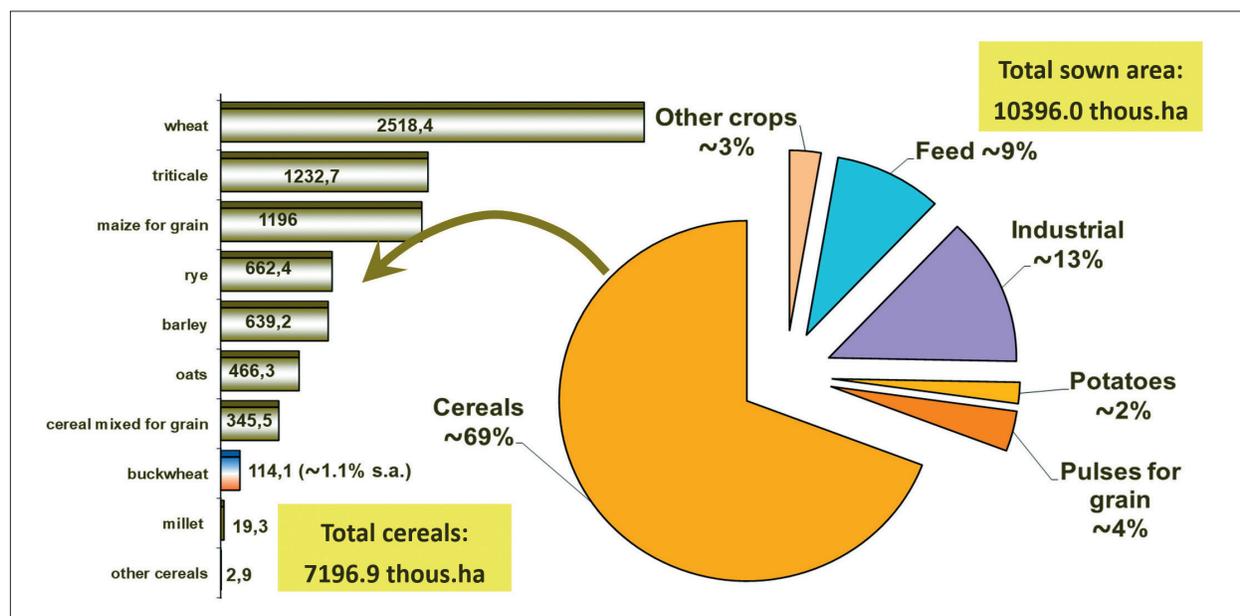
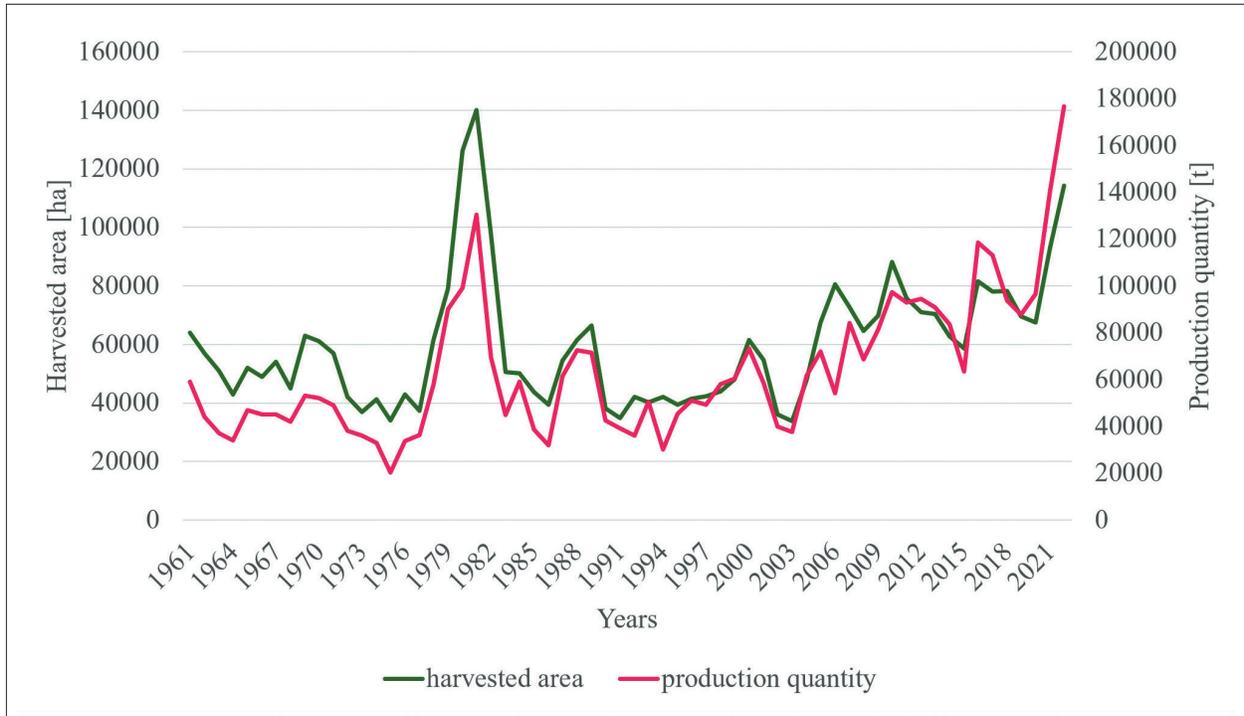


