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Editorial Board

Зміст

Contents

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Condition of the permanent forest seed base objects of the Slavuta Forestry branch of the State Enterprise "Forests of Ukraine"

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Abstract. The permanent forest seed base (PFSB) serves as the foundation for the procurement of improved selective seeds for forest regeneration and afforestation. Analysing the condition of PFSB objects enables the evaluation of the quality and quantity of valuable reproductive material used in forestry. This study encompassed: an analysis of the formation and localisation of PFSB objects under the conditions of the Slavuta Forestry branch; an investigation of the condition and

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selective structure of forest genetic reserves and plus stands; and an analysis of the dynamics of forest nursery production development within the branch. Within the forest fund of the branch, 27 plus trees of common oak and Scots pine were selected. The total area of permanent forest seed plots amounted to 71.3 hectares. The survey results indicated that the examined plus trees of common oak (7 trees) in the Partyzanske Forestry are in good to satisfactory condition, predominantly belonging to the 2nd selective category, and demonstrated a satisfactory level of reproduction. To establish permanent forest seed plots with optimal characteristics, it was recommended to gradually thin the stands and prune tree crowns. It had been determined that the seedling seed orchard of European larch (Zhukivske Forestry, compartment 8, plot 41, area 2.0 hectares, established in 2010) was in good condition, exhibits a high level of reproduction, and meets all required standards. Research findings indicated that the quality of forest seeds collected from PFSB objects was sufficiently high. Specifically, in 2021 and 2022, nearly all seeds (80% and 100%) were classified as Grade I and Grade II quality, with no substandard seeds detected. The efficiency of utilising permanent forest seed base objects within the enterprise was high, as in productive years, the maximum amount of seeds was collected, fully meeting the enterprise's needs. Data on the condition of PFSB objects are critically important for implementing measures related to forest regeneration and afforestation

Keywords: forest nursery production; genetic reserves; plus trees; forestry; forest restoration

Introduction

Research into the condition of permanent forest seed bases (PFSBs) and forest cultivation is essential for preserving the genetic diversity of forest ecosystems and ensuring sustainable forest management. It enables the evaluation of the effectiveness of forestry measures, the development of recommendations for their improvement, and contributes to the advancement of the scientific foundations of forestry. PFSBs serve as a strategic reserve of genetic material for forest tree species, used for forest restoration and the preservation of their biodiversity. Assessing the condition of PFSBs, seed quality, and the effectiveness of forest cultivation measures is a crucial task for forestry, as it determines not only the productivity of forests but also their ability to adapt to climate change and other anthropogenic factors.

The research by I. Neyko *et al.* (2022) on the condition of PFSB objects represents a significant step in their comprehensive assessment to determine their compliance with specific criteria. Since their initial creation and establishment in the 1970s and 1980s, a significant portion of these sites have lost their original importance and require replacement. In the 2000s, scientists at the Ukrainian Research Institute of Forestry and Forest Melioration (URIFFM) conducted assessments of most forest genetic reserves and plus trees, developing a corresponding methodology. However, field studies primarily focused on deciduous tree species, while clonal and seedling seed plantations were less studied. Therefore, a detailed examination of all PFSB sites within individual enterprises is urgently needed. Research on forest genetic resources by I. Neyko *et al.* (2022) indicates a certain deterioration of their condition, particularly regarding oak forests. Provenance tests and clonal seed orchards play a crucial role in studies aimed at assessing the impact of climate change on forest ecosystems. According to I. Neyko *et al.* (2022), the lack of a proper assessment of the condition and reproductive capacity of PFSB sites limits the possibility of obtaining high-quality forest seeds, especially under conditions of climate change and the spread of forest diseases and pests.

Clonal and seedling seed orchards have not been examined. In this regard, a detailed inspection

