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The current state and efficiency use of *in situ* and *ex situ* conservation units for seed harvesting in the central part of Ukraine

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Abstract

Significant increase of biological stability, timber volume, and economic value of forests is impossible without refinement and improvement of the organization, and implementation of forest seed production on a genetic and breeding basis. It is possible to solve this task by creating and efficiently functioning *in situ* and *ex situ* facilities.

In Ukraine, the basic principles of plus selection are envisaged, which include the selection and testing progeny of plus trees. The total number of progeny tests in Ukraine is 106 plots, in which 1,079 genotypes of plus trees are presented. Taking into account the total number of plus trees in Ukraine (4,560), only 23.7% was subjected to progeny tests. The largest number of progeny tests are represented by Scots pine (*Pinus sylvestris* L.) – 76 plots and a significantly smaller number of plots for English oak (*Quercus robur* L.) – 21. The corresponding representation of genotypes is for pine – 520, for oak – 365.

The area of tree breeding units in Ukraine is very small (0.4–0.6%) of the total forest area in the region. Despite the available areas, the use of *in situ* and *ex situ* objects for harvesting seed in Ukraine is low, around 30%. In the central region of Ukraine, the share of *in situ* and *ex situ* objects from the total forest area is 0.1–0.5%. On these sites, from 0 to 54% is harvested, which is insufficient.

According to the results of the conducted research, it was established that the areas of permanent forest-seed base (*in situ* and *ex situ* units) are insignificant and their use is insufficient. Testing of more than 70% of the selected plus trees is required. An important trend is to study the genotype-environment interaction in connection with trends of global climate change.

Key words

tree breeding, in situ and ex situ conservation, heritability, progeny tests, seed orchards, plus trees

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Introduction

The basic principles of increasing forest growth are improving their sustainability and widespread use of improved seed selection. Significant increase in productivity, biological stability and economic value of forests is impossible without improving the organization and management of forest seed production on a genetic and breeding basis (Wright 1976; Debrynyk et al. 1998; Crow and Riemenschneider 2006; Mullin and Lee 2013).

The forest seed base (*in situ* and *ex situ* facilities) in Ukraine was formed as a forestry branch, which has the task to obtain the seeds of forest species with valuable heritability properties and high sowing quality for the creation of high-productive and high-quality stands (Bilous 2004; Tkach et al. 2013; Los et al. 2014). This problem can be solved by creating and effectively functioning of forest genetic resources *in situ* and *ex situ*. Effective use of these units involves harvesting seeds from high-productive plus trees, clonal and seedling seed orchards. Development of seed basis of the improved breeding quality should be carried out within the forest seed zones (Lines 1992; Hamann et al. 2011; Los et al. 2014). Seed basis development is closely linked to the selection and preservation of a valuable genetic fund of forest species, the study of the genetic structure of forest stands, the creation of forest genetic reserves, the archives of clones of plus trees and the creation of progeny tests (Ehrenberg 1966; Nilsson and Andersson 1987).

The main task of forest seed production is to obtain a sufficient number of seeds of forest tree plants with valuable heritability properties and high crop qualities for artificial regeneration, reforestation in order to increase the productivity and stability of forest stands, improve wood quality. An important requirement for forest seed production is the assessment of the quality of seeds of each tree species.

Genetic properties of the seeds are the most important factor affecting the productivity and biological stability of the stands. However, during the entire history of forestry, the practical activities of the forestry sector did not always correspond to the scientific principles of genetics and tree breeding, selection and reproduction of the best forms of forest trees (Bilous, 2004). Until recently, the practice of forestry, as a rule, did not take into account the heritability properties of the initial sowing material from which the forest stands were created. Non-tested forest trees were used to harvest seeds, and some of them are use today. Preparation of seeds, regardless of its origin and heritability properties, leads to 'minus selection', resulting in subsequent harvesting of the forest stands with worse performance and stability than the previous ones (Yurkiv and Neyko 2017).

