

UDC 630*27(477)

DOI: 10.31548/forest/4.2023.40

The current status and future prospects for the production of ornamental planting materials in forestry nurseries in Ukraine

Victor Maurer*

PhD in Agricultural Sciences, Professor
Educational and Research Institute of Forestry and Landscape-Park Management
National University of Life and Environmental Sciences of Ukraine
19 Horikhuvatskyi Shliakh Str., Kyiv, Ukraine 03041
<https://orcid.org/0000-0002-8019-7207>

Iryna Boboshko-Bardin

PhD in Agricultural Sciences, Associate Professor
Educational and Research Institute of Forestry and Landscape-Park Management
National University of Life and Environmental Sciences of Ukraine
19 Horikhuvatskyi Shliakh Str., Kyiv, Ukraine 03041
<https://orcid.org/0000-0001-8519-4067>

Andrii Pinchuk

PhD in Agricultural Sciences, Associate Professor
Educational and Research Institute of Forestry and Landscape-Park Management
National University of Life and Environmental Sciences of Ukraine
19 Horikhuvatskyi Shliakh Str., Kyiv, Ukraine 03041
<https://orcid.org/0000-0003-1256-9838>

Abstract. The reduced demand for seedlings has created the conditions for the introduction of new profitable production areas, such as the cultivation of ornamental seedlings of woody plants. Therefore, there is a need to explore new ways to increase the profitability of growing ornamental plants. The purpose of this study was to investigate and estimate the capacity and condition of the forestry industry's planting base, identify its main problems, available reserves, and outline the main ways to improve its efficiency under self-financing conditions. The methodological framework was based on general scientific methods of analysis, synthesis, and generalisation, which allowed for the investigation of the reporting materials of forestry enterprises and statistical data of the State Agency of Forest Resources. The study characterised the state of seedling production of forestry enterprises and trends in the dynamics of its production capacities

Suggested Citation:

Maurer, V., Boboshko-Bardin, I., & Pinchuk, A. (2023). The current status and future prospects for the production of ornamental planting materials in forestry nurseries in Ukraine. *Ukrainian Journal of Forest and Wood Science*, 14(4), 40-56. doi: 10.31548/forest/4.2023.40.

*Corresponding author



during the period of the State Target Programme “Forests of Ukraine” for 2010–2015 (the last 4 years of 2012–2015) and after its completion (2016–2019). The study indicated the favourable conditions and expediency of increasing the production of ornamental planting material. The prospects for the wider introduction of the production of ornamental planting material in forestry nurseries were identified. The ways of modernisation of ornamental seedling production of forestry enterprises and increase of its profitability were proposed and substantiated. It was emphasised that the increase in the production of ornamental planting material in nurseries and the implementation of the recommended measures will not only increase the flow of extra-budgetary funds, but will also contribute to the modernisation of the process of growing forest seedlings, including those with a closed root system, as well as improve their quality. The results obtained will help accelerate a scientifically sound solution of problems related to modernisation and efficiency in the production of ornamental planting materials in nurseries. This, in turn, will help attract additional financial resources for forestry enterprises

Keywords: seedling; sapling; productive area; forest nursery department; forest seedlings; assortment

Introduction

In the Anthropocene, the processes of deforestation and degradation of natural ecosystems, especially green spaces that determine the quality of the environment and life, have become widespread and are one of the greatest threats to the sustainable development of humankind, causing serious environmental, social, and economic problems (University of Plymouth..., 2018). These challenges are also extremely acute in Ukraine, especially in densely populated and overly urbanised areas. According to Roshani *et al.* (2022), R. Vasylyshyn *et al.* (2023), since the late 1990s, they have been intensifying due to the acceleration of global climate change, accompanied by an increase in average annual temperatures, and a more frequent recurrence of extreme weather events, including dry periods that are not typical for certain regions.

The reasons for the deterioration of the environment and living conditions on the planet are complex and have their own historical background. Of particular significance is the deterioration of the ecologically balanced ratio between land covered with forests and green spaces

and technologically disturbed areas. This is due to the use of technologies that do not consider the adverse consequences in the long term.