of all PFSB sites within individual enterprises is extremely important. A comprehensive study of all sites allows for a complete assessment of their condition and functioning, as well as an evaluation of the effectiveness of their use. Most studies of forest genetic resources indicate some deterioration of their condition and an increasing negative impact of external environmental factors. O.M. Danylenko *et al.* (2022) considered that the deterioration of the condition, growth, and development of forest stands is largely due to unfavourable site conditions. At the same time, M. Kohler *et al.* (2021) emphasise the significant impact of management activities, which often change the structure and functioning of ecosystems, leading to the degradation of forest soils and a decrease in biodiversity. According to G. Weithmann *et al.* (2021), climate change and soil droughts have a key impact on the condition of forest ecosystems, leading to a deterioration of the health and resilience of forest ecosystems. Similar trends were observed by B. Schuldt *et al.* (2020). The authors conducted a detailed assessment of the impact of the extreme summer drought of 2018 on Central European forests. They noted a significant weakening of tree stands, including reduced growth, defoliation, and increased tree mortality, which were consequences of soil moisture deficits. They emphasise that such droughts can lead to long-term changes in the structure of forest ecosystems, weakening the resilience of forests to future extreme weather events. In response to the challenges facing forest ecosystems, research is being conducted to select the most resilient species, populations, and genotypes of tree species. For example, J. Amaral *et al.* (2022) used an interdisciplinary approach to identify genetically resistant trees to biotic factors, considering the case of pine trees affected by canker. V. Dyshko *et al.* (2024) focused on studying populations of pine resistant to root rot, which will contribute to preserving the resilience of future pine forests in conditions of increased pathogenic activity.

V. Tkach *et al.* (2019) highlighted the importance of assessing the reproductive function of major forest-forming species in clonal and seedling seed orchards, especially in the context of global climate change. According to recent surveys by Y. Hayda *et al.* (2019), most seed orchards in the region are in good condition, and coniferous species exhibit relatively high seed productivity. However, there is a trend towards decreasing seed productivity in deciduous species, particularly common oak. The lack of a proper assessment of the condition and reproductive capacity of PFSB objects prevents the prediction of the possibility of harvesting high-quality, selectively improved forest seeds. The issue of forest restoration within seed zones is particularly relevant due to global challenges such as climate change, intensive development and the spread of forest diseases and pests.

This study aimed to assess the condition of the permanent forest seed base of the Slavuta Forestry branch, evaluate seed material quality, and analyse the effectiveness of measures implemented in forest nursery production.

Materials and Methods

The study of the condition and utilisation of permanent forest seed base (PFSB) objects was conducted during the vegetation seasons of 2020-2024 within the Slavuta Forestry, branch of the state enterprise "Forests of Ukraine". The primary research objects included plus trees, forest genetic reserves, plus stands, seedling and clonal seed orchards, as well as permanent and temporary forest seed plots and forest nurseries. The assessment of PFSB objects was carried out in the Partyzanske, Zhukivske, and Komarivske forestries. Additionally, the condition of open forest stands established using seedlings with containerised and bare-root systems was specifically studied under the conditions of the Holytske, Partyzanske, and Komarivske forestries.

Most of the objects were designated and established in conditions of fresh fairly fertile site type. Field studies involved the evaluation of both individual trees and entire stands. Sample plots were established, with their number determined

by factors such as stand age, species composition, and productivity. The sample plots were set up following standard forest inventory methodologies, predominantly as strip plots. These plots adhered to key requirements, ensuring the inclusion of at least 100 trees of the main tree species – common oak and Scots pine in this case.

Various approaches were employed during the inventory of forest genetic resources to assess the condition and selective value of individual trees, stands, or seed orchards as a whole. These included the Sanitary Rules in Forests of Ukraine (Resolution of the Cabinet of Ministers of Ukraine No. 748, 2024), forest monitoring methodologies, and tree condition assessment methods developed by URIFFM (Los *et al.,* 2019).

The study of forest genetic reserves, plus stands, and permanent and temporary forest seed plots involved the determination of their forest inventory parameters. For each tree, in addition to measuring DBH and assessing technical suitability, both the selection category and condition category were established. The selection category was determined using a 4-point scale, while the condition was evaluated using a 6-point scale by the Sanitary Rules in Forests of Ukraine. The selection category assessment considered factors such as growth intensity based on diameter, the presence or absence of curvature, and any damage or diseases. The condition categories also took into account the percentage of crown defoliation and dechromation. Tree condition categories were determined at the end of the vegetation period to reflect the cumulative influence of all environmental factors. For the stands, average values of the selection and condition categories were calculated. To refine forest inventory characteristics, temporary sample plots were established in the most representative locations.

For each plus tree, the following parameters were assessed: condition indicators (condition category 1-6), selection category (selection category 1-4), total height (m), height to the first dry and live branch (m), and any damage or diseases present (Los *et al.,* 2019). A general overview of the certified objects of PFSB is presented in Table 1.