The aim of this paper is to provide an investigation of current condition and effective use of *in situ* and *ex situ* gene sources' conservation for harvesting of forests seeds in Ukraine and the central part of Ukraine and their use in forestry practice.

Material and methods

In this research, we used the existing statistical materials, reports of enterprises and organizations, and other documents. The information sources of the State Forestry Agency of Ukraine (http://dklg.kmu.gov.ua) as well as the reporting materials of the separate subdivision 'Vinnytsia Forest Seed Laboratory' were used to analyse the forest fund, the forest area and the forest cover. The article uses generalized information on the available genetic conservation units. The analysis is based on long-term studies of tree breeding units presented in FAO report (Los S.A. et al. 2014). The authors participated directly in the survey of forest genetic reserves, plus stands and plus trees. The generalized data on the status of forest genetic reserves as a result of the project 'Genetic resources of broadleaved forest tree species in Southeastern Europe' was used (Volosyanchuk et al. 2001). The survey of forest genetic reserves was conducted through the laying of sample plots. On sample plots, diameter, height of trees, selection category, condition, defects and damage were determined. The boundaries of genetic reserves were determined using GPS (Volosyanchuk et al. 2003). We have also used the European EUFGIS database (http://www.eufgis.org) to analyse the main trends in the state, tree species and age structure of forest genetic reserves. We used the information about seed harvesting on *in situ* and *ex situ* gene conservation units of local forest enterprises.

Results

Forests in different natural zones of Ukraine have significant differences and are lower than the optimal level. The Polissya natural zone is located in the northern part of Ukraine, which is covered mostly by pine forests (*Pinus sylvestris* L.). Oak forests (*Quercus robur* L.) dominate in the forest-steppe and steppe zones, which extends in the south of Polissya. Carpathian region located in the west of the country and represented mainly by beech (*Fagus sylvatica* L.) and spruce (*Picea abies* L.) forests (Hensiruk S.A. 2002).

At present, the forests of the territory of Ukraine are 15.7%, which is much less than the forests of most countries of the world: France – 36.7%, Poland – 28.8%, Germany – 32.0%, Italy 35.0%, Sweden – 68.9% and Finland – 72.0% (CIA Fact book 2012). In order to increase the forest cover of Ukraine to the optimum level, it is necessary to create many new forests, which in turn requires a large amount of planting and sowing material that would be marked by high heritability properties. For the harvesting of forest seeds in forestry state enterprises of Ukraine, the main forest species are the objects of genetic conservation *in situ* and *ex situ*. The area of creation of such units is very different in the context of natural zones (Tab. 1).

The share of *in situ* and *ex situ* objects in Ukraine is only 0.4% of the forest area. The smallest share of forest genetic units is in the Steppe (0.1%), and the largest is in the Carpathians (0.5%). In the central part of Ukraine (Vinnytsia, Zhytomyr, Odessa, Mykolaiv and Khmelnytskyi regions), the share of genetic objects ranges from 0.1% (Odessa region) to 0.5% (Vinnytsia region).

In order to conserve the genetic diversity of the best populations of basic forest species in Ukraine, more than 600 forest genetic reserves of coniferous and broadleaf species have been selected. The total area of forest genetic reserves is about 23,888 ha. The largest number of such objects is found in English oak and Scots pine forests; it is 249 and 115 tree stands, respectively. The area of genetic reserves of these tree species is the largest, 7,758.5 ha and 54,002.1 ha, respectively (Tab. 2).