The above and the current trend of accelerating urbanisation of the environment show that the only realistic and effective way to stabilise environmental conditions is to expand forest reproduction and substantially increase the area of green spaces in populated cities and adjacent lands. It is important to understand that if necessary and timely measures are not taken, the negative consequences of the Anthropocene for the environment and humanity will be catastrophic.

At the same time, Ukraine has accumulated some experience of a comprehensive, scientifically sound approach to solving the above-mentioned problems of greening settlements and urban landscapes, the main of which is the development of the following:

◆ propagation and cultivation of high-quality planting material for ornamental woody plants of a wide range of cultivars and different types (assortments) (Vereshchagina, 2014);

◆ improving the overall sanitary condition, decorative design and urban amenities through uniform and complete greening of urban and suburban areas (Levon, 2004; Order of the Ministry of Construction, Architecture and Housing and Communal Services of Ukraine No. 105..., 2006);

◆ reforestation of badlands and wastelands, creation of all types of park and protective plantations, harmonious placement of forests, parks, and gardens on the territory (Sheremeta & Tikhomirova, 2019);

◆ enriching the suburban landscape by introducing woody plants, forming green belts around settlements, and creating favourable conditions for environmentally safe recreation and health improvement (Kushnirenko, 2012; Shumyk, 2016).

The implementation of these important tasks requires some organisational and economic measures and, above all, the appropriate provision of forest restoration and greenspace expansion with the necessary forest and ornamental planting material, the production of which largely depends on governmental bodies and capacity of Ukrainian tree nurseries.

Prior to independence, the main producers of forestry and ornamental planting material of woody plants in Ukraine were state nurseries of forestry enterprises and communal regional green building companies of the Ministry of Housing and Communal Services (Kosenko, 2017). Most of the current permanent nurseries of forestry enterprises were designed and established in the second half of the last century, at a time when large-scale forestry operations were carried out and forest seedlings were in great demand. Therefore, despite the presence of forest nursery branches in the structure, their activities were mainly focused on growing a wide range of seedlings. V.M. Maurer *et al.* (2016) found that their production was carried out with sufficient budget funding. The

decorative planting material was usually produced for one's own needs, rather than to raise extra-budgetary funds. Y.I. Kosenko (2017) concluded that since the years of independence, Ukraine has formed a fairly strong private sector of ornamental seedling production, which has substantially increased the share (up to 50-70% according to expert estimates) of local planting material in the Ukrainian market of tree plant seedlings for landscaping.

At the same time, despite Ukraine's geographical location (central Europe), favourable soil and climatic conditions and available labour reserves, the capacity of ornamental nursery farming has not achieved its potential and, therefore, is unable to meet Ukraine's needs for planting material for landscaping and for exporting its products to foreign markets. The results of the study by V.M. Yezhov & I.V. Grinyk (2017) indicate the relevance of strengthening the Ukrainian base of ornamental seedling production and introducing the latest technologies to improve the production of woody plant seedlings.

A significant reserve for strengthening the Ukrainian base of ornamental nursery production is the forest tree nursery of the state nurseries of the forestry industry of Ukraine. V.M. Maurer (2019) argued that their use is not only possible, provided the state has an appropriate attitude and sufficient investment in production, industry science, and professional education, but is necessary for both the industry and the country, since ornamental nursery can become a powerful source of attracting extra-budgetary funds and foreign currency for forestry enterprises and increasing jobs in the country.

Due to the completion of the State Target Programme "Forests of Ukraine" for 2010-2015 (State target programme..., 2009) and a sharp decline in forestry and reduced need for seedlings, there was a significant release of space in

the sowing departments. Given the production areas that are not being used for their intended purpose, favourable conditions have been created for expanding or introducing new profitable production areas. This includes the cultivation of ornamental seedlings of woody plants, the production of which in forest nurseries does not require considerable capital investment. The relevance of its introduction is due not only to the possibility of using the production of ornamental planting material to attract extra-budgetary funds, especially in the absence of budgetary funding for forestry, but to the need to improve the supply to the Ukrainian market with seedlings for landscaping and gardening and reduce the share of imported products.