Table 1. *Characteristics of PFSB in the Slavuta Forestry branch*

PFSB Objects	Last basic forest inventory	For the previous year before inspection (based on reporting)
Plus trees, pcs	27	27
Plus stands, ha	-	-=
PFSS, ha	71.3	71.3
Seed plantations, ha	-	2.0
Genetic reserves, ha	-	-

Source: developed by the authors based on the Official website of Slavuta Forestry branch (n.d.)

According to the available information, the anticipated seed yield in the Slavuta Forestry branch was calculated for the following species: Scots pine, common oak, and European larch. Permanent sample plots were established across all PFSB objects to monitor and account for the expected harvest. Seed harvest was carried out by private contractors under formal agreements. Upon completion, a delivery-acceptance report was issued. Additionally, seeds were gathered by forestry personnel. All harvested seeds were processed either manually or in the cone dryer at the Iziaslavske Forestry branch. Approximately 27 plus trees were selected within the enterprise's forest fund. The total area of permanent forest seed plots amounts to 71.3 hectares. A seedling seed orchard of European larch covering 2.0 hectares has been certified. In the Zhukivske Forestry (compartment 19, plot 32, area 5.0 hectares), a seedling seed orchard of common oak was estab-

lished in 2010. However, as of August 2023, this orchard remains uncertified. Information regarding forest cultivation activities in the Slavuta Forestry branch is provided in Table 2.

Table 2. *Dynamics of forest cultivation in the Slavuta Forestry branch*

Types of work	Last basic forest inventory	For the previous year before inspection (based on reporting)
Planting and sowing of forest, ha	112.5	118.9
Natural regeneration, ha	25.7	18.7
Complementation of forest cultures, ha	136.0	247.9
Care for forest cultures, ha	1,500	1,425
Availability of forest nurseries, pcs./ha	4/2.38	6/1.5
Amount of seed sown in nurseries, kg	1,920.0	4,832.5
Number of seedlings, thousands pcs.	924.2	1,233

Source: developed by the authors based on the Official website of Slavuta Forestry branch (n.d.)

Data from the latest forest inventory period indicate an increase in forest planting and sowing activities. Conversely, there has been a slight reduction in the areas designated for natural regeneration. The production of planting material has significantly increased over recent years. All research adhered to widely accepted ethical norms and guidelines (Convention on the Trade..., 1973; Convention on Biological..., 1992). The primary source of reproductive material for establishing seed orchards was the archive of common oak clones. This archive, established in the 1970s-1980s within the Vinnytsia Forestry branch, provided selectively improved seeds. Seedling seed orchards were established using acorns collected from this clone archive.

Results and Discussion

An assessment of the plus trees of common oak (7 trees) in the Partyzanske Forestry revealed that their condition is generally rated as good to satisfactory, predominantly within the 2nd selection category, and exhibits a satisfactory level of reproduction. One plus tree of common oak (No. 23/9), with a condition category of 5, requires removal and replacement with an equivalent tree within the compartment. The PFSS of common oak (Partyzanske Forestry, compartment 52, plot 11, area 17.0 ha) is in good condition, demonstrating a good level of reproduction and meeting the functional criteria. It is advisable to implement thinning measures for the undergrowth. The PFSS of common oak (Komarivske Forestry, compartment 60, plot 9, area 5.3 ha) is also in good condition, with a satisfactory level of reproduction. The stand meets the current standards. The PFSS of Scots pine (Zhukivske Forestry, compartments 8, plots 4, 12, 16, 26, 29, area 18.2 ha, established in 1971-1976) is in unsatisfactory condition and fails to meet the required height and density criteria. This PFSS has lost its functional purpose, is no longer used for seed harvesting, and requires replacement. The PFSS of European spruce (Zhukivske Forestry, compartment 8, plots 29, area 2.7 ha and 4.5 ha, established in 2011) is in good condition and exhibits a good level of reproduction.

To form a PFSS with optimal characteristics, it is necessary to carry out a phased thinning of the stands and pruning of tree crowns. The European larch seedling seed orchard (Zhukivske Forestry, compartment 8, plot 41, area 2.0 ha, established in 2010) was in good condition, had a high level of reproduction, and fully met all requirements. Crown pruning and row maintenance were carried out on the plot. The common oak seedling seed orchard (Zhukivske Forestry, compartment 19, plot 32, area 5.0 ha, established in 2010) is in good condition and has entered the reproductive stage. The FP meets the basic criteria and can be

certified for subsequent inclusion in the enterprise's PFSB and the State Register. Plus trees are in good condition. Individual trees exhibit certain signs of deterioration and drying (Table 3, Fig. 1).