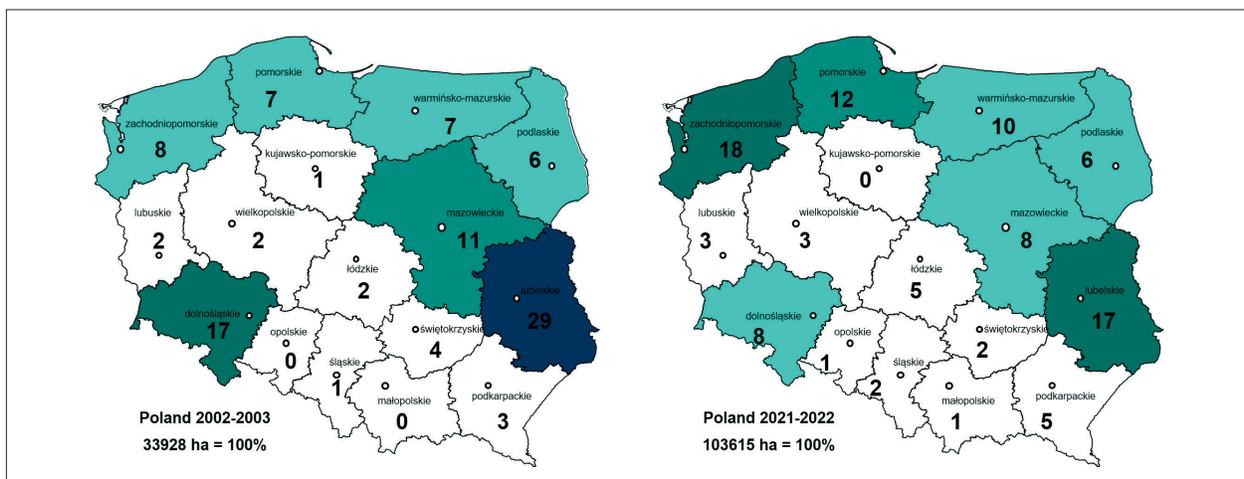
Fig. 1. Sown area in Poland (2022) (Source: own elaboration based on data provided by GUS 2023 (Statistics Poland))



**Fig. 2.** Harvested area and production quantity of buckwheat in Poland (1961-2022) (Source: own elaboration based on data provided by GUS and FAOSTAT)

oscillating around 1 t per hectare. Until the 1980s, buckwheat production per hectare did not exceed 1 t per ha, which reduced the scale of production. In the last decade, there has been a clear improvement in the yield of this pseudocereal (Fig. 2).

Buckwheat cultivation in Poland is concentrated primarily in the east and north of Poland. The traditional production area remains the Lublin region. The Dolnośląskie Voivodeship also has a relatively large share in buckwheat production (Fig. 3). In addition to historical



**Fig. 3.** Distribution of buckwheat growing in Poland (the average for the years 2002-2003 and 2021-2022, compiled based on data from the GUS 2023)

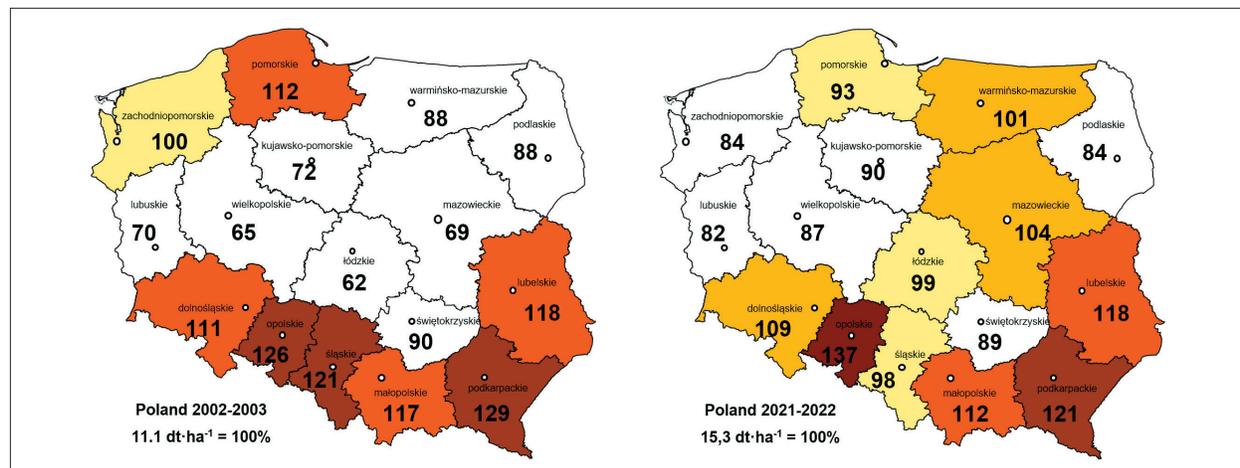


Fig. 4. Relative yields of buckwheat in Poland (the average for the years 2002-2003 and 2021-2022, compiled based on data from the GUS 2023)

traditions, the location of the buckwheat processing industry in Poland still has a significant impact on the distribution of buckwheat cultivation.