At the same time, there has been no thorough and comprehensive research on the state and prospects of growing ornamental planting material in nurseries of forestry enterprises since Ukraine gained independence, except for the above-mentioned scientific works, by both Ukrainian and foreign scientists. This is added evidence of the relevance of the findings presented in this paper.

The purpose of this study was to summarise the state of the forestry industry's seedling base and identify ways to improve its profitability in the absence of budget funding.

Materials and Methods

For this study, we researched professional publications on this subject by both Ukrainian and foreign scholars. We also reviewed studies by forestry enterprises and statistical data from the forms LG-14 and LG-15 published by the State Agency of Forest Resources of Ukraine (SAFR of Ukraine) for 2012-2019 (Reports on the availability..., 2012-2019).

To follow the methodological principles for comparing data characterising the relevant production processes, the reporting materials of the last four years of the State Target

Programme "Forests of Ukraine" for 2010-2015 (2012-2015) and the first four years (2016-2019) after its completion were used. There is no information for the following years.

During the research, the authors used philosophical and worldview approaches to formulate their scientific opinions on the subject and object of study. They employed these approaches to ensure appropriate evaluation of the results obtained, identification of trends, and use of accepted scientific methods. An evaluation was conducted using analysis, synthesis, and generalisation techniques to collect data on the quantity and size of the nurseries belonging to State Forest Resources Agency (SFRA) of Ukraine, with a focus on the natural zones and production areas, such as the sowing, cuttings, forest nursery, and nursery departments. The assessment also included an inventory of the types of plants found in the ornamental and fruit and berry nurseries, categorised according to genera and species. Additionally, the study involved an examination of the growth dynamics of tree nurseries under the auspices of the State Specialised Economic Enterprise "Forests of Ukraine" (SE "Forests of Ukraine") in terms of height.

The research findings were verified using verification methods and techniques that involved quantitative and qualitative analysis throughout the period under study.

The dialectical method of cognition helped investigate the trends in the development of the nursery base of Ukrainian forestry enterprises and the dynamics of production of forest and ornamental planting material of tree species in the context of the introduction of sustainable, balanced nature management and development of society, considering environmental, economic, social, and agrotechnical factors.

The formal logical method was used to define the system-forming concepts of the outlined research problem. This method helped

consider the opinions of researchers on the subject under study. Analysis and synthesis, as methods of cognition were used to investigate the scientific works of scholars on the subject under study and evaluation of current regulations (Law of Ukraine No. 3116-XII..., 1993; Law of Ukraine No. 411-IV... 2002) governing relations in the field of production of planting material.

Results and Discussion

According to the 2019 Green Economy Report of the Ministry of Communities and Territories Development of Ukraine (Nature-oriented solutions..., 2019), the total area of ornamental nurseries of its subordinate enterprises producing woody planting material is about 1.6 thousand ha. The analysis of the report's data shows a significant uneven territorial distribution of the production area of tree nurseries of the agency responsible for the country's green economy. Almost half of the total area of ornamental nurseries (729 ha) is concentrated in the enterprises of Odesa region. The area of nurseries in the south-eastern regions is significant: Kharkiv (over 300 ha), Dnipro (about 100 ha), Poltava (72 ha), Mykolaiv (48 ha) and Kyiv (123 ha). At the same time, in a third of the country's regions (Donetsk, Lviv, Sumy, Ternopil, Khmelnytskyi, Cherkasy, etc.), the Ministry's enterprises do not grow ornamental planting material of woody plants due to the lack of nurseries, most of which have been privatised or re-profiled. Given the rising need for ornamental seedlings for landscaping and gardening, this situation is unacceptable.

In this context, it is important to search for reserves and capacities, the use of which would not only substantially increase the share of Ukrainian ornamental planting material of tree species in the total volume of landscaping work in the country but export it to countries with less favourable conditions for its production.