Table 3. *Characteristics of surveyed plus trees of common oak within the Partyzanske Forestry*

Plus Tree No. (PT)	DBH, cm	Condition	Selection category (SC)	Crown parameters	Remarks
19/5	64	1	2.0	8*10	Curvature
18/4	47	3	2.5	7*9	Curvature
17/3	54	1	2.0	12*14	Curvature
89/6	56	3	2.0	-	Replaced tree
89/6	60	2.5	2.5	12*13	Curvature
23/9	66	6	-	-	Dry
16/2	64	1	2.0	13*14	Crown low-hanging
15/1	58	1		9*10	Crown low-hanging

Source: developed by the authors based on their own research

Figure 1. *The overall appearance of the plus trees of common oak*
Note: Slavuta Forestry branch, Partyzanske Forestry
Source: photo by the authors

According to Table 3, the average DBH of the selected plus trees of common oak is within 47-66 cm. These are mostly well-developed trees with crown parameters of 10-12 m. One tree is die and needs to be replaced. The selection category of most trees is 2.0, due to the presence of stem curvature. In some trees, the length of the knot-free (branchless) part is insignificant and does not exceed 25% of the total height.

The efficiency of using PFSB objects in the enterprise is high, as in productive years, the maximum amount of seed is harvested from

common oak PFSSs, which fully meets the needs of the enterprise. For example, in 2021, the enterprise harvested a total of 5,210 kg of seeds, of which 1,501 kg were from PFSB objects, which is 28.8% (Table 4). In 2022, the enterprise harvested a total of 2,426 kg of seeds, and no harvesting was carried out from PFSB objects.

Since the enterprise has PFSB objects not only for common oak but also for other species, the harvesting of seeds from these objects depends primarily on the periodicity of seed years for this species. The general view of permanent seed plots and seedling seed orchards is shown in Figure 2.

Table 4. *Assessment of the effectiveness of using PFSB objects within the Zhukivske Forestry branch*

Name of PFSB object	Forestry	Compartment	Plot	Area, ha/pcs.	Forest seeds collected over the past 3 years, kg		
					2021	2022	2023
Plus trees, pcs	-	-	-	-	-	-	-
Plus stands, ha	-	-	-	-	-	-	-
PFSS, ha	Zhukivske	17	27	9,3	1,500	-	-
	Zhukivske	8	28	2.7	-	-	1
Seed orchards, ha	Zhukivske	8	41	2.0	1.0	-	2
Genetic reserves, ha	-	-	-	-	-	-	-

Source: developed by the authors based on their own research

Figure 2. *General view of permanent seed plots and seedling seed orchards in the Slavuta Forestry branch*

Source: photo by I.S. Neyko

A seed harvesting plan is provided to each forestry at the beginning of the year. Thus, in 2021, with a plan of 5,000 kg, the enterprise harvested 5,210 kg of seeds, in 2022, with a plan of 1,720 kg, the enterprise harvested 2,426 kg, which indicates the fulfilment of the plan. The planned and actual harvesting of forest seeds by species in 2022-2023 is presented in Table 5.

Table 5. *Planned and actual harvesting of forest seeds in 2022-2023 by species*

No.	Species	Seed harvest plan, kg	Harvested and purchased with seed quality documents, kg	Tested for seed quality, kg
		2022		
1	*Coniferous - total*	20	33.5	26
	including: - Scots pine	20	28	26
	- European spruce	-	0.5	-
	- European larch	-	5	-
2	*Deciduous - total*	1,700	2,400	2,400
	including: - common oak	1,500	2,300	2,300
	- northern oak	-	-	-
	- common viburnum	4	4	4
	- small-leaved lime	24	24	24
	- spreading plum	-	-	-
	- European wild apple	-	-	-
	- common walnut	72	72	72
	- eastern American black walnut	-	-	-
	- common ash	-	-	-
	- horse chestnut	-	-	-
	-other deciduous	-	-	-
		2023		
1	*Coniferous - total*	3.4	3.4	3.4
	including: - Scots pine	-	-	-
	- European spruce	1	1	1
	- European larch	2	2	2
	- blue spruce	0.4	0.4	0.4
2	*Deciduous - total*	-	-	-
	including: - common oak	-	-	-
	- northern oak	-	-	-
	- common ash	-	-	-
	- Norway maple	-	-	-
	- spreading plum	-	-	-
	- European wild apple	-	-	-
	- small-leaved lime	-	-	-
	- common walnut	-	-	-
	- eastern American black walnut	-	-	-
	- horse chestnut	-	-	-
	- *other deciduous*	-	-	-

Source: developed by the authors based on the Official website of Slavuta Forestry branch (n.d.)

