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RYE PRODUCTION AND BREEDING IN POLAND

ABSTRACT

Rye (*Secale cereale* L.) originates from Asia Minor, where it has been grown for food and feed since the time of Roman Empire. In the 5th century B.C. rye was brought to Poland. Comparatively low environmental requirements, high uptake potential of macro– and micronutritients from a poor soil, tolerance to acid pH, low temperatures and frost resistance contributed to widespread cultivation of rye in Poland since ever. Over the centuries rye has become a staple crop in the country. In XVI and XVII centuries , in addition to human and animal feeding rye was extensively produced for export. Before the Second World War rye constituted 60% of grain production of all small grain cereal species in Poland. Rye made bread was at high demand and constituted 85% of all consummed one. Up to present rye is used for human consumption, animal feeding and alcohol production.In 1950s rye was grown on 5 mln ha and constituted 53% of all cereal grown in the country. Since that time the acreage of rye grown in Poland has been dropping steadily down. It is anticipated that when Poland will join the European Union the rye acreage will drop further down to 1.6–1.3 mln ha and remaining land will be forested or laid fallow.

Rye improvement by breeding in Poland has a long tradition. So far, over 80 cultivars were under production. Cultivars with an epithet 'Dańkowskie' are known for about a century. Up to 1995 solely population rye cultivars in Poland was released. Poznań Plant Breeding Co. Ltd., Danko Plant Breeding Co. Ltd and IHAR/Smolice Plant Breeding Co. Ltd. arre the main breediders and competitors over the last half of a century. In 2000 twenty one rye cultivars were officially registrated in poland. The first hybrid rye cultivar was registrated in Poland by german breeders in 1995 under the name Marder. Afterwards, other hybrid cultivars have been appearing on Polish market – Esprit (1996), Nawid (1998), Luco (1999), Klawo and Ursus (2000).

Kye words: breeding of rye, cultivation of rye, hybrid rye

RYE ORIGIN AND PRODUCTION

Rye (*Secale cereale* L.) originates from Minor Asia (Vavilov 1917), where on the northern part of Alps it has been grown for food and feed since the time of Roman Empire. Most probably in the 5th century B.C. rye was brought to Poland. Comparatively low environmental requirements, high uptake potential of macro– and micronutrients from a poor soil, tolerance to acidic pH, low temperatures and frost resistance contributed to widespread cultivation of rye in Poland since ever. It is necessary to stress that high hectareage of light, acidic soils (about 50–60%)

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in Poland is very stimulative for rye cultivation. Rye is grown in the whole country but especially in Mazowsze – Podlasie and Wielkopolska lowlands as well as in Gdańsk – Kołobrzeg Pomerania regions, where the share of rye soils is the largest (Figure 1).

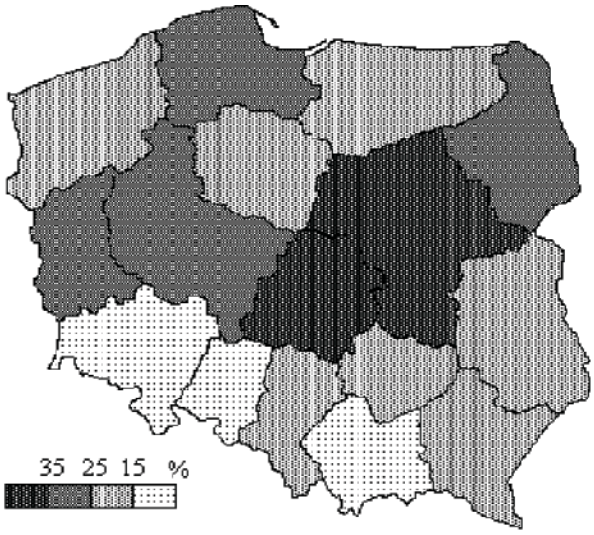

Fig. 1 Geographic distribution of rye plantations in Poland

In 1950s rye was grown in Poland on 5 mln ha and constituted 53% of all cereals grown in the country. Since that time the hectareage of rye grown in Poland has been dropping steadily down because of many rea–sons explained beneath (Figure 2).