The highest yields are obtained in the south-east and south of the country, but considering the scale of production, attention should again be paid to the Lubelskie region and Lower Silesian. In the remaining southern regions, the high productivity reported in statistical reports is due to the extremely small size of crops (single plantations) and not to the mass scale of buckwheat production (Fig. 4).

### Buckwheat breeding in Poland

The buckwheat breeding program in Poland began late, compared to other species. In the Polish agricultural literature from the nineteenth century, there are descriptions of two varieties of buckwheat, but this applies to ecotypes and not agricultural cultivars (Tab. 1).

The first form was called black or common buckwheat, with dark brown or black seeds. The second form was called Scottish or Swedish, or silver buckwheat. It was characterized by a light gray color of seeds (less fertile, with higher soil requirements, maturing later, with

Table 1. Species and forms of cultivated buckwheat described in agricultural literature at the turn of the 19<sup>th</sup> and 20<sup>th</sup> centuries

Species	Forms	Additional information
<b>Common buckwheat</b> <i>(Fagopyrum esculentum Moench)</i>  <b>Tatarka,</b> <b>Hreczka,</b> <b>Gryka</b>	<b>Czarna (Black)</b> or <b>Zwyczajna (Common)</b>	dark brown, almost black small achenes, good yielding form
	<b>Szkocka (Scotch) or</b> <b>Szwedzka (Swedish) or</b> <b>Srebrna (Silver)</b>	the light gray color of achenes, less fertile, with higher soil requirements, later maturing, with larger seeds
<b>Tartary buckwheat</b> <i>(Fagopyrum tataricum (L.) Gaertn.)</i>  <b>Tatarka,</b> <b>Gryka syberyjska</b> (Siberian buckwheat) <b>Chińska tatarka</b> (Chinese buckwheat) <b>Rdest tatarski</b> (Tatar knotweed) ( <i>Polygonum tataricum</i> or <i>P. emarginatum Rth.</i> )	cultivated and weed	high green biomass, low yield of achenes, late ripening; cultivated to obtain green biomass for fodder; some of its forms as a weed in the cultivation of common buckwheat

finer seeds) (Kowalski, 1885; Jachner 1920). Tartary buckwheat (*Fagopyrum tataricum* (L.) Gaertn), also known as Siberian buckwheat or Chinese tartare or Tartar knotweed (*Polygonum tataricum* or *P. emarginatum* Rth.) used for green fodder was also cultivated. Even then, attention was paid to the form of Tartary buckwheat, which appeared as a weed in buckwheat fields (Krafft 1876).

In the late thirties of the twentieth century, preliminary breeding studies began at the Institute of Soil Science and Plant Cultivation (IUNG) in Puławy, failing to create expected cultivars (Arseniuk et al., 2009). Breeding work returned at the turn of the 40s and 50s of the twentieth century. In the first period, 9 local buckwheat ecotypes (created by farmers as a result of long-term selection) were collected (Ruszkowski, 1955; Ruebenbauer and Brej, 1957). They were characterized by a relatively short vegetation period, a short stem and little branching, and a low 1,000 seed weight (Ruszkowski, 1983) (Tab. 2).

The first Polish cultivated buckwheat varieties created on the basis of the selection of the best individuals within local ecotypes were: “Hruszowska” (1957), “Puławska” (1958), “Modzurowska” (year not known),

and “Dańkowska” (1963) (Król, 1986). In the 1960s, new breeding directions were set and the new methods used in buckwheat breeding were extended. In 1969, the first tetraploid variety “Emka” was registered. It was created by genomic mutation by doubling the number of chromosomes using colchicine (Komenda-Ronka et al., 1994). Due to the larger size of achenes, requiring changes in the buckwheat processing and a higher share of husks, the variety did not gain the interest of farmers and processors, and work on further polyploids was limited (Tab. 3) (COBORU, 1980; 1983; 1985; 1987; Komenda-Ronka et al., 1994).

Ather Polish varieties (Kora, Luba, Panda) were created by crossing ecologically distant forms. At the turn of the 70s and 80s, mutagenesis developed in Polish breeding of buckwheat (Samborska-Ciania, 1999). The work led to the development of two lines (Gema and Green Corolla), with increased inflorescences and achenes on the plant and thin husk (Komenda-Ronka et al., 1994). In parallel, work was carried out on homostyle self-fertile forms. Despite high hopes placed in this direction of breeding (synthetic, hybrid varieties), it did not bring the desired results (Ruszkowski and Noworolnik, 1983).