Y.I. Kosenko (2015) testified to the export of small-sized ornamental planting material to European countries by the industry's enterprises in Soviet times at the end of the last century, and a preliminary analysis by V.P. Yukhnovska (2013) suggests that a considerable reserve for strengthening the Ukrainian ornamental nursery base is the capacity of tree nurseries of the forestry industry. Their use, given the availability of space, specialists, interest of farms, and with the appropriate attitude of the industry's management and sufficient investment, is not only possible but also highly advisable.

In this context, it is important to objectively estimate the current state and capacity of the nursery base of forestry enterprises, identify the main problems and determine the prospects for the production of ornamental planting material of woody plants in state forestry nurseries.

Currently, 590 permanent and 1,380 temporary nurseries with a total area of about 3.4 thousand ha produce planting material for artificial reforestation, afforestation, and landscaping for the forestry industry (Fig. 1). Between 2012 and 2019, their total number and area decreased, which, given the outstanding professional value and potentially high profitability of producing planting material, especially large-sized material, indicates that the industry's nursery is not being used for its intended purpose. The substantial (17%) decrease in the number of nurseries and the reduction of their area by one third (by 1,566 ha) has its own reasons and regional specific features. Thus, in the Forest-Steppe, their number remained almost constant, but at the same time, the area of permanent nurseries almost halved. Given that the soil and climatic conditions of the region are most favourable for growing large-sized ornamental planting material, it is not advisable to reduce the area of permanent nurseries.

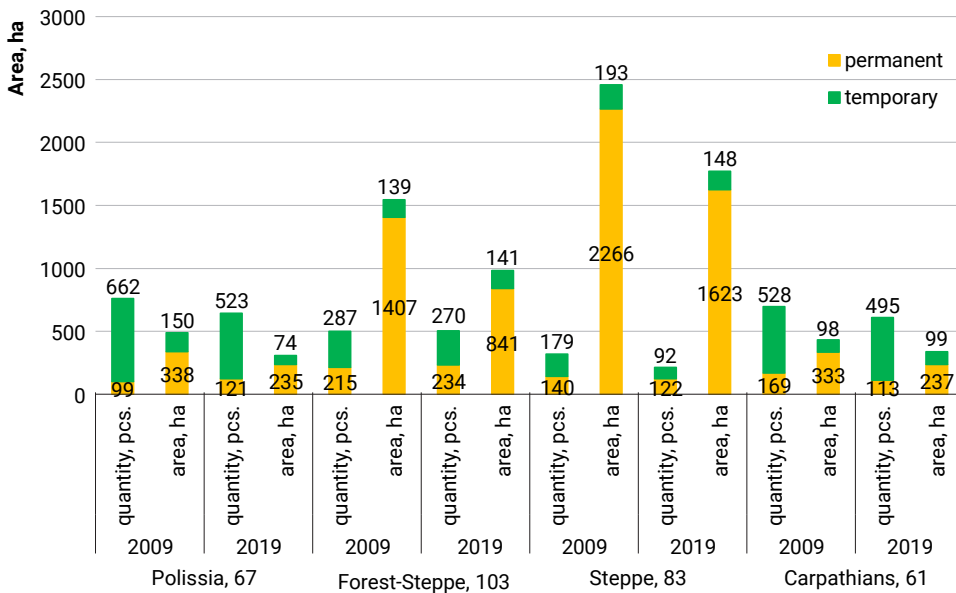


Figure 1. Number and area of nurseries of the SFRA of Ukraine by natural zones

Source: developed by the authors of this study based on reporting data from the State Statistics Service of Ukraine (Reports on the availability..., 2012-2019)

The decrease in the number of nurseries and their areas in the Steppe is conditioned upon a substantial reduction in reforestation after the completion of the State Target Programme “Forests of Ukraine for 2010-2015” and the termination of budget funding, and in the forestry enterprises of Polissia and the Carpathians, apart from the above reason, the share of natural reforestation in the total volume of forest reproduction is also increasing. The authors of this study believe that the areas withdrawn from forest nursery could be used for the cultivation of ornamental planting material with open (Forest-Steppe and Carpathians) and closed (Polissia and Steppe) root systems.

