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Seed Production of Winter Cereals – the Basis of National Selection and the Task of Ukrainian Breeding Science in 2022

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► **Abstract.** The strategic importance of grain as a commodity in the domestic market and the main export agricultural commodity determines the relevance of the study. Today, the problem of high-quality seed production in Ukraine has worsened, as insufficient funding for the industry, outdated material and technical base of breeding organisations, scarce royalties and lack of breeding payments threatens the development of Ukrainian seed production. The dynamic development of the industry requires a more active and balanced policy in the industry, which would include state target programmes and the development of the regulatory framework in terms of ensuring legal and transparent intellectual property rights to breeders and breeding institutions. The purpose of the article is to analyse and assess the state of seed production of winter cereals and determine the objectives of Ukrainian breeding science for 2022. The following methods were used in the research process: dialectical, systematic approach, monographic, economic-statistical, tabular, graphical, empirical, comparative analysis, abstract-logical, analytical forecasting. The state of seed production of winter cereals was studied and it was found that in Ukraine there are 583 varieties of wheat, 79 – barley, 55 – rye and 51 – triticale. Only 32% of wheat, 33.3% of triticale, 17.7% of barley and 5.5% of rye are produced. Of these, Ukrainian is only 58.3% for wheat, 47.5% for barley and 15.5% for rye; the average annual need for winter cereals in the regions of Ukraine and in the country as a whole was determined. 1.4-1.6 million tons of wheat, 122 thousand tons of barley, 36 thousand tons of rye and 10 thousand tons of triticale are needed to ensure the sowing of grain in volumes not less than the sown area; tasks for Ukrainian breeding science on the development of winter cereals for 2022 are set, which will contribute to technical and technological support of breeders and seed producers, harmonisation and adaptation of the seed industry of Ukraine to world standards, increase competitiveness and the export potential of Ukrainian seed production

► **Keywords:** grain production, conditioned seeds, selection, market, variety, seed production system, additional and basic seed production

► Introduction

The national grain economy occupies a central place in the country's agricultural production [1] and guarantees its food security, which is why it is considered an area of strategic importance. In addition, grain production is the main activity for most agricultural enterprises. Therefore, more attention should be paid to the development of this activity. This will allow agricultural enterprises to increase their profits. After all, favourable geopolitical and territorial-economic position, favourable soil and climatic conditions have defined Ukraine as one of the main grain countries in the world. At the same time, the volume of grain in the export potential of the state is constantly growing. If in the 2013/2014 marketing year grain exports

from Ukraine amounted to 32.5 million tons, in 2019/2020 – 57.2 million tons [2]. That is why the competitiveness of grain products will largely determine the competitiveness of Ukraine in the global agricultural market. At the same time, qualitative indicators of grain products and seed exports offered on the market become especially important in market conditions. This can be achieved primarily through well-organised and efficient seed production of cereals of Ukrainian selection.

In today's conditions of agricultural production there are many unresolved issues related to the prospects for the development of conditional seed production of grain crops in Ukraine. The main ones are: low

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level of provision of Ukrainian agricultural producers with seeds of higher categories [3]; dominance of imported varieties [4]; lack of mandatory declaration of varietal production crops; imperfect legal norms on royalty and selection payments in Ukraine; limited state support for the seed industry. The solution of these problems will contribute to the provision of national producers with seeds of Ukrainian selection, the establishment of exports of winter cereals, additional investment in the development of selection and seed production. They are gaining dynamism, need more thorough research and identify ways to solve them.

To determine the scale of problems in the field of seed production and find ways to solve them, it is necessary to analyse and assess the state of seed production of winter cereals and set goals for Ukrainian breeding science in 2022.

Based on the research, the current state of the organisation of the system of winter cereal production in Ukraine is summarised, proposals for improving the current state of Ukrainian conditional seed production are developed and the main tasks of Ukrainian selection for the future are formed.

Issues related to the development of the seed industry, improving the efficiency of the seed system and the further strategy of the industry are the research of many Ukrainian and foreign scientists.

O.P. Caviglia, R.H. Rizzalli, J.P. Monzon, F.O. García, R.J.M. Melchiori, J.J. Martinez, A. Cerrudo, A. Irigoyen, P.A. Barbieri, N.V. van Opstal, E.H. Andrade [5] study the increase of economic efficiency of production and yield of grain crops depending on different agronomic methods of growing grain. Maximising yields through maximum use of various natural and logistical resources, tillage technologies, crop rotations. Ensuring food security for the world by increasing grain yields on the same or smaller area and with minimal impact on the environment.