The total area of forest genetic reserves in the central part of Ukraine is about 4,551.5 ha. The largest areas occupy the genetic reserves of English oak – 2,774.9 ha (61%) and almost twice smaller area of genetic reserves of Scots pine – 1,505.4 ha (33.1%). The area of genetic reserves of other tree species varies from 12.5 ha to 39.3 ha (0.3–5.0%). The largest number of English oak populations is selected in the Vinnytsia region – 46. In Zhytomyr region, the largest number of species has been selected from the forest genetic reserves. In particular, populations of European beech (*Fagus sylvatica* L.), English oak, European larch (*Larix decidua* Mill.), Scots pine and Silver fir (*Picea abies* L.) are presented. The genetic reserves of the Zhytomyr region include

Table 1. Forest area and certified of *situ* and *ex situ* units in the natural zones of Ukraine (State Forestry Agency of Ukraine, 2017)

Natural zone/ Region	Area of forests [thous. ha]	Forest cover [%]		*In situ* and *ex situ* gene conservation				% of *in situ*
		current	optimal	number of plus trees	plus stands [ha]	gene reserves [ha]	seed orchards [ha]	
polissya	3,133.6	26.0	37.0	1,129	701.2	6,187.0	456.5	0.2
Zhytomyr	1,001.6	33.6	36.0	290	111.6	2,909.7	92.0	0.3
Forest Steppe	2,704.1	13.0	17.0	1,269	1,204.6	5,232.8	504.8	0.2
Khmelnytskiy	265.1	12.8	17.0	148	99.9	355.9	70.1	0.2
Vinnytsia	346.5	13.1	15.0	123	530.3	1,224.7	120.3	0.5
Steppe	1,701.6	3.5	8.0	853	12.8	1,509.3	33.2	0.1
Odessa	203.9	6.1	9.0	27	5.5	172.8	0.0	0.1
Mykolaiv	98.2	4.0	7.0	35	0.0	0.0	0.0	0.0
Carpathian region	1,973.1	40.2	53.0	1,309	177.2	9,032.5	123.7	0.5
Ukraine	9,512.4	15.7	22.0	4,560	2,095.8	21,961.6	1,118.2	0.3

Table 2. Gene reserves of the main tree species, selected for gene pool conservation in Ukraine (FAO report, Ukraine)

Species	Number of populations	Total area [ha]
Pinus sylvestris L	115	5,420.1
Picea abies	47	2,178.9
Pinus pallasiana	7	133.8
Pinus cembra	5	632.1
Abies alba	27	1,273.3
Quercus robur	249	7,758.5
Quercus petraea	16	220.4
Fagus sylvatica	62	4,286.8
Fraxinus excelsior	5	203.7
Alnus glutinosa	25	179.4
Total	558	22,287.0

63 populations of Scots pine. A significant number of European beech forest populations were selected in the Khmelnytskyi region – 6 (Tab. 3).

According to the authors' researches of the forest genetic reserves of broadleaf tree species (project: 'Genetic resources of broadleaved forest tree species in Southeastern Europe'), a large part of genetic reserves is in poor condition. This is due to the deterioration of the state and the decline in the share of the main forest species, in particular, English oak. Therefore, it is necessary to take measures today, not only on the selection of forest genetic reserves, but also for seed regeneration of the valuable forest stands. Deterioration in the status of oak forests in the recent decades is due to the negative influence of climate change and other abiotic and biotic environmental factors. This is especially true given that the oak stands are located on the southern boundary of the natural distribution area. Forests suffered a negative impact in 2000 due to the influence of ice-breaking. The largest areas of plus stands are found in the forest-steppe – 1,204.6 ha. At the same time, with the largest forest area in the Polissya (mixed-forest zone), the area of plus stands is only 701.2 ha.