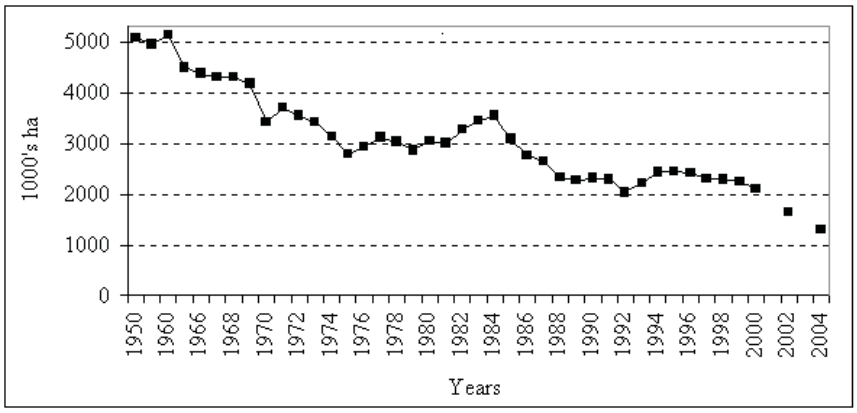

Fig. 2 Hectareages of rye grown in Poland over 1950 – 2004

Nevertheless, in 2000 rye was still grown on 2.13 mln. ha, what constituted 25.8% of hectareage of all cereals grown in Poland. It is anticipated, that when Poland will join the European Union the rye acreage will drop further down to 1.6 – 1.3 mln ha and the remaining land will be forested or lain fallow (Rabinowicz 2000). Data presented in Table 1 show that the largest rye grower in the world is Russia. Poland is rated second regarding the growing rye area on which produces the largest amount of grain worldwide, constituting 26.8% of world production of the crop grain.

Table 1

The largest rye growers and producers in 1999 worldwide

No.	Country	Growing area [1000's ha]	% of the total	Total yields [1000's tons]	% of the total
1.	Poland	2243	22.8	5181	26.8
2.	Russia	4000	40.7	4500	23.2
3.	Germany	825	8.4	4289	22.2
4.	Belarus	800	8.1	1370	7.1
5.	Ukraine	600	6.1	1200	6.2
6.	China	500	5.1	800	4.1
7.	Danmark	90	0.9	470	2.4
8.	Lithuania	159	1.6	393	2.0
9.	Canada	166	1.7	376	1.9
10.	USA	160	1.6	280	1.4
11.	Spain	124	1.3	261	1.3
12.	Turkey	153	1.6	237	1.2
	Total	9820	100.0	19357	100.0

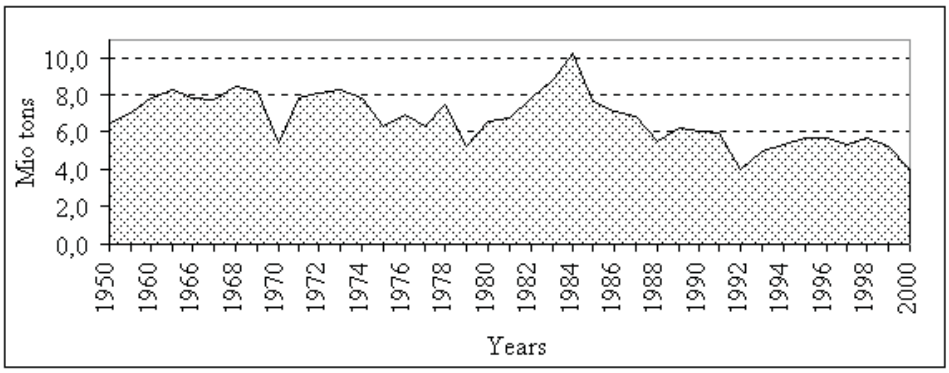

Fig. 3 Rye grain production in Poland over 1950 – 2000

The reduction in rye production area in Poland has not been compensated by increasing the total grain production (Fig. 3, Fig. 4) and grain

yields, which even dropped from the range of 20 – 25 dt/ha to 18 dt/ha in recent years.