In their studies, A. Klimek-Kopyra, M. Bacior, T. Zajac [6] analyse the productivity of the main winter cereals – wheat, rye and triticale. The role of winter cereals in food security in both developed and developing countries is considered. In addition, the authors, like the previous ones, study the dependence of winter cereal yields on natural factors such as natural disasters, droughts, diseases and pests.

The same researchers study the nutritional value and yield of single and interspecific grains and their impact on overall crop productivity.

A.-J. Albert, M. Bitomský, L. Götzenberger, O. Mudrak, J. Klimešová [7] study the reproduction of grass seeds and their productivity depending on their growing conditions, species, and M.B. Khan, A. Khaliq [8] – the economic efficiency of growing depending on crop rotations.

J.B. Ang, P.G. Fredriksson [9] studied the efficiency of wheat production on family farms, and D. Nabuuma, C. Reimers, K.T. Hoang, T.J. Stomph, K. Swaans, J.E. Raneri [10] – the role of seed systems in providing seeds to the same category of farms. They include in seed systems technologies, organisational institutions, market and non-market institutions through which seeds are accessed. The official

seed system is guided by plant breeding and breeding methodologies, which are mainly used by the public or private sector, including official regulation, certification and laws. Small farms, in their opinion, regardless of geographical affiliation, usually do not use conditioned seeds, conditioned upon its high cost. The use of certified seeds is typical of large and medium-sized agricultural producers.

The role of seed systems in the development of agricultural production and providing agricultural producers with certified seeds was considered by Ukrainian scientists Y. Lupenko, A. Hutorov, O. Dorokhov and, in fact, O. Zakharchuk [11]. The main directions of their research are the analysis of the current state and prospects of seed production development in Ukraine; creation of an integrated market infrastructure of plant varieties, all components of which would work in a coordinated economic regime and ensure the most efficient sale of seeds and risk sharing in the process of its production and sale; solving the problems of commercial turnover of seeds and planting material and payments for the use of intellectual property.

In the analysed studies on the topic of seed production, mainly agronomic and, rarely, economic studies are presented. Therefore, the results presented in the article are relevant, timely and necessary.

► Materials and Methods

The methodological basis of the study is the dialectical method of cognition and a systematic approach to the study of economic features of seed production in Ukraine. At the same time, the following methods were used in the research process: monographic (in highlighting the views of scientists on the issues and problems studied in the work, in analysing the current state of production of winter grain seeds); economic and statistical (to study the specific features of the development of winter cereal production in the NAAS system, to reflect the state of Ukrainian seed production in quantitative and cost terms through a system of absolute and relative indicators); tabular and graphical (with visual display of research results in the form of figures and tables), empirical (for a comprehensive assessment of the effectiveness of seed use); comparative analysis (to identify the main problems of seed production of winter cereals in Ukraine); method of analytical forecasting (to determine the tasks and recommendations on the organisational and economic mechanism of seed production in Ukraine), abstract and logical (generalisation and formulation of conclusions).

The main stages of the study are: analysis and systematisation of research of Ukrainian and foreign scientists on grain production and seed production of grain crops; analysis of production of conditioned seeds of winter cereals in Ukraine by producers, varieties and volumes; the share of seeds of Ukrainian selection in the total volume of winter grain seeds was determined; the average annual need for winter grain seeds calculated considering the sown areas by regions and sowing norms by regions of Ukraine; the main tasks were identified and recommendations were made to improve the condition of Ukrainian conditional seed production to adapt

it to world requirements and strengthen its export potential.

The average annual need for seeds for the main types of winter cereals was determined considering the sown areas by regions of Ukraine and sowing rates for each of the crops.

The information base of the research was the works of Ukrainian and foreign scientists, reference and information publications, materials of scientific and practical conferences, information and analytical materials of research institutions, materials of personal observations of the authors.

Calculations were made based on the Ministry of Agrarian Policy and Food of Ukraine (production of conditioned winter grain seeds in general and by regions, producers, varieties, volumes of Ukrainian and foreign seeds) [4], State Statistics Service (sown areas) [12], Ukrainian Institute examination of plant varieties (number of varieties in the state register) [13] and own calculations.

► Results and Discussion

The strategic importance of grain seed production is revealed through the system of functioning and development of the country's grain economy. Cereal seeds as sowing material are a prerequisite for the grain production process and cannot be replaced by any other factor of production. One of the main factors in the intensification of grain production is high-quality sowing material and high-yielding varietal resources of national selection. They are the main factor in obtaining high yields and expanding the process of grain production in a sharp reduction in the application of mineral and organic fertilizers, plant protection products [14, p. 221].