Large-sized planting material is more efficiently grown on permanent nurseries with an area of more than 5 ha (Nature-oriented solutions..., 2019). From this perspective, the data on the average area of permanent nurseries by regional forestry and hunting departments

(SFRA, Table 1) are of some interest. These data indicate better conditions for the production of ornamental planting material in Polissia in the permanent nurseries of the enterprises of the Volyn Department, in the Forest-Steppe – in Vinnytsia, Khmelnytskyi, Kharkiv, and Cherkasy, in the Carpathians – in Chernivtsi, and in the Steppe in the enterprises of almost all regional departments.

Of no less interest are the data on the dynamics of the productive area of permanent forestry enterprises according to the type of use in the context of production departments during 2012–2019 (Fig. 2). Given the completion of the aforementioned State Programme, it is understandable that the total area of cultivation will decrease. At the same time, it is difficult to explain the steady downward trend in the area of nurseries against the backdrop of growing demand for ornamental seedlings in the country and abroad, and given the potential for a substantial increase in their

production in forest nurseries, where significant areas are used for other purposes, there is no budget funding, which necessitates the attraction of extra-budgetary funds, etc.

Table 1. The number and average area of permanent nurseries in the forestry industry by region in 2012-2019

Regional Forestry and Hunting Department, natural area	Characteristics of nurseries enterprises under SFRA of Ukraine				
	total		including permanent		
	area, ha	quantity, pcs.	area, ha	quantity, pcs.	average area, ha
Volyn	71.0	157	63.7	5	12.7
Zhytomyr	110.0	190	71.0	26	4.3
Chernihiv	42.8	103	28.9	39	0.8
Total for Polissia	329.9	663	248.1	132	1.9
Vinnitsia	230.3	31	213.4	14	15.3
Kyiv	139.8	116	99.4	35	2.8
Poltava	62.3	18	62.3	18	3.5
Sumy	87.0	69	75.4	16	4.7
Ternopil	53.2	70	20.5	15	1.4
Kharkiv	142.4	40	131.0	12	10.9
Khmelnyskyi	143.1	59	124.5	21	5.9
Cherkasy	207.8	46	184.5	22	8.4
Total for Forest-Steppe	1,065.9	459	911.0	153	6.0
Dnipro	162.1	29	148.4	11	13.5
Donetsk	128.0	11	124.0	5	24.8
Zaporizhzhia	237.7	32	170.4	14	12.1
Kropyvnytskyi	87.0	30	75.3	25	3.0
Luhansk	270.3	36	256.9	9	28.5
Mykolaiv	187.2	32	184.5	30	6.2
Odesa	523.8	20	511.6	17	30.1
Kherson	177.3	24	152.7	12	12.7
Total for Steppe	1,773.3	214	1,623.8	123	13.3
Zakarpattia	62.0	140	44.1	46	1.0
Ivano-Frankivsk	73.0	210	52.7	26	2.0
Lviv	108.6	168	87.9	30	2.9
Chernivtsi	84.4	82	46.0	2	23.0
Total for the Carpathians	328.0	600	230.7	104	2.2
Total	1,936	3,497.1	512	3,013.6	5.9

Source: developed by the authors of this study based on reporting data from the State Statistics Service of Ukraine (Reports on the availability..., 2012-2019)