**Table 2.** Local ecotypes of buckwheat grown in Poland until the 1960s (Source: Ruszkowski, 1983)

Ecotype	Vegetation period	Plant height [cm]	1000 seed weight [g]	Soil requirements	Additional information
Borówka	short	25-45	18-24	light soil	Small, dark brown achenes. High yield - 2.0 t·ha <sup>-1</sup> , high yield of groats
Majówka	long	50-70	22-23	from light to heavy soil	Light brown achenes, small yield of achenes and groats
Ruska	long	do 100	15-17		Unstable yield
Podolanka	short	do 40	18-20	light soil	Brown achenes with wings. Stable and good yielding ecotype, also like a cath crop
Holewica	Medium long	do 55	22-23	Wet sandy soil on slope	Very easy infested by Tartary buckwheat
Różowa (Pink)	long	45-55	ok. 20		Pink perianth ecotyp. Dark brown achenes, strongly embedded in the bottom of flower
Biała (White)	short	do 50 cm	20-21		Uniform ripening, brown achenes
Siwa (Gray)	middle	70-80	17-19	light also new soil	Gray-brown achenes with wings, embedded in all inflorescences, without shattering.
Czarna (Black)	short	30-40	13-18	light soil	Uniform ripening, dark brown almost black achenes

**Table 3.** Polish cultivars of buckwheat (Source: own study based on the : COBORU, 1970; 1976; 1993; 1996; 1998; 2017; 2019; 2023; Arseniuk i in. 2003; Suchecki, 2008; Monitor Polski, 1958; 1959; 1964; 1970; Plant Breeding and Acclimatization Institute – NRI/National Centre for plant genetic resources data base, access: May 2023)

Cultivar	Entry date	Date of deletion	Breeder	Author of cultivar	Description
<b>Hruszowska</b>	1957	2008	Stacja Hodowli Roślin Hruszów	Alina Dziubikowska, A. Bęcik, Bogusław Komenda, Kalina Komenda, J. Got, W. Got	ecotypes from Rejowiec, Hruszów, Radzyń Podlaski and Puławy region
<b>Puławska</b>	1958	1976	IHAR Puławy/ Staszówek/ Chodów	Stefan Lewicki, Marek Ruszkowski	Selection from domestic local population (Lublin region)
<b>Modzurowska</b>	?*	?*	Centralne Zrzeszenie Selekcji Roślin	?*	?*
<b>Dańkowska</b>	1963	1969	Stacja Hodowli Roślin Dańków	Stanisław Janasz, Piotr Kolago, Tadeusz Wolski, Stanisław Ramenda	Selection from domestic local ecotypes (Gościeradowo and Nowe Miasto regions).
<b>Emka (4x)</b>	1969	1996	Stacja Hodowli Roślin Jeleniec	Kalina Komenda, Bogusław Komenda, Mirosław Łapiński	Krupnieplodnaja 4n x form of 4n from Hruszowska cv.
<b>JEC 179</b>	1980	1983	Stacja Hodowli Roślin Jeleniec		Breeding line applied for addition to NLI (The Polish National List of Agricultural Plant Varieties) without acceptance for the official testing
<b>JEC 284</b>	1985	1987	Stacja Hodowli Roślin Jeleniec		Tetraploid (4n) Breeding line applied for addition to NLI without acceptance for the official testing
<b>Kora</b>	1993 2017	2004 (2027)	Stacja Hodowli Roślin Jeleniec / Palikije / Małopolska Hodowla Roślin Spółka z o.o.	Bogusław Komenda, Kalina Komenda, Joanna Komenda-Ronka (Wolińska)	Cultivar's cross
<b>Luba</b>	1998	2004	Stacja Hodowli Roślin Palikije	Bogusław Komenda, Szymon Suchecki	Cross of Jubilejnaja with Hruszowska and own breeding materials
<b>Panda</b>	1998 2017	2004 (2027)	Stacja Hodowli Roślin Palikije / Małopolska Hodowla Roślin Spółka z o.o.	Bogusław Komenda, Szymon Suchecki	Cross within own breeding materials
<b>MHR Korona</b>	2019	(2029)	Małopolska Hodowla Roślin Spółka z o.o.	Szymon Suchecki?*	Cross of Koto x Kora
<b>MHR Smuga</b>	2019	(2029)	Małopolska Hodowla Roślin Spółka z o.o.	Szymon Suchecki?*	Cross of Smugljanka x Kora
<b>GK/2022/1</b>	2022		"Pietrzak" sp. z o.o. sp. k.		Breeding line applied for addition to NLI and accepted in 2023 for the official testing. Origin?

\* In the table are question marks where the information is not confirmed

**Table 4.** Yield of buckwheat seeds in official cultivar studies (Source: own calculations based on COBORU 2015; 2018 data)

Cultivar	Breeder	Seed yield					
		dt·ha <sup>-1</sup>					
		2014	2015	2016	2017	2018	Mean
Standard*	MHR, Poland	19.9 (8.1-26.5)	16.2 (9.0-29.0)	21.9 (7.6-28.3)	17.0 (9.2-25.2)	17.3 (10.6-31.4)	18.5
Kora		20.4	16.0	22.4	17.3	17.3	18.7
Panda		18.7	16.2	22.0	16.7	17.3	18.2
PA 13		20.6	16.6				18.6
PA 14				20.2	16.4	18.2	18.3
PA 15			15.8	23.3	17.4	18.7	18.8
		% of standard					
Standard*	MHR, Poland	19.9	16.2	21.9	17.0	17.3	18.5
Kora		103	98	102	102	100	101
Panda		94	99	100	98	100	98
PA 13		103	102				103
PA 14				92	97	105	98
PA 15			98	106	102	108	104
Yield in production areas (dt·ha <sup>-1</sup> )		13.3	10.9	14.6	14.5	12.0	13.1
Yield of standard vs. production (%)		150	149	150	117	144	141

\*Standard: 2014-2016 – Kora, Panda, PA 13; 2017-2018 – Kora, Panda

After the political and economic transformation in Poland (1989/1990), breeding programs of buckwheat were suspended, and only conservative breeding of owned varieties was carried out, as well as reproduction and evaluation of buckwheat collection from the resources of the Polish gene bank (Suchecki, 2006).