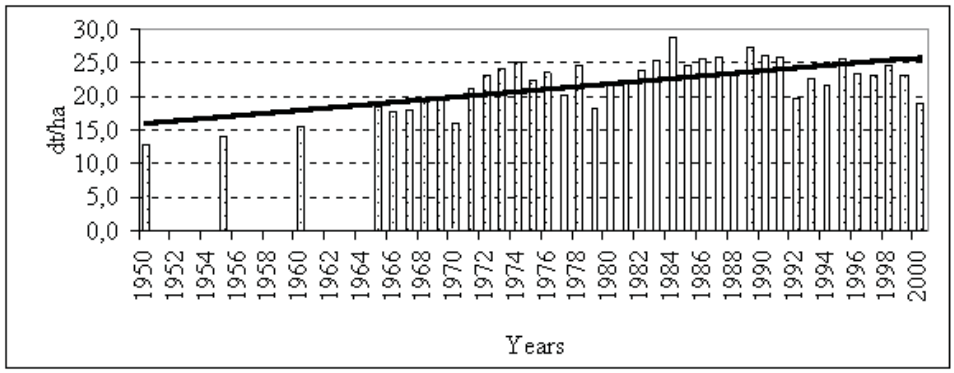

Fig. 4 Rye grain yield in Poland over 1950 – 2000

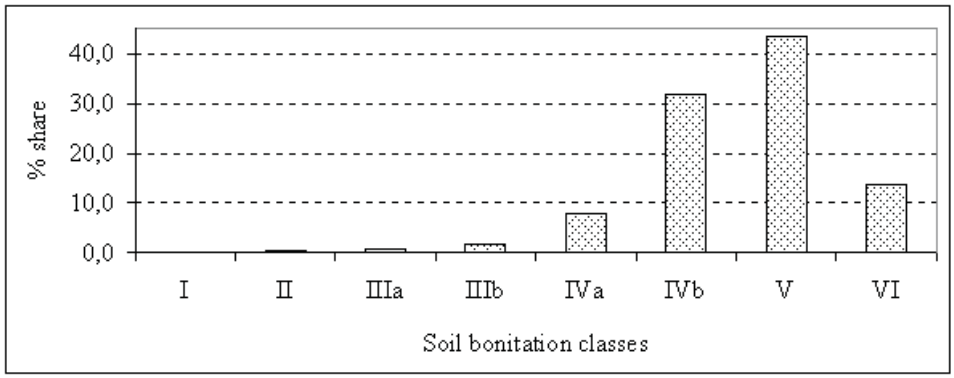

Fig. 5 Soil structure used for growing rye in Poland (survey data of 1999)

In addition, a steady improvement of other cereals for their ability to grow on poorer soils, e.g. triticale, contributes steadily to withdrawing of rye cultivation from better onto poorer soils. Traditionally, rye was grown on poorest soils, which affected its yielding capacity. At present, the soils on which rye is grown in Poland range from IVa to VI bonitation class (Fig. 5).

Low prices for rye grain on the cereal market accompanied by increas–ing costs of production means have contributed into unprofitability of rye production on the poorest soils. Under present Polish conditions rye grain yield lower than 40 – 45 dt/ha makes its production unprofitable. Rye grain yield also heavily depends upon a rainfall. Decreasing de–mand for straw has also contributed to the reduction of rye cultivation and production. Under a standard production technology at least 70 ha

are necessary to put under rye production in order to get a satisfactory income for a farm to function (Grabiński 2000).

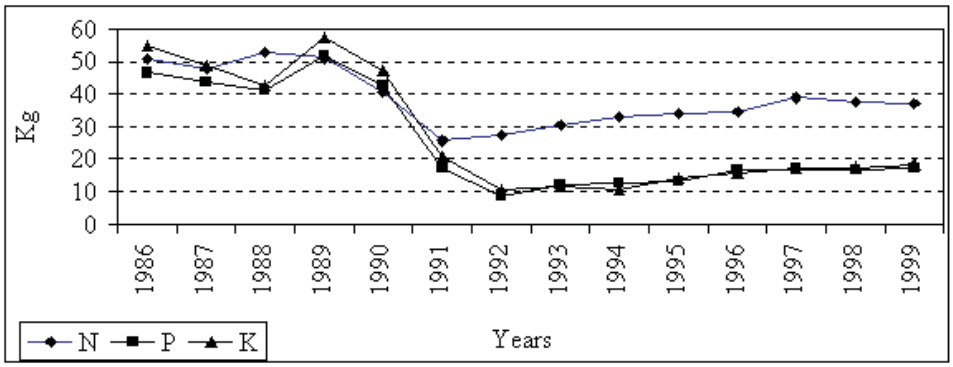

Fig. 6 Mineral fertilization of rye in Poland with nitrogen (N), phosphorus (P) and potassium K (over 1986 – 2000, survey data)