In Ukraine, about 4,560 trees are selected. The largest number of plus trees was selected in the Carpathian (mountain and pre-mountain forests zone) – 1,309 trees. A large number of them are also selected in the Polissya and Forest-steppe zone, 1,129 and 1,269 trees, re-

Table 3. Characteristics of gene reserves of the Central part of Ukraine in 2018

Region	Species	Number of populations	Total area [ha]	Area [ha]		
				average	max	min
Vinnytsia	*Quercus robur*	46	1,286.0	28.0	204.0	1.2
Total		46	1,286.0	28.0	204.0	1.2
Zhytomyr	*Fagus sylvatica*	1	2.0	2.0	2.0	2.0
	Quercus robur	31	1,357.0	43.8	115.0	2,0
	Quercus borealis	1	13.0	13.0	13.0	13.0
	Larix decidua	2	12.5	6.3	11.9	0.6
	Pinus sylvestris	63	1,505.4	23.9	546.0	1.2
	Picea abies	4	19.7	4.9	9.0	1.4
Total		102	2,909.6	28.5	546.0	0.6
Odessa	*Quercus robur*	1	164.1	164.1	164.1	164.1
	Quercus petraea	1	8.7	8.7	8.7	8.7
Total		2	172.8	90.8	172.8	8.7
Mykolaiv		0	0.0	0.0	0.0	0.0
Total		0	0.0	0.0	0.0	0.0
Khmelnytskyi	*Fagus sylvatica*	6	224.0	37.3	74.0	9.4
	Quercus robur	7	131.9	18.8	41.0	9.1
Total		13	355.9	27.4	74.0	9.4

spectively. In total, about 30 forest tree species are presented. The largest proportion of selected trees is: Scots pine – 29% and English oak – 30% and significantly less selected European larch trees – 7%, Silver fir – 6% and Norway spruce – 5%.

In the central region, about 600 plus trees have been selected from the age of 55 to 129 years. The largest number of plus trees – 290 – was selected in Zhytomyr region. The least plus trees are represented in Odessa and Mykolaiv region, 27 trees and 35 trees, respectively. The main tree species are English oak, Scots pine, European larch, Norway spruce and European beech. The largest number of chosen trees were oak trees – 305 (49.1%) and lesser number of pine trees were picked – 188 (30.3%). These are high-yielding specimens, the DBH of which is from 37 to 76 cm and the height varies within the range of 27–34 m. The number of selected plus trees of other species is stacked from 15 to 65 trees (2.4–10.5%) (Tab. 4).

Table 4. Characteristics of plus trees in the year of selection in the Central part of Ukraine

Region	Species	Number of trees	Average		
			age [year]	DBH [cm]	height [m]
Vinny-tsia	*Quercus robur*	116	90	50.2	29.3
	Larix decidua	5	71	40.2	28.2
	Picea abies	2	70	46.0	28.5
Total		123	89	49.8	29.2
Zhyto-myr	*Quercus robur*	70	109	53.4	30.3
	Larix decidua	37	129	75.6	33.9
	Pinus sylvestris	159	90	42.6	30.0
	Picea abies	24	55	37.3	27.1
Total		290	97	49.0	30.3
Odessa	*Quercus robur*	25	73	39.8	24.0
Total		25	73	39.8	24.0
Myko-laiv	*Quercus robur*	35	79	51.0	30.0
Total		35	79	51.0	30.0
Khmel-nitskyi	*Fagus sylvatica*	22	120	54.6	32.5
	Quercus robur	59	101	51.5	31.2
	Larix decidua	23	76	58.0	32.5
	Larix sibirica	15	70	36.3	28.6
	Pinus sylvestris	29	90	52.1	31.2
Total		148	95	51.5	31.3

The selection and use of plus trees and plus stands are more effective if it is accompanied by an examination of heritability properties for that progeny. To date, a number of progeny tests have been established in Ukraine with the purpose of checking the genetic properties of the main forest tree species. Along with this, the area and their representation are insufficient (Tab. 5).