The seed harvesting plan for coniferous species was fulfilled 100%. The assortment of harvested forest seeds in the enterprise is quite high and amounted to 13 species in 2021 and 6 species in 2022. For 2023, according to the seed harvesting plan, the assortment is 8 species. The seed quality results of the first check, which was carried out by the separate department (SD) Vinnytsia Forest Seed Laboratory, are presented in Table 6.

Table 6. *Sowing qualities of seeds verified during the first inspection at the SD Vinnytsia Forest Seed Laboratory, 2021-2023*

Year of harvest	Total seeds harvested, kg	Of which checked in the year of harvest		Seed quality, kg/%		
		kg	%	I class	II class	III class
2021	5,200	5,200	100	198/4	5,002/96	-
including conifers	10	10	100	8/80	1/10	1/10
2022	2,400	2,400	100	2,400/100	-	-
including conifers	26	26	100	26/100	-	-
2023	-	-	-	-	-	-
including conifers	3.4	3.4	100	-	2/59	1.4/41

Source: developed by the authors based on their own research

According to the data obtained in Table 6, the quality of forest seeds is quite high. Thus, for 2021 and 2022, almost all seeds (80% and 100%) are of the first and second quality classes. There is no substandard seed. Coniferous seeds are of high quality, which can be explained by compliance with processing and storage requirements. In 2023, the enterprise harvested and checked 3.4 kg of coniferous species, 1.4 kg of spruce, and 2 kg of European larch. Of these, 3 kg were harvested from PFSB objects. At the time of the check, the enterprise did not have a balance of harvested coniferous seeds, but there were 12.4 kg of Scots pine seeds purchased from the Shepetivske Forestry branch. The seed moisture content at the time of the inspection is normal.

At the Holytske Forestry (compartment 31, plot 2.2, area 2.2 ha), forest stands established in 2020 using containerised common pine planting stock are thriving. The site is characterised as a fresh hornbeam-oak fairly fertile site type, with a planting pattern of 3.0×1.0 m. The condition of the forest stands is good (Fig. 3).

Figure 3. *General view of forest cultures at the Slavuta Forestry branch*

Source: photo by the authors

In compartment 31, plot 6.3 (0.5 ha), forest stands were established in 2023 using containerised seedlings. The forest type is characterised as a fresh hornbeam-oak fairly fertile site type, with a spacing scheme of 2.0×0.8 m and an alternating row composition: one row of common oak followed by one row of European spruce. The condition of the forest stands is good. In

compartment 31, plot 2.7 (0.9 ha), forest stands were established in 2022 in a similar fresh hornbeam-oak fairly fertile site type. The planting arrangement alternates one row of common pine with one row of European spruce. Both containerised and bare-root seedlings were used for planting. An inventory conducted in 2022 revealed a 92% survival rate for seedlings planted with containerised root systems. The trees planted with containerised seedlings exhibited greater height and root collar diameter compared to those planted with bare-root seedlings.

In the Partyzanske Forestry, compartment 42, plot 4.1 (3.0 ha), forest stands established in 2020 in a fresh hornbeam-oak fertile site type are performing well. The planting scheme is 3.0×1.0 m, with a row composition of four rows of common oak interspersed with one row of coniferous species, including European larch, European spruce, silver fir, and Douglas fir. All seedlings were planted using containerised root systems, and the condition of the forest stands is good.

In the Komarivske Forestry, compartment 62, plot 12 (1.1 ha), forest stands established in 2023 in a fresh oak fairly infertile pine site type are thriving. The spacing scheme is 2.0×0.8 m, with a composition of eight rows of common pine followed by two rows of common oak. The stands was established using containerised seedlings and is in good condition.

A comparison of growth rates and overall health between forest stands established using bare-root and containerised seedlings revealed a significant advantage in growth for the latter. Containerised seedlings exhibited a growth rate up to 30-40% higher in terms of height. However, no substantial differences were observed in overall plant health. The superior growth of containerised seedlings can be attributed to their cultivation method, which ensures a consistent supply of moisture and nutrients. It is anticipated that this growth advantage will diminish over time.