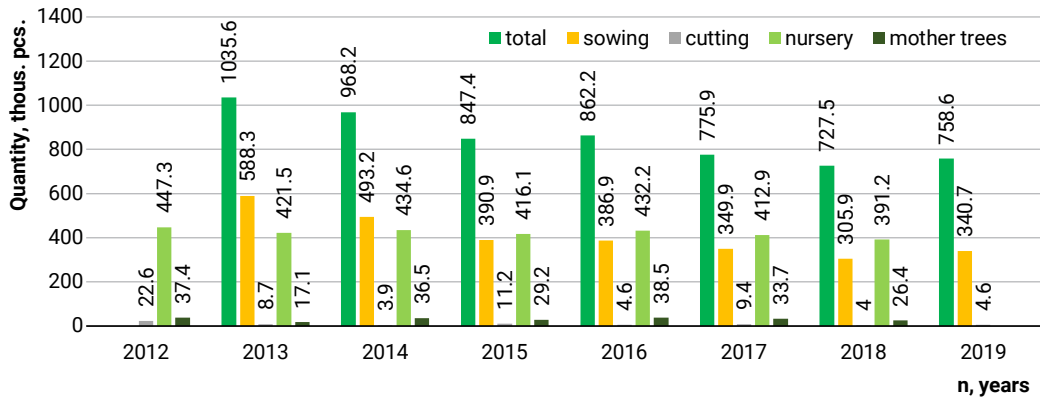


Figure 2. Dynamics of the productive area of nurseries of the enterprises under SFRA of Ukraine according to types of use by production departments

Source: developed by the authors of this study based on reporting data from the State Statistics Service of Ukraine (Reports on the availability..., 2012-2019)

In this context, the data on the dynamics of changes in the area of ornamental trees in the nurseries of industry enterprises according to natural zones during 2012-2019 are of interest (Fig. 3). The largest fluctuations in the surface area of forestry nurseries have had a tendency

to decrease after the elimination of funding. During the analysed period were inherent in the nurseries of resource forestry enterprises in the Carpathians (33%) and Polissia (32%), and the smallest – in the Forest-Steppe (11%) and Steppe (18%).

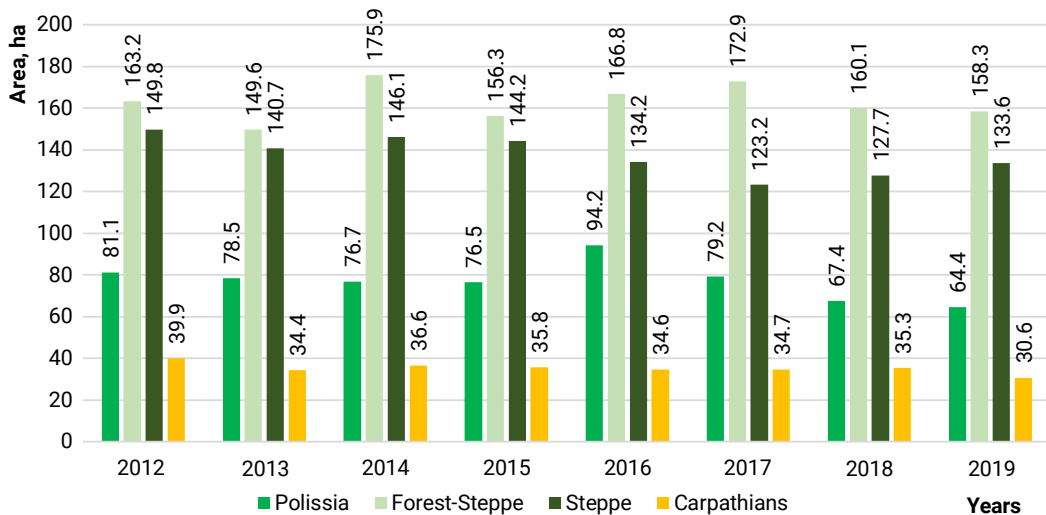


Figure 3. Dynamics of changes in the area of tree ornamental nursery trees in the nurseries of the SFRA of Ukraine according to natural zones

Source: developed by the authors of this study based on reporting data from the State Statistics Service of Ukraine (Reports on the availability..., 2012-2019)

The decrease in the area of nurseries of forestry enterprises continued last year, except for the nurseries of low-resource forestry enterprises in the Steppe, which have been showing an upward trend over the past two years. This is indirect evidence that the production of ornamental planting material is an affordable and effective source of extra-budgetary funds even in the unfavourable soil and climatic conditions of the Steppe. At the same time, the profitability of producing ornamental tree and shrub seedlings largely depends on a range of factors: natural conditions, the technology used to produce the variety (with an open or closed root system, with a shaped or unshaped crown) and the range of nursery products.