Because productive varieties and conditioned seeds of grain crops are one of the key and indispensable factors influencing the intensification and expansion of the grain production process. Among winter cereals, productive varieties are those that have not only high yields, but also resistant to freezing and drought, diseases, adapted to a certain natural and climatic zone. Among the varieties of winter wheat are: Bogdana, Podolyanka, Wisdom of Odesa, Katrusya of Odesa, Astarta; Sofia Kyivska, League of Odesa, Landscape, Oranta Odesa, Shestopalivka (Ukrainian), RZHT Reform, Skagen, Julia, Tobacco, Kubus, Patras, Artist Ethan, KVS Jersey (foreign); winter barley Ninth Shaft, Snow Queen, Worthy and Valkyrie (Ukrainian), Luran, Leicester, KVS Tenor, Lucien, Isocel, Highlight, Hannelore, Maibrit (foreign) [4].

According to the Law of Ukraine "On Seeds and Planting Material" of 12/26/2002 No. 411-IV "conditioned seeds – seeds whose varietal and sowing qualities meet the requirements established by legislation in the field of seed and nursery" [15]. In

Ukraine, DSTU 2240-93 [16], DSTU 2949-94 [17] and DSTU 4138-2002 [18] are legally approved. These are the standards according to which the produced, certified and sold seeds are controlled.

Intensification of grain production in today's conditions, according to I.V. Kuzmenko [19] is also possible by mastering modern innovative technologies. The same opinion is shared by other researchers. E.N. Simonyan and M.O. Yandola [20] in the first place put innovative technologies and, at the same time, emphasise the impossibility of their implementation conditioned upon limited funding for the industry. And it is impossible to disagree with this, because the lack of state programmes for the development of the industry, outdated material and technical base of breeding institutions and the lack of royalties and breeding payments make it impossible to renew production at a sufficient level for modern conditions. This indicates that the focus today should be the system of economic relations in the field of seed production of grain crops, as a separate organisational and economic link of the grain complex of the state.

From the agro-technological and production-economic standpoint, the main task of the seed industry, both grain and other crops, is to reproduce (produce) seeds of high-yielding varieties, to preserve and improve its purity and yield properties. The level of efficiency of an important and integral component of the grain production system – the process of variety replacement and variety renewal [21] depends on the efficiency of the system of seed production of grain crops.

An important role in increasing the yield and gross harvest of grain products is played by winter cereals, which are the basis of food security and a source of strategically important raw materials for many branches of the processing industry. In addition, they play a special role in providing a forage base. Winter cereals occupy about 7.5-8.0 million hectares of crops [12]. Winter wheat is the leader in terms of sowing and gross harvest in world grain production with a sown area of up to 6.9 million ha [12]. In Ukraine, it is the main food and export crop. Also winter cereals include winter barley (sown area of about 1.0 million hectares), winter rye (sown area of 150-200 thousand hectares) and winter triticale (sown area of 10-15 thousand hectares) [12].

In 2021, the production of certified seeds of winter soft and durum wheat amounted to 112.1 thousand tons, including its imports amounted to 0.6 thousand tons, as well as 39.2 thousand tons of seeds of foreign selection produced in Ukraine (Table 1). The share of Ukrainian seed production was 65% (73,3 thousand tons) of the total result. It has decreased by almost 20% over the last decade.

Table 1. Production of conditioned seeds of winter wheat in Ukraine for sowing in 2022

Regions	Ukrainian production				Foreign production of foreign selection		Total	
	Ukrainian selection		Foreign selection		Tons	Number of varieties	Tons	Number of varieties
	Tons	Number of varieties	Tons	Number of varieties				
Vinnitsya Region	1927.2	23	1604.0	11	–	–	3531.2	34
Volyn Region	–	–	1788	10	–	–	1158	10
Dnipropetrovsk Region	8126.1	36	1275	8	–	–	9401.1	46
Donetsk Region	1497.9	17	0	–	120	–	1497.9	17
Zhytomyr Region	394.5	6	2845.0	10	1.2	3	3240.7	19
Zakarpattia Region	1	–	10.5	–	–	–	10.5	1
Zaporizhzhya Region	3285.3	28	–	–	–	–	3285.3	28
Ivano-Frankivsk Region	–	–	–	–	–	–	–	–
Kyiv Region	4247.7	69	1760.0	22	191.46	16	6199.2	92
Kirovograd Region	165.1	10	848.2	4	–	–	1013.3	14
Luhansk Region	550	9	–	–	–	–	550	9
Lviv Region	174.9	8	110.0	1	–	–	284.9	9
Mykolayiv Region	4604.4	46	–	–	–	–	4604.4	46
Odesa Region	10755.4	94	520	4	–	–	11275.4	98
Poltava Region	9091.4	40	2322.4	12	84	7	11497.8	59
Rivne Region	–	–	–	–	–	–	–	–
Sumy Region	900.1	14	303.3	4	–	–	1203.4	18
Ternopil Region	957.2	11	17188.7	43	199.0	9	18145.9	54
Kharkiv Region	17309.1	84	106	3	–	–	17415.1	87
Kherson Region	3625.5	42	90.9	2	–	–	3716.4	44
Khmelnysky Region	849.6	14	8351.6	33	11.0	3	9201.2	47
Cherkasy Region	3675.0	32	94.5	11	10.5	5	3780	41
Chernivtsi Region	–	–	–	–	–	–	–	–
Chernihiv Region	1129	13	–	–	–	–	1129	13
Total in Ukraine	73266.4	266	39218.1	103	617.16	33	112140.7	369