Table 5. Number of units and representation of progeny tests of the main tree species in Ukraine (FAO report, Ukraine)

Species	Ukraine		Central part	
	number of			
	units	genotypes	units	genotypes
Pinus sylvestris	76	520	5	69
Pinus nigra	6	90	0	0
Picea abies	1	14	0	0
Quercus robur	21	365	4	48
Quercus petraea	2	90	0	0
Total	106	1,079	7	117

According to the data given, the total number of progeny tests is only 106 plots, in which 1,079 genotypes of plus trees are present. Taking into account the total number of plus trees in Ukraine (4,560 trees), only 23.7% are subject to investigation. The largest number of progeny tests is represented by Scots pine – 76 plots and a much smaller number of plots of English oak – 21. The corresponding representation of genotypes is 520 of Scots pine and 365 of English oak. In the central region, there are 7 sites of progeny tests, including 5 for Scots pine and 4 for English oak. The genotype representation is 69 pine and 48 oak trees. At present, the share of the studied genotypes of plus trees in the progeny tests of pine is 37% and oak is 16%.

Forestry, according to forest tree breeding basis, develops rapidly in many countries. A significant area of the current forests in the world is created from seeds, which are collected from seed orchards of different types.

In Ukraine, significant areas of seed orchards of the main forest tree species have been created. The total area of clonal seed orchards is 1,007.6 ha. The largest area of seed orchards is concentrated in the region of forest-steppe zone – 504.8 ha. The area of seedling seed orchards is 187.8 ha. The largest areas of clonal seed orchards of Scots pine is 533.5 ha and of English oak is 281.8 ha. Taking into account that these tree species are of the greatest importance in forestry production, pine and oak seed orchards of the 1.5 generation are created, the area of which is 39.0 ha and 11.2 ha, respectively. Seedling seed orchards are mainly Scots pine (96.6 ha) and English oak (60.4 ha) (Tab. 6).

Table 6. Distribution of area clonal and seedling seed orchards of main tree species in Ukraine (FAO report, Ukraine) and Central Part

Species	Generation	Seed orchards [ha]			
		Ukraine		central part	
		clonal	seedling	clonal	seedling
Pinus sylvestris	1	533.5	96.6	62.0	5.0
	1.5	39.0	0.0	0.0	0.0
Pinus nigra	1	35.1	9.0	0.0	0.0
Picea abies	1	20.4	3.8	0.0	0.0
Abies alba	1	49.4	0.0	0.0	0.0
Larix decidua		25.3	0.0	13.0	0.0
Pseudotsuga menziesii	1	10.0	0.0	0.0	0.0
Quercus robur	1	281.8	60.4	198.2	4.2
	1.5	11.2	0.0	0.0	0.0
Quercus rubra	-	0.0	2.0	0.0	0.0
Fagus sylvatica	-	0.0	16.0	0.0	0.0
Fraxinus excelsior	1	1.9	0.0	0.0	0.0
Total	-	1,007.6	187.8	273.2	9.2

In the central region of Ukraine, the area of clonal seed orchards is 273.2 ha. Small areas have seedling seed orchards (9.2 ha). These are mainly the seed orchards of oak, the largest area of which is 202.4 ha. The total area of pine seed orchards is much smaller covering an area of 67 ha. The European larch clonal seed orchards is 13.0 ha.

In addition to the main purpose, the production of genetically improved and high-quality forest seed, clonal seed orchards perform an equally important function of preserving the gene fund of the corresponding forest tree species. After all, the existence of objects of a valuable genetic fund in current conditions, in particular, plus trees, threatens many of the risks of abiotic and biotic nature (illegal logging, windbreaks, pests and diseases, aging and dying, etc.). Therefore, the conservation of particularly valuable genotypes on clonal seed orchards is also a way to reduce the risk of their complete loss.

Despite the available *in situ* and *ex situ* tree breeding facilities, the percentage of seeds harvested from them in Ukraine is extremely low (about 30%). These objects are most effectively used for harvesting seeds in Polissya and the Carpathians, and the least in the Steppe zone. In the context of regions of Ukraine, tree breeding units are used more extensively in the Volyn region (73%) (Fig. 1).