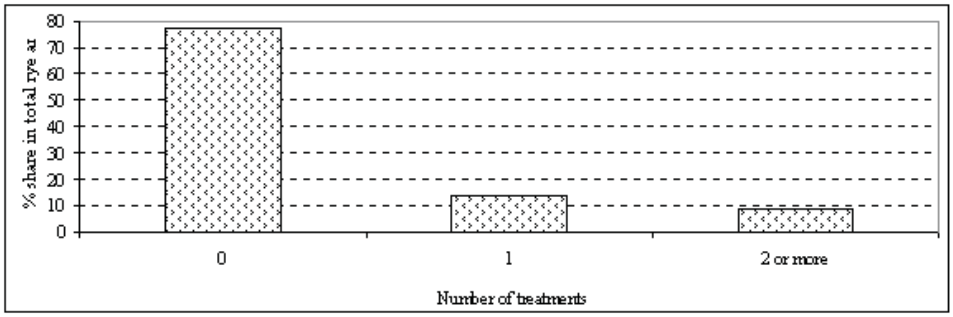

Fig. 7 Chemical control of rye plantations against pathogens, pests and weeds in 1999

According to findings of Dzierżyc (1993) and Dmowski (1993) differ–ences in yielding capacity of rye depended heavily on soil quality and reached up to 50%. Cultivation technology can reduce such differences, to about 10% if it is satisfactory (Mazurek 1989) and 4 – 5% when the technology is at a level allowing to get a yield of 6 tons of grain from 1 ha (Budzyński 2000). However, the,cultivation technology applied by farmers is far from recommendations of agricultural specialists. Rye is usually the last crop in crop rotation, where also a cereal was fore crop–ped. In addition to the above factors, triticale, a new man made crop, is competing successfully with rye for better soils since 1980's.

Such a negative course of events for rye is not necessarily offset by ap–plication of yield making factors, e.g. low input rye cultivars, better mineral fertilization (Fig. 6), application of pesticides (Fig. 7).

The use of better cultivars will be discussed in the following chapter on rye breeding. As it is demonstrated on Fig. 6 the application of fertilizers by Polish farmers dropped rapidly down after 1990 and over the following years it is climbing up very slowly. The optimal dosage of nitrogen should be 100 kg/ha (Fotyma 1998) for conventional cultivars and 140 – 160 kg/ha for the hybrid ones. The optimal dosage of NPK, i.e. nitrogen, phosphorus, potassium, should reach 280 – 300 per 1ha. The data in Figure 6 show, that the dosages are well below the recommended ones.

Also, the control of rye pests, pathogens and weeds seems to be insufficient. Although, no major disease epidemics on rye in Poland have been reported in recent years. However, such diseases like leaf rust (causal agent: *Puccinia recondita* f. sp. *secalis*), powdery mildew (causal agent *Erysiphe graminis* f. sp. *secalis*), head blight and snow molds (*Fusarium* spp., *Microdochium nivale*), ergot (*Claviceps purpurea*) and scald (*Rhychosporium secalis*) are quite common on rye in Poland. The majority of rye plantations (77%) is not treated with any pesticide. Only 14% and 9% of plantations are treated twice (seed treatment with a pesticide and a herbicide application) and once, respectively (Fig. 7).

Over the centuries rye has become a staple crop in Poland. In XVI and XVII centuries, in addition to human and animal feeding, rye was extensively produced for export. Before the World War II rye constituted 60% of grain production of all small grain cereal species in Poland. Rye made bread was at high demand and constituted 85% of total bread consumption. Up to the present rye is used for animal feeding, human consumption and alcohol production (Czarnecki, Michniewicz 2000). The nutritional value of rye is lower than other cereals. Its use for animal feeding is reduced by resorcinols and starch less polysaccharides contained in grain. Nevertheless, more than 50% of rye is used for feeding. Digestible protein content in rye grain is lower than one in wheat and barley, although, its energetic value is comparable to the latter small grain cereal species.

Close to 25% of rye grain is used for human consumption. Despite of an opinion that rye flour contains many nutritional components curing, the so called, civilization diseases its use for bread making drops down all the time. In the last 50 years the percentage share of rye bread in the total bread consumption got reduced from 50% to 2%. It is also due to about 50% reduction of bread consumption during the years.