Source: calculated by the author based on ITC data [32]

The total demand of agricultural producers for winter wheat seeds is 1.5-1.6 million tons. If we assume that only two thirds of the produced conditioned seeds are sold (average percentage of sales of conditioned seeds by research institutions of NAAS), it will be about 92 thousand tons (5.8% of total demand). On average in the European market, this share of conditioned seeds is about 50% [22].

The largest producers of conditioned seeds of national selection among the regions of Ukraine are Kharkiv (17.4 thousand tons), Dnipropetrovsk (11.6 thousand tons), Odesa (10.7 thousand tons), Poltava (9.4 thousand tons) and Kyiv (5.4 thousand tons) regions, foreign selection – Ternopil (16.2 thousand tons), Khmelnytsky (9.9 thousand tons), Kyiv (3.9 thousand tons) and Zaporizhzhya (3.3 thousand tons) area. The largest number of certified imported seeds in Kyiv region is 1.1 thousand tons (73% of the total volume of imported winter wheat seeds) [4].

Production of conditioned seeds in the regions is closely connected with the presence of scientific breeding centers of the National Academy of Agrarian Sciences. Thus, in the Kharkiv region there is the Institute of Plant Breeding named after V.Ya. Yur'yev of the National Academy of Agrarian Sciences of Ukraine, in Dnipropetrovsk region – Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine, in Odesa region – Breeding and Genetics Institute-National Center for Seed and Cultivar Investigation of the National Academy of Agrarian Sciences of Ukraine [23].

The most productive varieties of winter wheat in recent years were Bohdana, Novosmuglyanka, Astarta, Zhytynsya Odesa, Katrusya Odesa, Zysk, which exceeded the yield of 10 t/ha and more [4]. They were produced by the Institute of Plant Physiology and Genetics of the National Academy of Sciences of Ukraine (Kyiv) and the Breeding and Genetics Institute – National

Center for Seed and Cultivar Investigation of NAAS (Odesa).

Of the Ukrainian hybrids, the best sold in 2021 were: Bohdana (7707 tons), Podolyanka (4697 tons) Astarta (2064 tons), Sofia Kyivska (1867 tons), Novosmuglyanka (1231 tons), producer – Institute of Plant Physiology and Genetics of the National Academy Sciences of Ukraine; Wisdom of Odesa (4011 tons), Katrusya of Odesa (2338 tons), League of Odesa (1658 tons), Oranta of Odesa (1657 tons), Zysk (1401 tons), producer – Breeding and Genetics Institute – National Center for Seed and Cultivar Investigation of NAAS of Ukraine; Landscape (1658 tons), producer – National Research Center “Institute of Agriculture of the National Academy of Agrarian Sciences”; Shestopalivka (1638 tons), producer – Private Agricultural Breeding and Research Enterprise “BOR” [24].

The most common varieties of winter wheat

for sowing in 2022 were also such foreign varieties as RZHT Reform, Kubus, Skagen, Colonia, KVS Jersey, Mescal, Praktik, Rebel, Bonanza and Felix. These varieties account for a significant share of Ukrainian agricultural production, which is growing dynamically. The main foreign companies operating in the Ukrainian seed market are: RAJT 2n (France), Nickerson International Research SNA (France), Zaatun Union Romania Srl. (Romania), Seyer Planteforledning I/S (Denmark), Nordic Sid A/S (Denmark), Deutsche Zaatferedelung AG (Germany) and Zaatucht Donau Hes.m.b.H. & CoCG (Austria). French, Czech, German, Danish and Austrian selections are represented in Ukraine [4].