In the central part, the largest amount of forest seed is harvested from the tree breeding facilities in Vinnytsia (54%) and Zhytomyr (39%) regions. Less seed is harvested in Mykolaiv (25%) and Khmelnytskyi regions (6%). The intensity of harvesting of forest seed and the efficiency of using breeding facilities depends on the dominating tree species. The largest share of acorns is harvested from *in situ* and *ex situ* objects in the Vinnytsia region (89%). In Zhytomyr region, acorns is harvested from such objects almost twice less (39%). The largest share of pine forest seed is harvested in the Mykolaiv and Zhytomyr region (67% and 37%) (Tab. 7).

In some forest enterprises, the *in situ* and *ex situ* facilities for forest harvesting are not used at all. In practice, often used for harvesting seeds are random trees, usually low-growing, with low-down crowns that are not marked by high qualities. According to information received from foresters in Ukraine, the majority of acorns are harvested from trees on the boundary of forest area, from single trees in field and other stands, which do not belong to *in situ* and *ex situ* facilities. On such trees, more often there is a crop. Harvesting of pine seed is usually carried out after logging. Partially, the seeds are harvested from clonal and seedling seed orchards.

Therefore, in Ukraine, work should be carried out on: selection and establishment of *in situ* and *ex situ* gene sources conservation units, the area of which is currently insufficient; estimation of the heritability properties