In 2008, the breeding of buckwheat was taken over by a strong, professional breeding company – Małopolska Hodowla Roślin (Małopolska Plant Breeding Company) as a result of consolidation in the Polish breeding and seed sector. It should be mentioned that after Polish accession to the European Union, the situation in buckwheat breeding was difficult because buckwheat was excluded from the varieties registration and seed certification system. Only changes in seed regulations in 2016 allowed for the registration of buckwheat varieties as a species traditionally cultivated in Poland. This change and the new company's strategy resulted in the introduction of new buckwheat varieties MHR Smuga and MHR Korona, to the Polish official catalogue. Cur-

rently, another breeding line (GK/2022/1) from one of the seed companies from Mazovia has appeared in the registry research.

The results of official variety research show high variability in seed yields of buckwheat varieties and new breeding lines between years and places of experiment (Tab. 4).

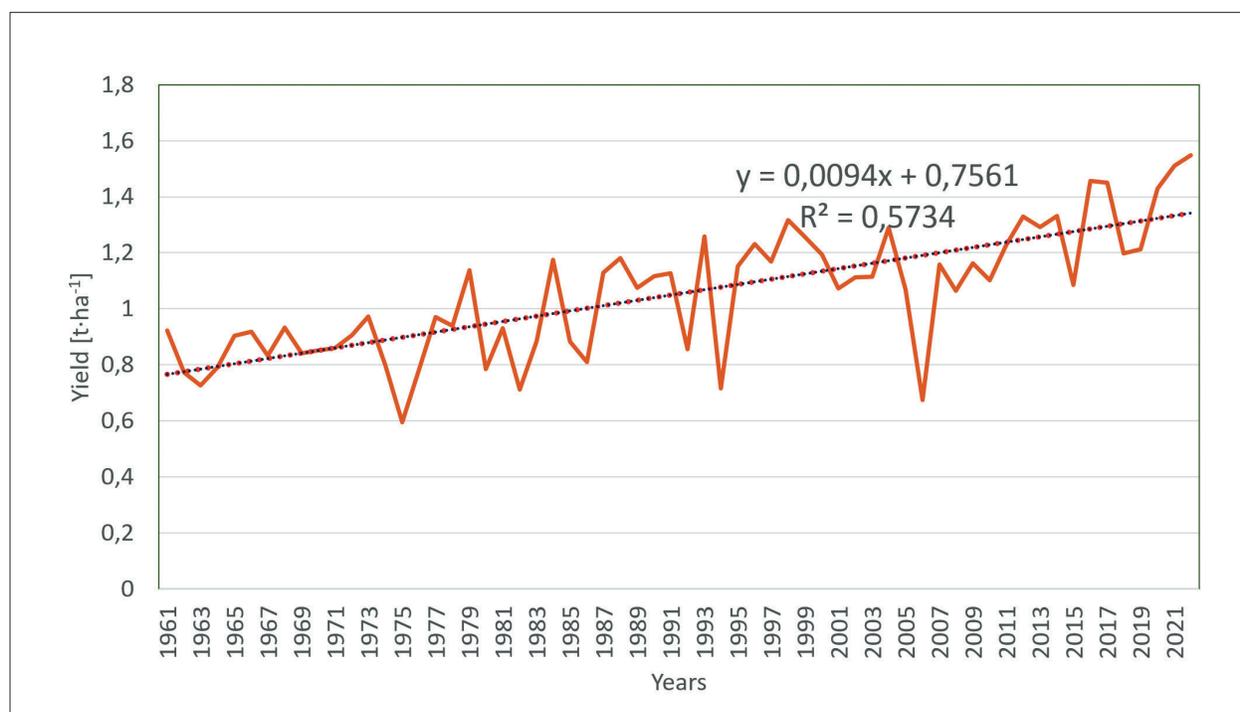
The same is in the results of organic variety testing of buckwheat (Tab. 5).

Although the progress in buckwheat breeding is not big, new varieties are gradually entering into agricultural practice. The introduction of new varieties to production has contributed to a systematic increase in the yield. Although it is very small - an average of about 9.5 kg per hectare per year, the trend is clear (Fig. 5).