In total, in Ukraine, according to the State Register of Plant Varieties [4] suitable for distribution in Ukraine, 583 varieties of durum and soft winter wheat, 79 varieties of winter barley, 55 varieties of winter rye and 51 varieties of winter triticale (Table 2).

Table 2. Number of winter grain varieties used for additional seed production for the 2022 harvest

Cultures	TOTAL VARIETIES			NAAS		
	Number of varieties in the register, total	Number of varieties in the production of pre-seed, total	The share of varieties in the production of pre-seed, %, total	Number of varieties in the register (applicant – NAAS institutions)	Number of varieties in pre-seed production (NAAS institutions)	The share of varieties of NAAS institutions in the production of pre-seed, %
Winter wheat	583	188	32.2	338	97	28.7
Winter barley	79	14	17.7	29	5	17.2
Winter wheat	55	3	5.5	34	3	8.8
Winter triticale	51	17	33.3	37	14	37.8
Total	768	222	28.9	438	119	27.2

Source: calculated by the author based on ITC data [32]

The number of varieties used for the production of additional seeds for winter wheat is 32.2%, for winter triticale – 33.3%, for winter barley – 17.7%, and for winter rye – the least, only 5.5%. A low percentage indicates that not all varieties registered in the Register of Plant Varieties [19] are primary seed production. This is explained by both the demand for this type of product and its commercialisation. There are “still-born varieties” that are only produced for “demonstration” activities of enterprises or institutions, also,

there are varieties that are 15-20 years old or more, and they are only maintained in the Register by paying the relevant payments (for Ukrainian breeding public institutions, they are not significant – 20-50 UAH per year). It should also be considered that primary seed production of foreign varieties is primarily carried out in their countries of origin, and basic seeds (super-elite and elite) and certified of different generations are already imported to Ukraine (Fig. 1).

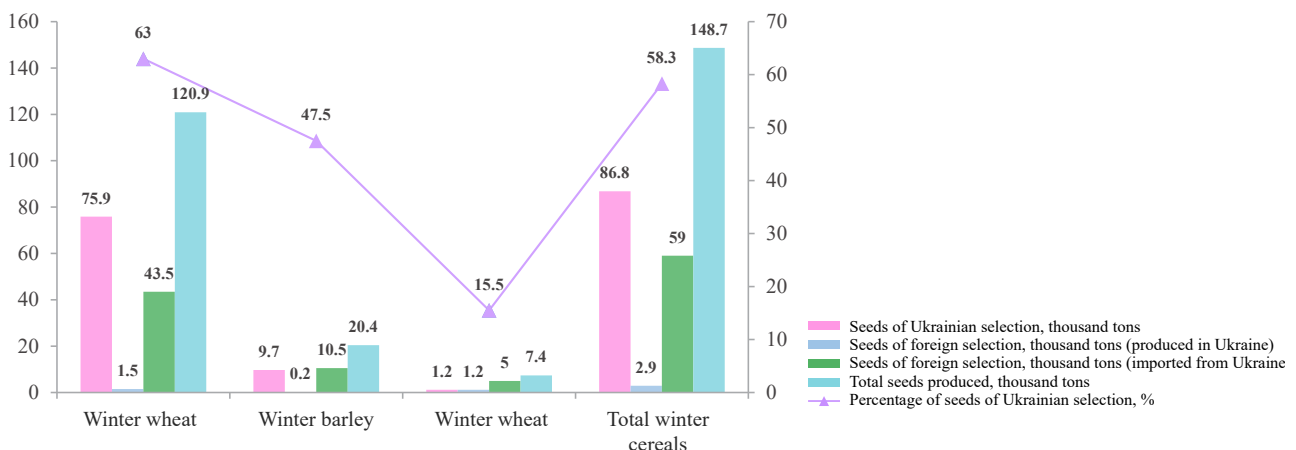


Figure 1. Production of conditioned seeds of winter cereals in Ukraine in 2021 (additional, basic and certified)

Source: calculated by the author based on ITC data [4]

The share of Ukrainian seeds in the total volume of winter grain seeds was 58.3%, including 63% for winter wheat, 47.5% for barley and 15.5% for rye. Seeds are a commodity of production demand from seed farms, which lead to its reproduction, and from direct producers, who use it as a resource in production. To study the demand for varietal seed resources, we first analysed the average annual demand, namely its material component – the seeds of winter cereals for all categories of farms.

To ensure the demand for varieties and seeds of winter cereals, it is estimated that 1.4-1.6 million tons of wheat seeds, 122.0 thousand tons of barley, 36.0 thousand tons of rye, and 10 thousand tons of triticale are needed (Table 3). The annual amount of varietal seed material required for sowing winter cereals in volumes not less than in the context of the regions of our state is calculated according to the sown areas of these crops.