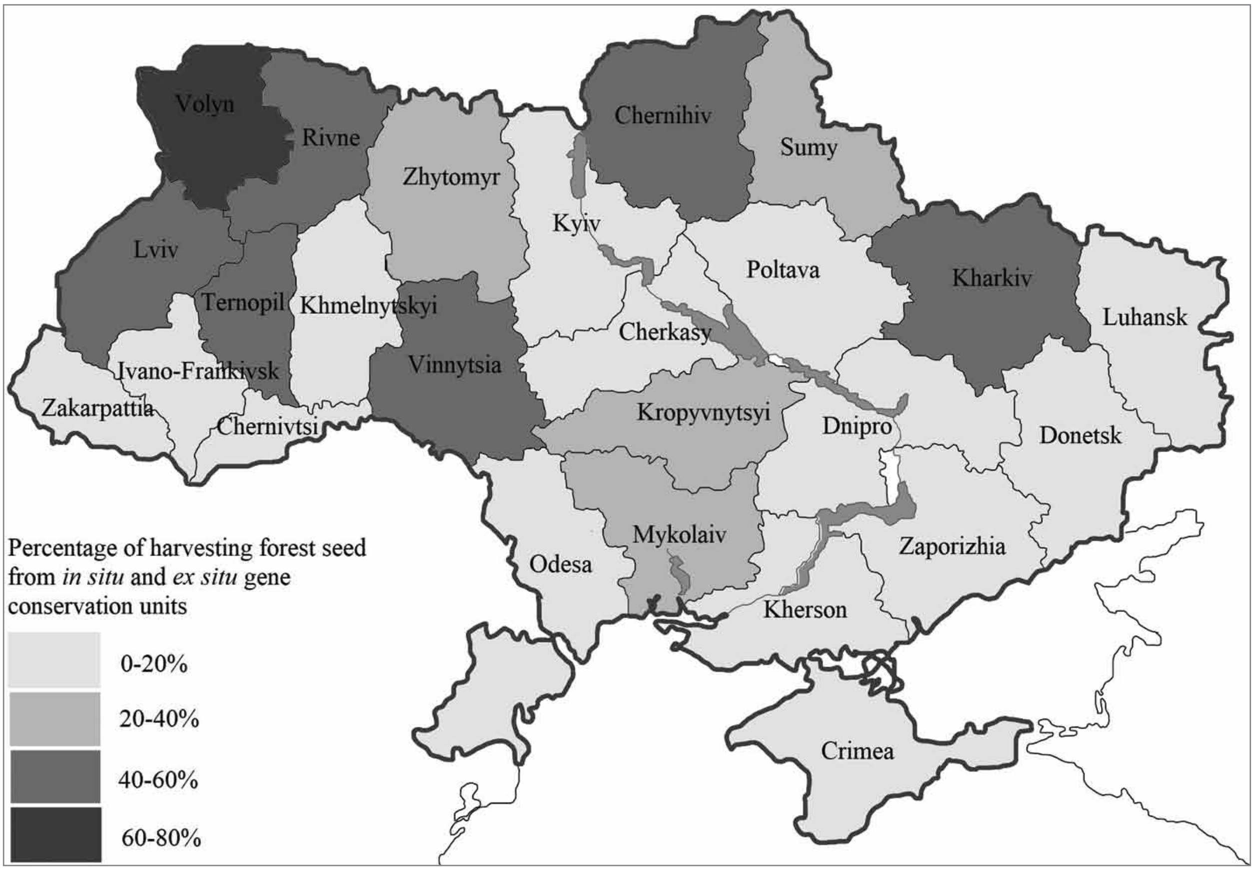

Figure 1. Percentage of harvesting forest seed from *in situ* and *ex situ* gene conservation units in regions of Ukraine

Table 7. Harvesting of forest seed by the Forestry enterprises of Ukraine (State Forestry Agency of Ukraine, 2017)

Natural zone/ Region	Harvested seed [kg]									
	total	coniferous	broadleaves	oak (Q.r)	on *in situ* and *ex situ* units					
					total	% to total	coniferous	%	oak (Q.r)	%
Polissya	148,971	7,597	141,374	95,089	78,197	52.5	2210	29.1	65,583	69.0
Zhytomyr	49,658	2,014	47,644	22,148	19,325	38.9	733	36.4	8,592	38.8
Forests steppe	390,483	3,427	387,056	210,826	112,602	28.8	367	10.7	92,444	43.8
Khmelnytskiy	43,221	380	42,841	26,160	2,453	5.7	103	27.1	2,300	8.8
Vinnytsia	105,073	328	43,969	43,969	56,564	53.8	0.0	0.0	39,174	89.1
Steppe	87,286	724	86,562	73,717	13,965	16.0	12	1.7	13,698	18.6
Odessa	12,837	24	12,813	9,795	0	0.0	0	0.0	0	0.0
Mykolaiv	1,073	15	1,058	0	265	24.7	10	66.7	0	0.0
Carpathian region	65,858	5,450	60,408	41,068	23,722	36.0	1789	32.8	17,580	42.8
Ukraine	692,598	17,198	675,400	420,700	228,486	33.0	4378	25.5	189,305	45.0

of plus trees, through the creation of progeny tests under different environmental conditions; improvement of the condition and quality of seed orchards; increasing the efficiency of using *in situ* and *ex situ* gene sources conservation units for harvesting forest seed.

Discussion

Selected units of the forest gene pool *in situ* and *ex situ* conservation are an important source of increasing timber volume. Until recently, considerable attention was paid to the development of methodological aspects of forest tree breeding. In the experimental and productive attitude, the pioneer selection system, which focuses on the creation of artificial high-yielding stands, has been particularly intensively developed (Eriksson et al. 2006). Thousands of plus trees of different species were selected in Ukraine, a selective evaluation of forest stands was conducted and a number of plus stands were chosen, forest stands were selected for genetic reserves were identified, clonal and seedling seed orchards and progeny tests were created. In the opinion of many scientists, the introduction of a plus selection in the practice of forestry can increase the volume of forest stands on 10–15% (Albenskiy 1959; Krynytskiy 2002; Bilous 2004; Los et al. 2014).

Despite the great importance of forest tree breeding, it should be noted that due to its specificity and relatively long experience, it is strongly opposed to the plant breeding in agricultural, which develops rapidly and has important achievements in agricultural production, providing it valuable varieties of agricultural crops. Plant breeding programs primarily focus on improving a crop's environmental adaptability and biotic stress tolerance in order to increase yield (Brummer et al. 2011).