For almost 70 years, buckwheat breeding was carried out primarily by the state-owned company Lublin Plant Breeding in the Lublin region (Plant Breeding Station in Hruszów, Jeleniec, Palikije). Over the past 15 years, a breeding program has been conducted at the Malopol-

**Table 5.** Yield of buckwheat seeds in ecological cultivar experiments in 2022 (Source: COBORU 2023)

Lp.	Cultivar	Białogard		Krzyżewo		Śrem Wójt.		Lućmierz		Cicibór duży		Mean	
		dt·ha <sup>-1</sup>	% of standard										
	Standard	14.4		7.5		8.9		25.5		17.3		16.2	
1	Kora	14.0	97	8	108	7.7	87	24.3	95	18.1	104	-0.1	99
2	Panda	15.0	104	7.3	98	8.6	97	24.8	97	17.9	103	0.1	100
3	MHR Korona	14.4	<b>100</b>	8	<b>108</b>	10.8	<b>121</b>	26.5	<b>104</b>	17.4	<b>100</b>	0.4	<b>102</b>
4	MHR Smuga	14.2	99	6.5	87	8.3	94	26.5	104	15.9	92	-0.4	98

**Fig. 5.** Yield of buckwheat achenes in production [t·ha<sup>-1</sup>] (Source: own elaboration based on data provided by GUS and FAOSTAT)

ska Plant Breeding Company (Plant Breeding Station in Nieznanice).

### Buckwheat seed market in Poland

Seed is the carrier of genetic potential for the performance of a crop. Buckwheat seed sector in Poland preceded its breeding by almost a century. From the early periods of buckwheat cultivation to the beginning of

the 19<sup>th</sup> century, when the foundations of the seed industry began to take shape, farmers used their harvested seeds for sowing. At that time, many farmers believed that only small sized buckwheat seeds should be used for sowing (Sempołowski 1902, Miczyński 1909, Komenda et al. 1994). This view was due to two reasons. The first concerned the volumetric measure of seeds for sowing. The same volume contained more fine seeds, which, un-

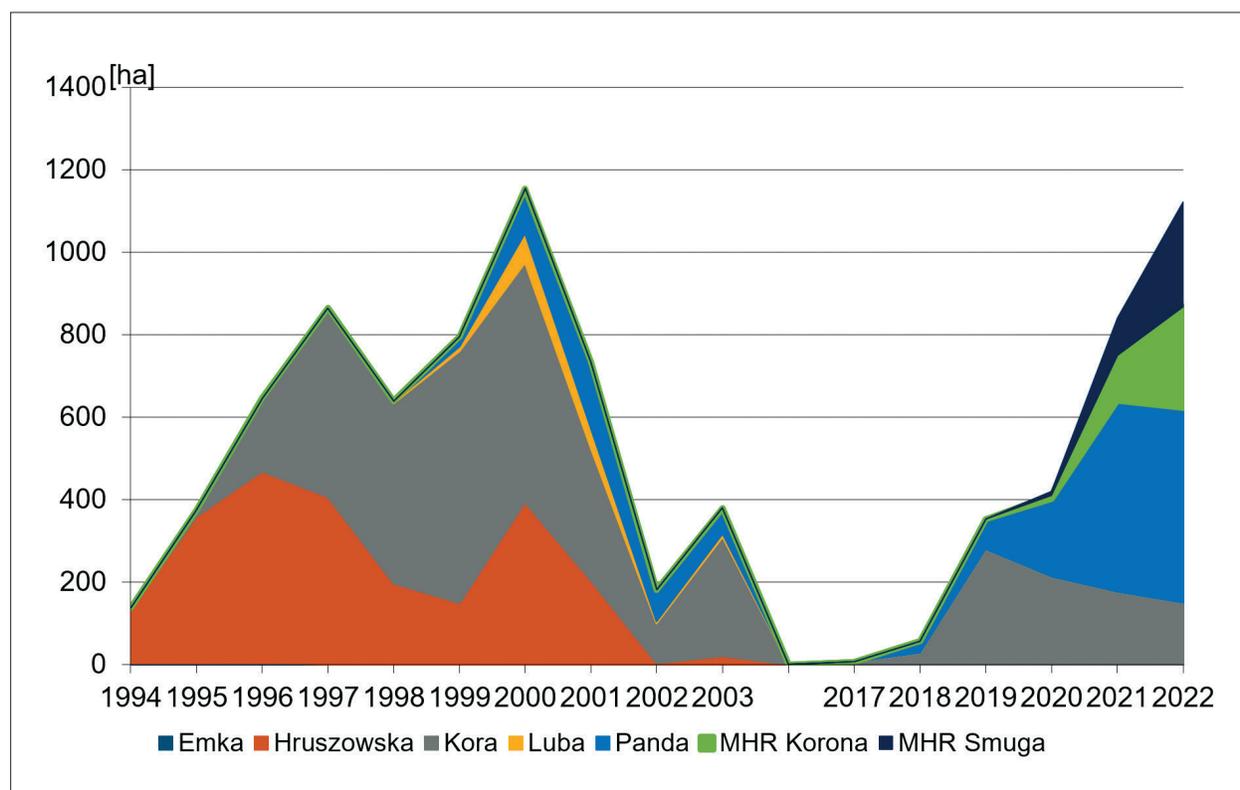
der favorable conditions, resulted in a higher density of plants per area unit than large, heavy seeds. The second premise resulted from frequent weed infestation of buckwheat plantations with Tartary buckwheat plants. Tartary buckwheat seeds (with wings) are similar in size to good buckwheat seeds, and therefore when using small common buckwheat seeds for sowing, there was no Tartary buckwheat in the sowing material (Komenda et al. 1994).