Table 3. Average annual need for seeds of winter cereals

No.	Region	Sowing area in 2021, thousand hectares	The need for all, thousands of tons	Including:			
				Wheat	Barley	Rye	Triticale
1	Vinnitsia	324.3	84.3	72.7	8.8	2.0	0.8
2	Volyn Region	183.8	31.1	27.5	0	3.1	0.5
3	Dnipropetrovsk Region	677.2	133.2	119.9	13	0.3	0
4	Donetsk Region	396.8	89.1	82.5	4.6	1.0	1.0
5	Zhytomyr Region	154.7	29.8	24.4	0.2	5.2	0
6	Zakarpattia Region	24.4	6.4	4.4	2	0	0
7	Zaporizhzhya Region	795.1	132.5	125.5	6.8	0.2	0
8	Ivano-Frankivsk Region	51.1	11.6	10.3	0.8	0.5	0
9	Kyiv Region	209.1	60.5	58.0	0.4	1.6	0.5
10	Kirovograd Region	469.2	83.3	70.8	12.2	0.3	0
11	Luhansk Region	308.9	57.8	56.3	0.4	0.6	0.5
12	Lviv Region	172.5	32.1	28.9	1.2	2.0	0
13	Mykolayiv Region	703.0	135.6	114.8	20.6	0.2	0
14	Odesa Region	836.2	159.1	130.3	28.4	0.4	0
15	Poltava Region	256.3	60.7	58.1	1.6	1.0	0
16	Rivne Region	134.0	25.0	21.8	0.2	2.7	0.3
17	Sumy Region	182.9	40.1	37.5	0	1.8	0.8
18	Ternopil Region	201.7	41.8	38.7	1.6	1.5	0
19	Kharkiv Region	599.0	106.2	100.1	0.6	0.6	4.9
20	Kherson Region	613.2	113.7	101.9	11.2	0.6	0
21	Khmelnitsky Region	207.0	45.6	40.5	2.4	2.5	0.2
22	Cherkasy Region	234.4	58.9	56.1	1.8	1.0	0
23	Chernivtsi Region	36.7	10.3	7.9	2.2	0.2	0
24	Chernihiv Region	201.3	43.7	35.5	1	6.6	0.6
	TOTAL	7972.8	1592.4	1424.4	122.0	35.9	10.1

Source: calculated by sources [12; 25]

The national seed market can be described as fairly balanced, although at the beginning of the millennium it was an oversaturated market, the share of the final balance before consumption was almost 50% [22]. The reason for this was the low purchasing power of agricultural producers in the market of conditioned seeds and the possibility of one-time purchase of certified seeds with its subsequent long-term use without renewal, 5-8 years).

M. Suchek [26] also insists on the need for varietal replacement and varietal renewal. He also claims that the energy of the variety works on yields only for the first three years. Because only conditioned upon genetic potential it is possible to increase yields by 1-2 t/ha.

To stimulate demand in the seed market, efforts should be made to support the demand of Ukrainian grain producers for high-category seeds, as the condition of sown seeds has not deteriorated in recent years. At the same time, the yield of each subsequent reproduction decreases on average from 0.5 to 1.5 t/ha per year [26].

Therefore, it would be positive to improve the demand of the final consumer of grain seeds, the implementation of state programs for the formation of varietal plant resources and selection in crop production, including selection in primary crop, which operated in Ukraine until 2012. Positive was the partial reimbursement of agricultural producers of varietal allowances for purchased conditioned seeds in

research institutions, research farms of universities, which was carried out within the funds allocated from the state budget for these purposes, which is currently canceled.

Author's research on the financing of state programmes, in the main ideas coincide with the opinion of V. Kyrychenko – Director of the Institute of Plant Breeding named after V.Ya. Yuryev of the NAAS of Ukraine [27]. He claims that without financial support, breeders are left alone with their initiatives and achievements. Because the innovative development of any industry requires high-level state support. He agrees with us that seed production in Ukraine can be revived by funding NAAS research institutions on a competitive basis; modernisation and updating of the material and technical base of scientific institutions and networks; improvement of legal aspects of NAAS research institutions and their harmonisation with European standards on the basis of public-private partnership – resumption of the programme of state support for the production of high-generation seeds and creation and storage of seed funds on a competitive and transparent basis; adaptation of the seed industry of Ukraine to the relevant world requirements for seed production and certification, accession to all OECD seed schemes; strengthening the export potential of Ukrainian seeds by increasing its competitiveness in terms of quality, and eliminating bureaucratic barriers to seed access to the international market; systematic varietal renewal and varietal change, using seeds of exceptionally high generations, F1 hybrids and first and second generation in self-pollinating crops.