As noted by S.A. Los *et al.* (2019), a comprehensive approach is required for the establishment and management of PFSBs in the context of adapting to current climate conditions. Climate change, characterised by rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events, is significantly impairing the reproductive functions of major forest tree species. Under these conditions, the selection of genetically resistant populations and genotypes is of paramount importance. According to a comprehensive assessment of the current state of forest genetic resources conducted by V.P. Tkach *et al.* (2019), the conservation and restoration of these resources is a critical priority. This is particularly important in the context of implementing the principles of sustainable forest management and preserving biodiversity at both the species and genetic levels.

The restoration of oak stands remains a critical issue, especially given the decline in natural regeneration within genetic reserves (Danylenko *et al.*, 2022). This can disrupt the natural evolutionary process of oak forests, leading to an increased reliance on artificially created stands. The lack of reliable natural regeneration necessitates the implementation of various harvesting techniques, including measures to promote the successful growth and development of oak stands, as outlined in the research by V. Lukyanets *et al.* (2023).

Most forest genetic reserves in the region consist primarily of oak stands, with some oak-pine mixtures. There is a concerning trend of inadequate natural regeneration in oak forests. O.B. Bondar *et al.* (2020) attributed this to factors such as site conditions, stand composition and productivity, seed years, and harvesting activities. B. Kanjevac *et al.* (2021) highlighted the significant impact of competition from herbaceous and woody vegetation on the successful growth and development of natural oak regeneration, as competing vegetation can reduce resource availability. Z. Govedar *et al.* (2021) emphasised the substantial influence of silvicultural treatments, such as thinning and tending, on the condition of young oak stands, creating more favourable conditions for their development. O.M. Danylenko *et al.* (2023) also confirmed the importance

of using containerised seedlings to improve the growth of oak in the Kharkiv Forestry. V. Lukyanets *et al.* (2023) argued that effective restoration of oak forests requires not only ensuring the emergence of natural regeneration but also implementing measures to promote its sustained growth. A significant portion of research by V. Lukyanets *et al.* (2022) focuses on evaluating the biometric characteristics and health of oak stands established using various methods and planting materials, which are crucial for the successful restoration of oak forests in the southeastern Forest-Steppe of Ukraine.

One of the most significant components of forestry research involves progeny tests. The majority of these progeny tests, like many other breeding objects, were established during the mid-20th century (Los *et al.,* 2019). Most of these were created under uniform forest growth conditions, limiting the applicability of the "genotype-environment" model to separate genetic and environmental influences. As a result, the establishment of progeny tests remains a critical area of focus. Current methodologies outlined by V. Andreieva *et al.* (2020) include specific guidelines for the creation of progeny tests to apply modern approaches for selecting superior populations and genotypes of primary forest-forming species. S.A. Los *et al.* (2019) utilised comprehensive methods to assess progeny in progeny tests, including hybrids.

Provenance tests are particularly significant (Petrík *et al.,* 2023). S.A. Los *et al.* (2019) noted that evaluating the productivity and condition of Provenance tests enables the assessment of global climate change impacts on forest ecosystems and populations of primary forest-forming species.

Research by Y. Hayda *et al.* (2019) on the functioning of seed orchards underscores the importance of assessing their reproductive performance. A crucial aspect involves studying the development of generative organs across phenological forms. It has been observed that tree ageing often leads to reduced seed productivity in seed orchards. This highlights the need for the establishment of new clonal and seedling seed orchards to sustain genetic diversity and productivity.

Trial progeny tests are essential for identifying the most promising genotypes (Andreieva *et al.*, 2020). However, no such progeny tests have previously been established within the forest fund of the Slavuta Forestry branch, underscoring the need for their creation. Trial cultures facilitate long-term studies and the evaluation of selected genetic material. They enable the identification of superior genotypes that can subsequently be used for forest regeneration. Furthermore, the establishment of progeny tests is crucial for enhancing the resilience of forest stands to climate change, diseases, and pests. Progeny tests should be established in various forest growth conditions, allowing the application of the "genotype-environment" model to select the most favourable specimens (Neyko *et al.*, 2022). Most researchers note similar trends regarding the condition of PFSB objects established in Ukraine.