With the development of seed testing stations in Europe (including Poland land) in the second half of the nineteenth century, this species' seed samples were submitted for testing. These were few samples because at that time mainly the seeds of small-seeded *Fabaceae* species were tested. However, they show that attention was paid to the quality of the seed material of this cereal. At the end of the 19<sup>th</sup> century, Sempołowski (1899) based on the testing of many seed samples, proposed the following quality requirements for buckwheat seeds: germination - minimum 80% and purity - minimum 98%. These requirements were slightly stricter (seed purity)

than those in force today in Poland. The system of seed quality standards evolved, and at the beginning of the 20th century, the Polish seed market introduced quality requirements for buckwheat seeds with three quality levels: high (germination – 96%, purity - 98%), medium (90 and 93%) and the lowest (80 and 90%) (Jachner 1920). The results of buckwheat seed quality published in the years 1913-1915 indicate high germination capacity (98-99%) and sufficient purity (83.9-98.4%) of buckwheat seed material (Grabowski 1920).

In 1994-2003 the area allocated to buckwheat seed production ranged from 169 ha in 2002 to 1129 ha in 2000. The leading varieties in reproduction were: Hruszowska, Kora, and later Panda. The weight of certified seed varied from 1996 to 2002, and nearly five-fold differences were observed between the years (Fig. 6).

Following the harmonization of Polish seed laws with EU regulations (2004), buckwheat was removed from the official crop list, and selected varieties were deprived of legal production (no novelty varieties). No official controls were imposed on seed production, supplies were not



**Fig. 6.** Seed production area of buckwheat in Poland in 1994-2003 and 2017-2022 [ha] (Source: own elaboration based on data provided by PIORIN (The State Plant Health and Seed Inspection Service))

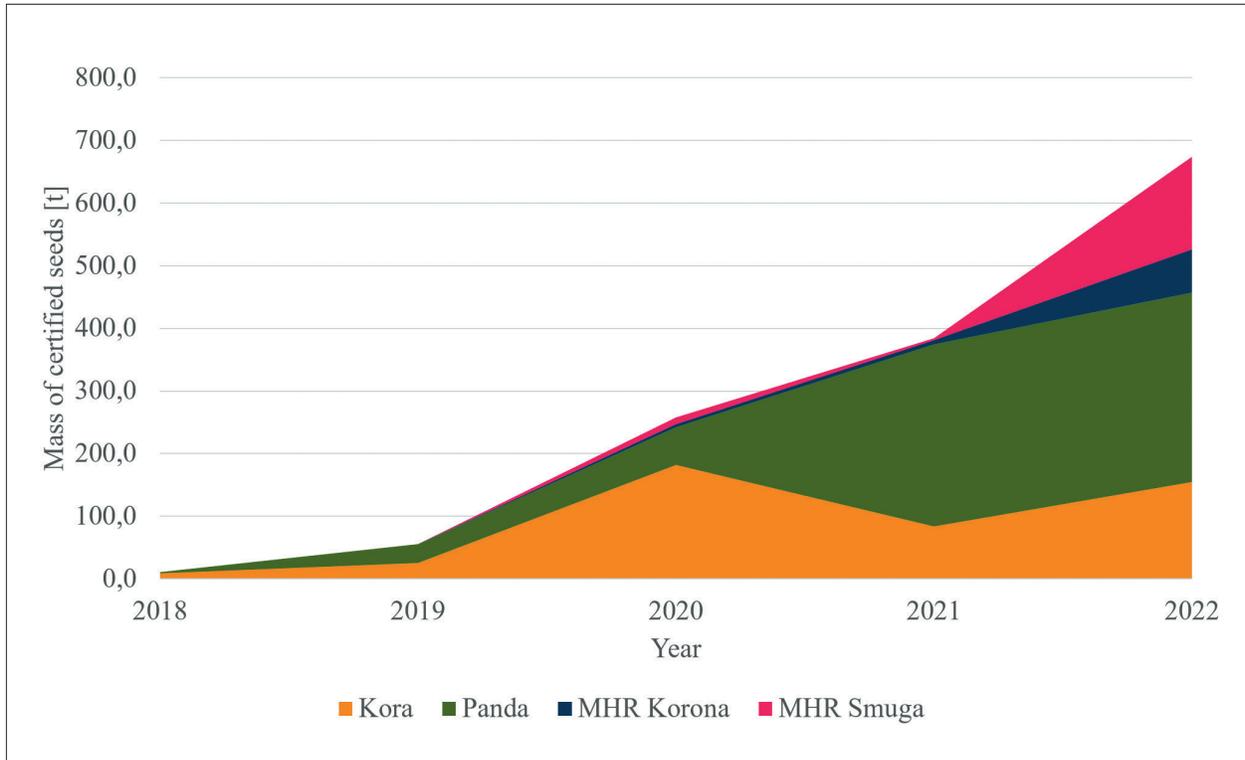


Fig. 7. Mass of certified seed of buckwheat in Poland in 2018-2022 (Source: own elaboration based on data provided by PIORIN)