The study of varietal crops shows that varietal resources in agricultural enterprises are mainly formed based on own reproductive seed production and commercial crops. Conditioned seed production in all crops is only from 5% to 8%, respectively [3]. In general, it occupies about 10.0-12.0% of varietal crops of all crops in Ukraine. But in terms of crops, this percentage differs [13].

With limited domestic demand for grain seeds, it would be important to develop aggregate export demand at the expense of foreign consumers of Ukrainian seeds. However, the opportunities for Ukrainian seed market operators to enter foreign markets are limited conditioned upon:

- low awareness and financial capacity of breeders to transfer their varieties for testing to potential foreign consumers;
- non-membership in or membership in a number of international trade organisations;
- non-compliance with accepted European and world quality standards for certification;
- low solvency of potential consumers of seeds in the CIS countries, which are the primary potential buyers;
- weak marketing of foreign markets, especially European and North American.

However, the limited possibilities do not mean the absolute futility of their search. Ukraine has always been a supplier of conditioned seeds to regions of the Soviet Union that had less favourable conditions for its production. The payment crisis, the construction of new borders and expert duties have significantly affected

agricultural producers of all newly formed states, and have sharply limited the possibility of Ukrainian seed exports. Those countries that have more developed systems of breeding and seed production, in 25-30 years, gradually abandoned imports and switched to self-sufficiency of their own seeds.

In the future, it is also possible to resume the export of Ukrainian seed material to the countries of Central Asia and North Africa, where there is a significant potential market capacity and liberal trade rules. Ukraine can take a leading place in this field. Cereal seeds (wheat, barley, rye, buckwheat and millet) are especially popular in the Asian and North African markets.

All developed countries finance from the budget basic research as the most expensive. Private breeding establishments compete to improve the discovery, usually only after a fundamental study has been done. This is especially true for the process of breeding new varieties and hybrids. In most western countries, only a breeder has the right to reproduce and sell conditioned seeds. This contributes to the intensification of seed production and its civilized market circulation. And government support, protection of plant variety rights and royalties provide an opportunity to conduct research and accelerate the supply of new innovative varieties and hybrids to the market.

The lack of construction of a similar system in Ukraine in the near future will lead to a loss of priorities, chronic backwardness of the breeding industry and further dominance of foreign breeding varieties. Given the limited budget funding, the introduction of a system for collecting royalties and selection payments and their 100% payment by agricultural producers may support the protection of the interests of breeding centers and breeders in Ukraine.

The main tasks of Ukrainian breeding science for the revival of Ukrainian breeding in 2022 should be: improving the technical and technological support of breeders and agricultural producers, developing recommendations for modern technologies for growing agricultural products in different climatic zones of the country; improving the legal aspects of the activities of research institutions of NAAS and NAS based on public-private partnership; adaptation of the seed industry of Ukraine to the relevant world requirements for seed production and certification, accession to all OECD seed schemes; strengthening the export potential of Ukrainian seeds of national selection by increasing its competitiveness in terms of quality, and eliminating bureaucratic barriers to entry of seed products on the international market.

Eight OECD Seed Schemes have been identified according to the groups of cultivated plant species: Grasses and Legumes scheme, Crucifers and other Oil or Fibre species scheme, Cereals scheme, Sugar and Fodder Beet scheme, Subterranean clover and similar species scheme, Maize scheme, Sorghum scheme, Vegetable scheme. They set out the requirements for the propagation of basic and certified seeds, approved as satisfactory for varietal identity and purity. They are applied at the official level and cannot be lower than those set by each Scheme [28].

By participating in Schemes for the Varietal Certification of Seed, seed operators can produce

and certify seeds of these crops in accordance with international standards and participate in world seed trade using OECD labels and certificates recognised by 60 OECD member countries. OECD certification is used for varieties that meet the requirements of DUS (difference, uniformity and stability). In this way, schemes during the process of propagation, processing, etc. ensure the preservation of purity and originality of the variety. Each Scheme includes a number of Rules and Regulations aimed at ensuring varietal certification of seeds, except for the Vegetables scheme, according to which seeds defined as "Standard Seeds" in general trade cannot be certified, but may only to be controlled, in particular: requirements for the production of basic and certified seeds in accordance with the Seed Schemes; field inspection of seed crops; seed batch size; marking and issuance of single varietal documents recognised by 60 countries participating in the OECD Seed Schemes [28].