The significance of rye is steadily increasing for industrial purposes. More than 70% of alcohol in the country is produced out of rye grain. Its importance may still be increased because of use of ethanol as an environment friendly biofuel (Czarnecki, Michniewicz 2000). Nevertheless, it should be stressed, that a steady crop improvement by breeding, application of modern plant cultivation and grain production, human and animal feeding technologies, other cereal species have become more and more competitive for rye.

RYE IMPROVEMENT BY BREEDING

Rye improvement by breeding in Poland has a long and a rich tradition. The first known rye cultivar Szklane was grown in 1835 on Suchorzewski farm nearby Września in Western Poland (Grochowski, Górski 2000, Byszewski 1969). The first plant breeding companies which also were involved in rye breeding were established in 1880 by Władysław Żeleński in Grodkowice nearby Cracow and by Aleksander Janasz in Dańkow. Cultivars with an epithet "Dańkowskie" are known for more than a century. Dańkowskie Selekcyjne was the first cultivar released after a purposeful crossing of parental forms. This cultivar was grown commercially over 90 years and despite of its withdrawal from the Polish register in 1988 it is still being met on farmers fields in Poland. The other cultivar Dańkowskie Złote was released in 1968 and it is being cultivated. Its shares in commercial and certified seed production in 1999 and 2000 was 49.4% and 71%, respectively. So far, over 80 rye cultivars were under production in Poland (Krzymuski *et al.* 1992). Up to 1995 these were in great majority population type cultivars. Because of this fact Poland has been well known from population rye breeding.

Population rye cultivars from Poland are in the registers and on the fields of many countries around the world. POZNAŃ Plant Breeding Company, Ltd., DANKO Plant Breeding Co. Ltd. and SMOLICE Plant Breeding Company, Ltd. of IHAR are the main breeders and competitors since 1950s (Table 2). In 2001 twenty one rye cultivars were officially registered in Poland – 7 released by DANKO plant breeders, 4 by POZNAŃ plant breeders, 6 by SMOLICE plant breeders, and 3 were of German origin. The first hybrid rye cultivar was registered in Poland by German breeders in 1995 under the name Marder. Afterwards, other hybrid cultivars have been releasing on Polish market. These were: Esprit (1996), Nawid (1998), Luco (1999), Klawo and Ursus (2000). Among registered cultivars only one is of the spring type (Table 2). The data presented in Table 2 show that population rye cultivars are still predominating. This is also because the certified seed of hybrid cultivars is more expensive than the population ones and that their production technology is more expensive, too. The hybrid cultivars are also more vulnerable to lodging.

Despite of increasing number of rye cultivars in the Polish Register of original cultivars the certified seed production is steadily dropping down (Fig. 8). In 1999 18 900 ha was grown for certified seed production and in 2000 solely 10 300 ha of rye was grown for the purpose. The 45.5% reduction in the hectareage results from a decreasing demand for the certified seed of rye and other cereals, as well. According to conducted surveys only 11% of rye plantations is planted with the certified seed. Such a low use of certified seed by Polish farmers for plantings slows down heavily the introduction of newly released rye cultivars into commercial production. This way, rye breeding is adversely affected, too.

Table 2

Percent share in certified seed production of selected cultivars from the Polish register

Owner Company	Registration year	Cultivar	1998	1999	2000
		Winter type	%	%	%
IHAR/SMOLICE Co. Ltd.	1996	Zduno	1.0	3.4	2.8
	1994	Wibro	8.3	10.8	5.2
	1999	Hegro	–	–	0.3
	1999	Luco F_1	–	0.0	–
	2000	Klawo F_1	–	0.0	–
	2001	Bosmo	–	–	–
DANKO Co. Ltd.	1968	Dańkowskie Złote	57.7	40	49.9
	1976	Dańkowskie Nowe	1.3	1.2	0.5
	1991	Warko	16.6	21.8	14.6
	1995	Marder F_1 DE	2.6	4.2	–
	1998	Esprit F_1 DE	0.0	3.4	2.2
POZNAŃ Co. Ltd	1998	Nawid F_1	0.0	0.1	0.9
	2000	Ursus F_1 DE		0.0	–
IHAR/SMOLICE Co. Ltd.	Spring rye 1999	Abago	–	100	100