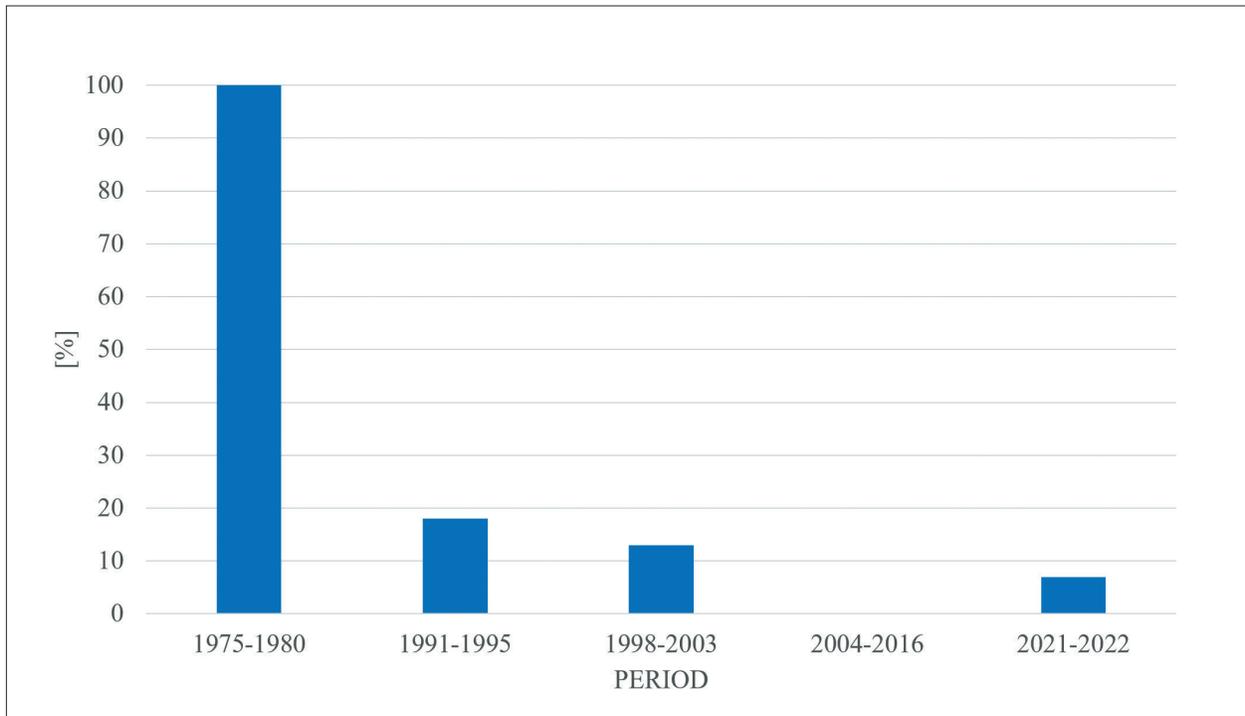


Fig. 8. Percentage of buckwheat production area sown with certified seeds (Source: own calculations based on PIORiN and GUS data)

under obligation to pay license fees, and they were not held accountable for seed quality. The Polish market was flooded with foreign buckwheat varieties produced in the east countries.

With the change of seed regulations in 2016, which enabled the registration of buckwheat varieties, the production of certified seeds of this species was resumed. In the first year after the change in the regulations (2017), two seed material plantations of the Kora and Panda cultivars, with a total area of 6.5 ha, were submitted for evaluation. Since then, there has been a steady increase in both the area of seed plantations and the quantity of certified seed. In 2022, the area of buckwheat seed plantations was nearly 1,090 ha. The Panda cultivar had a dominant share in it (43%). The total share of two new cultivars: Korona and Smuga was similar to Panda. The

quantity of certified seed of buckwheat increased from 10.7t in 2018 to 674t in 2022 (Fig. 7).

Such quantity allows for sowing with certified material on only 7% of the buckwheat's production area. In comparison - in the 1990s, the percentage was twice as high. However, considering current specific status of buckwheat in terms of variety registration and seed certification, non-certified seeds on the seed market can exist, with confirmed or unconfirmed quality in seed laboratories (Fig. 8).

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## IZVLEČEK

### Žlahtnjenje ajde in semenarstvo na Poljskem

Ajdo so na Poljskem začeli žlahtniti pred skoraj 80 leti. 'Hruszowska' je bila prva požlahtnjena sorta, leta 1956 je bila vključena v uradno poljsko sortno listo (The Polish National List of Agricultural Plant Varieties (NLI)). Doslej je bilo uradno potrjenih 10 sort ajde. Dodatno so bile tri žlahtniteljske linije vključene v uradno testiranje, a brez vključitve v uradno listo (NLI). V času planskega gospodarstva (do leta 1989), je bilo ne glede na omejeno število sort dovolj potrebnega semena ajde glede na povpraševanje. Sedaj je zaradi manjšega pridelovanja ajde na Poljskem in glede na to, da ajde ni na uradnem seznamu sort v EU manjše zanimanje za trgovanje s potrjenim semenskim materialom ajde.