The lagging of forest tree breeding is associated with a number of objective and subjective reasons, mainly of a social and economic nature. In most cases, the inhibition of breeding activities in the forestry sector was spurred by a long period of research that could take dozens or even hundreds of years. So, it was necessary to start breeding research for one generation of scientists, and to finish another. As a result, contradictions often occurred between the scientists at different stages of breeding work (Yurkiv and Neyko 2017).

The braking of breeding activities in the forestry of Ukraine was also due to the fact that forest tree breeding continued to be considered important and promising for the future of forestry, but at some stage, not related to the everyday needs of forestry production, which would have an instantaneous effect (Yurkiv and Neyko 2017). Such an incorrect approach led to the fact that the development of forest tree breeding was held back, the material and human resources of forest selection were limited. All this has led to the fact that the needs of forestry in our time exceeds the level of development of forest tree breeding that it would have achieved in the relevant conditions, and it was found to be largely unprepared to quickly respond to the present production needs. It should be noted that the answers of breeding science to the needs of production are much more complicated than those of other branches of forestry science (Tkach et al. 2013; Los et al. 2014; Yurkiv and Neyko 2017).

The reality of the present requires that forest breeding develop more intensively and ensure the production of high-yielding and valuable varieties of forest species. To do this, it is necessary to significantly increase the efforts of forest breeding staff and provide them with the most favourable working conditions. Work on the development of new varieties of plants requires in our time, trained professionals and the appropriate material and technical base, appropriate equipment, the availability of sufficient areas for the establishment of tree breeding facilities, progeny tests, experimental seed orchards and so on. Significant work in this direction is currently being carried out, but for some reason or another (lack of funding), this is not enough to fully respond to the current production needs (Yurkiv and Neyko 2017).

Today, in our country and abroad, there is a process of intensification of forest management, in which more and more tree breeding methods and scientific achievements are being introduced in the cultivation of forest stands. In many countries (Poland, Sweden, Germany, etc.), large-scale work on the improvement of forest species is being conducted, using the achievements of forest genetics and forest tree breeding (Namkoong 1976; Giertych 1988; Lindgren and Mullin 1988; Gomory 1992; Eriksson et al. 1995; Falconer et al. 1996; Eriksson et al. 2006; Kowalczyk 2005). At the same time, the main focus of research is on the organization of elite seeding of forest species using such sciences as physiology, biochemistry, cytology, cellular and molecular biology, and others (Krynytskiy 2002; Eriksson et al. 2006; White et al. 2007; Nowakowska et al. 2014).

In our time, quite a lot of institutions are working on the emergence of new forms of tree species and their improvements. Methods of mass receipt of hybrid seeds, methods of genetic evaluation of seed material and inheritance of valuable features are developed (Lindgren et al. 1988; Eriksson et al. 1995; White 2007; Mullin 2013). In many countries, these works are conducted in both public and private forests. This once again confirms the expediency and the prospect of introducing breeding methods in the forestry industry in order to obtain a result in the form of improving forests in the future. In the work on the selection of best forest stands and trees, and using reproductive material of main tree species, we must definitely use a positive law-based experience.

Conclusions

The maintenance of forestry with high-quality seeds with valuable heritability properties is sufficient in terms of availability and effective use of objects *in situ* and *ex situ*. In Ukraine, in particular, in the central part, the proportion of such sites relative to the forest area is extremely low and ranges from 0.1 to 0.5%. These units are not used efficiently. The share of harvested seeds from them is about 30%.

In order to fully meet the needs of forestry, it is necessary to increase the number and area of *in situ* and *ex situ* facilities in Ukraine. It is necessary to improve the condition and upgrade the genetic level of *ex situ* units. In order to verify the heritability of genotypes, the area of progeny tests and the number of representative genotypes should be significantly increased. Due to the trends in global climate change, in Ukraine, it is feasible to create progeny tests of main tree species in different environment condition.

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