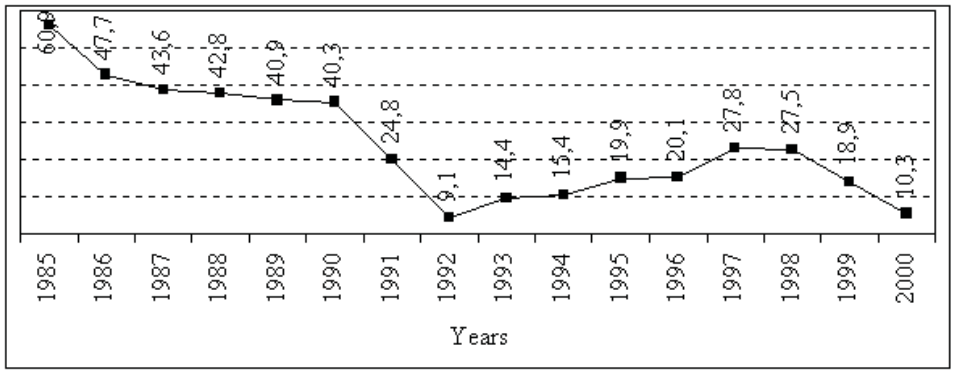

Fig. 8 Certified seed production of winter rye in Poland [thousands of ha]

In the period of 1986 – 2000 an increase in rye grain yield per 1 ha reached 63 kg per year under cultivar testing conditions and only a few kg under commercial production conditions (Oleksiak 2000). It is neces–sary to point out, that the increase in yielding potential resulted to a great extent from the introduction of hybrid cultivars into practice (Figure 9). Difference yield analysis (DYA) values indicated that the F_1 rye cultivars in comparison to the standard cultivar Dańkowskie Złote yielded from 4.1 dt/ha up to 12.2 dt/ha higher.

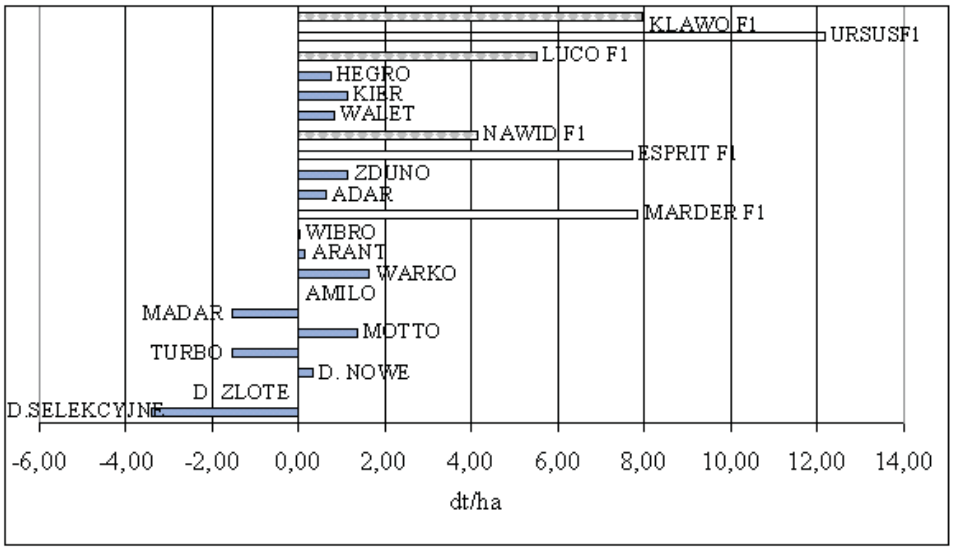

Fig. 9 Genetic yielding potential of winter rye cultivars. DYA values in relation to the standard cultivar 'Dańkowskie Złote'

In conclusion it should be pointed out that the rye production technology in Poland is extremely extensive what delays the introduction into commerce modern high yielding population and hybrid cultivars. This way the genetic yielding potential of cultivars is not properly utilized what stops the release of new cultivars and the development of rye breeding technology. Average rye grain yields in Poland under regular production conditions are 29% to 40% lower as compared to experimental cultivar testing ones. Thus, there is an urgent need to improve not only the crop itself but also its production as well as grain handling, marketing and utilization technologies. It is also to under line that the situation results also from low incomes of farms. If farmers would get higher incomes they would also be more willing to introduce modern production technologies in their farms.

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