Research conducted on the condition of PFSBs has corroborated findings from previous studies indicating a significant decline in the health and reproductive capacity of major forest tree species. It was determined that various ecological factors, such as climate change, droughts, and anthropogenic pressures, have led to a decrease in the natural regeneration capacity of these species, negatively impacting their resilience and productivity. Furthermore, it was found that forest species populations within genetic reserves are experiencing considerable stress, hindering their natural regeneration process and necessitating additional measures to ensure the long-term sustainability of ecosystems. These results underscore the need to develop new forest management strategies that include active interventions to restore and conserve genetic resources.

Conclusions

Research findings have revealed that most genetic units are in good condition. A total of 27 plus trees have been identified within the enterprise's forest fund. The majority of these plus trees are

classified as the 2nd selection category, necessitating further efforts to identify and select trees of a higher (first selection) category. All plus trees exhibit a satisfactory level of reproduction. However, one plus tree of common oak (No. 23/9), classified as being in the condition category of 5, requires removal and replacement with an equivalent tree within the same compartment. The total area of permanent forest seed stands (PFSSs) is 71.3 hectares. Oak PFSSs are in good condition and fulfil their functional purpose. For most oak PFSSs, thinning is required to ensure a higher level of reproduction. Scots pine PFSSs are in unsatisfactory condition and most do not meet the basic criteria. The dense pine stands and high crowns prevent the harvesting of reproductive material. Therefore, there is a need to select and establish new Scots pine PFSSs. European spruce PFSS is in good condition and characterised by a high level of reproduction. Seedling seed orchards of common oak and European larch are in good condition and have entered the reproductive phase. A seedling seed orchard of common oak was established in 2010 within the forest state of the Zhukivske Forestry (compartment 19, plot 32, area 5.0 hectares). As of August 2023, the seed orchard has not been certified. Overall, the procurement of reproductive material from genetic units within the branch is quite high, ensuring the corresponding productivity of newly established stands.

A critical next step for further research involves the regular inspection of PFSB objects to gather information on their condition and reproductive capacity. Such research will facilitate the selection of superior genotypes for future use, contributing to the cultivation of highly productive stands.

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Conflict of Interest

None.

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Стан об'єктів постійної лісонасіннєвої бази філії «Славутське лісове господарство» Державного підприємства «Ліси України»

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Анотація. Постійна лісонасіннєва база (ПЛНБ) є основою для заготівлі покращеного селекційного насіння для лісовідновлення та лісорозведення. Аналіз стану об'єктів ПЛНБ дає можливість оцінити якість та обсяги отримання цінного репродуктивного матеріалу, який використовується у лісокультурній справі. У статті проведено: аналіз формування та локалізації об'єктів ПЛНБ в умовах філії «Славутське лісове господарство»; досліджено особливості стану та селекційної структури лісових генетичних резерватів та плюсових насаджень; проаналізовано динаміку розвитку лісокультурного виробництва у філії «Славутське лісове господарство». У межах лісового фонду філії відібрано 27 плюсових дерев дуба звичайного та сосни звичайної. Загальна площа постійних лісонасіннєвих ділянок становила 71,3 га. За результатами обстеження встановлено: обстежені плюсові дерева дуба звичайного (7 дерев) у Партизанському лісництві перебувають у доброму та

задовільному стані, переважно 2-ї селекційної категорії та характеризуються задовільним рівнем репродукції. Для створення постійних лісонасіннєвих ділянок з оптимальними характеристиками рекомендовано поетапно зріджувати насадження та проводити обрізку крон дерев. Встановлено, що родинна плантація модрини європейської (Жуківське лісництво, кв. 8, вид. 41, площа 2,0 га 2010 року створення) перебуває у доброму стані, високого рівня репродукції та відповідає усім вимогам. Згідно з проведеними дослідженнями виявлено, що якість лісового насіння, зібраного із об'єктів ПЛНБ є достатньо високою. Так, за 2021, 2022 роки практично усе насіння (80 % і 100 %) було І-го і ІІ-го класу якості. Некондиційного насіння не виявлено. Ефективність використання об'єктів постійної лісонасіннєвої бази на підприємстві є високою, оскільки в урожайні роки з них збирається максимальна кількість насіння, яка повністю покриває потреби господарства. Дані щодо стану об'єктів ПЛНБ є надзвичайно важливими з огляду на необхідність виконання у заходів щодо лісовідновлення та лісорозведення

Ключові слова: лісокультурне виробництво; генетичні резервати; плюсові дерева; лісове господарство; відновлення лісів

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