In Ukraine, at the time of creation of new scientific and innovative centers for propagation of conditioned seeds in different regions of the country based on already established seed plants, introduce mandatory declaration of varietal crops by agricultural producers who own agricultural land of 25 hectares and more, increase the role professional public organisations of Ukraine in terms of registration of license agreements and royalty payments, including control, registration and introduction of the database of seed and commodity crops in terms of varieties and hybrids.

► Conclusions

The research presented in the article shows that despite the strategic importance of the seed industry in Ukraine, it has accumulated a number of problems. The main problem is the dominance of foreign varieties. Although Ukrainian varieties are better adapted to the natural and climatic conditions of Ukraine, the share of additional seeds of Ukrainian winter grain selection is less than 60% more resistant to drought and germination. The advantages of foreign varieties

are higher yields, resistance to diseases and pests, transportability and appearance of marketable products. The share of varieties of scientific institutions of NAAS of Ukraine, which are engaged in additional seed production is only 28.7% – for winter wheat, 17.2% – for winter barley, 8.8% – for rye and 37.8% – for triticale.

The average annual need for winter grain seeds was determined according to the sown areas by regions and in Ukraine as a whole. In total, it is 1.4 million tons of wheat, 122 thousand tons of barley, 35.9 thousand tons of rye and 10.1 thousand tons of triticale.

Demand for seeds is determined by the purchasing power of Ukrainian agricultural producers. Today, varietal crops are formed mainly conditioned upon their own reproductive seed production from commercial crops. The share of used conditioned seeds is only 5-8 %.

In conditions of limited domestic demand for seeds of Ukrainian selection, it is important to develop external. Potential buyers of grain seeds are from Asia and North Africa.

Given a number of problems that have accumulated in the industry, the task for Ukrainian breeding science for 2022 has been identified. The results of their implementation are aimed at: improving the material and technical base of breeding institutions, especially those belonging to NAAS. It provides for the acquisition by research institutions of new, modernisation of existing small breeding and seed processing equipment, devices and equipment; improving the legal norms for the payment of royalties and selection payments, considering the experience of their use in the world, which could be directed to the development of the industry; adaptation of modern technologies to their use in different natural and climatic zones; adaptation of the seed industry to the world requirements for seed production and certification and accession to the OESD. This will open great prospects for Ukrainian seed exporters on the world market and strengthen Ukraine's export potential.

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Насінництво озимих зернових культур – основа діяльності національної селекції та завдання української селекційної науки у 2022 році

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► **Анотація.** Стратегічне значення зерна як товару на внутрішньому ринку та основного експортного сільськогосподарського товару визначає актуальність дослідження. На сьогодні проблема виробництва високоякісного насіння в Україні загострилася, адже недостатнє фінансування галузі, застаріла матеріально-технічна база селекційних організацій, мізерність роялтих та відсутність селекційних платежів ставить під загрозу розвиток українського насінництва. Динамічний розвиток галузі вимагає більш активної та зваженої політики в галузі, яка включала б державні цільові програми та розвиток нормативно-правової бази в частині забезпечення законних та прозорих прав на інтелектуальну власність селекціонерам та селекційним установам. Мета статті – проаналізувати та надати оцінку стану насінництва озимих зернових культур й визначити завдання української селекційної науки на 2022 рік. У процесі дослідження використано такі методи: діалектичний, системний підхід, монографічний, економіко-статистичний, табличний, графічний, емпіричний, порівняльний аналіз, абстрактно-логічний, аналітичне прогнозування. Досліджено стан насінництва озимих зернових культур і виявлено, що в Україні 583 сорти пшениці, 79 – ячменю, 55 – жита та 51 – тритикале. Виробництво добазового насіння здійснюється лише по 32 % сортів пшениці, 33,3 % – тритикале, 17,7 % ячменю та 5,5 % жита. З них українське становить лише 58,3 % по пшениці, 47,5 % – по ячменю та 15,5 % – по житу; визначено середньорічну потребу в насінні озимих зернових по регіонах України та в цілому по країні. Для забезпечення посіву зернових в обсягах, не менших посівних площ необхідно 1,4-1,6 млн т. пшениці, 122 тис. т. ячменю, 36 тис. т. жита та 10 тис. т. тритикале; сформовано завдання для української селекційної науки щодо розвитку насінництва озимих зернових культур на 2022 рік, які сприятимуть техніко-технологічному забезпеченню селекціонерів та виробників насіння, гармонізації та адаптації насінневої галузі України до світових стандартів, підвищенню конкурентоспроможності та збільшенню експортного потенціалу українського насінництва

► **Ключові слова:** зерновиробництво, кондиційне насіння, селекція, ринок, сорт, система насінництва, добазове та базове насінництво