Thus, in modern conditions, a considerable reserve for increasing the demand for ornamental seedlings of forest nurseries is the expansion of the range of plants grown, according to which the products of the industry's enterprises are substantially inferior to the range offered on the Ukrainian market by foreign (Bojanowski Szkółka, n.d.) and private Ukrainian producers (Permanent forestry nursery..., 2019). The assortment of foreign producers is dominated by

woody plants of form and variety levels, whereas in forest nurseries, a considerable share belongs to species-specific planting material (Shepeliuk *et al.*, 2021).

Equally important is a significant increase in the volume of container culture – the cultivation of planting material with a closed root system, the production of which has several organisational, agrobiological, economic, and technological advantages.

This should be facilitated by amending the current statistical reporting form LG-15, which concerns the volume, variety, and range of ornamental planting material grown in the nurseries of the SFRA of Ukraine, a portion of which is presented in Table 2. The current reporting materials do not contain complete information on the range of woody plants grown (their species, form, variety) and the range of planting material (seedlings with a closed root system, open root system, with a clump, etc.). This complicates the professional analysis of production results and the adoption of scientifically sound decisions to improve both the process of producing ornamental planting material in forest nurseries and its sale.

Table 2. Report on the availability of seedlings in ornamental and fruit and berry nurseries of the SFRA of Ukraine, 2012-2019

No. Seq.	Species, genus	Decorative and other forest nurseries					
		total		of which seedlings for sale, thous. pcs.			
		area, ha	thous. pcs.	total	including height, m		
					up to 0.7	0.8-1.8	1.9 and >
1	2	3	4	5	6	7	8
1	Conifers, including	215.30	2,959.5	1,922.2	1,504.8	346.5	70.9
2	Scots pine	13.42	89.5	31.6	25.4	5.8	0.4
3	Crimean pine	43.25	184.8	89.7	37.5	38.3	13.9
4	spruce	48.85	647.7	457.5	360.3	75.4	21.8
5	fir	4.31	339.1	184.2	176.5	7.6	0.1
6	larch	2.30	75.4	37.5	32.9	4.1	0.5
7	thuja	59.19	958.8	615.7	470.2	126.3	19.2
8	juniper	31.77	391.1	293.9	216.2	67.4	10.3
9	other	12.21	273.1	212.1	185.8	21.6	4.7
10	Deciduous, incl.	92.09	811.2	664.0	432.5	147.2	84.3

Table 2, Continued

1	2	3	4	5	6	7	8
11	common oak	5.76	39.9	24.6	21.9	1.3	1.4
12	red oak	4.99	25.3	16.8	4.5	6.9	5.4
13	common ash	0.94	16.6	10.7	8.5	1.3	0.9
14	common beech	0.52	83.4	74.4	74.2	0.1	0.1
15	small-leaved linden	19.24	108.4	81.8	37.2	26.3	18.3
16	maples	7.29	63.2	51.2	36.8	7.4	7.0
17	birch	12.56	53.0	46.5	19.0	14.0	13.5
18	nuts	5.31	42.4	33.9	12.0	10.6	11.3
19	poplars	0.16	1.8	1.8	0.7	0.5	0.6
20	willow	2.73	21.8	19.1	7.8	10.0	1.3
21	alder	0.30	2.1	2.1	0	1.1	1.0
22	robinia	0.02	0.2	0.2	0.1	0.1	0
23	honey locust	0.05	0.2	0.2	0	0.1	0.1
24	hornbeam	0	0	0	0	0	0
25	elms	0.34	2.2	2.2	0.7	0.7	0.8
26	mulberry	0.35	1.7	1.7	0.1	1.5	0.1
27	rowan	7.88	28.7	18.9	5.2	7.6	6.1
27	rowan	7.88	28.7	18.9	5.2	7.6	6.1
28	apple	1.03	5.5	5.2	2.6	2.4	0.2
29	pear	0.01	0.1	0.1	0.1	0.0	0
30	stone fruits	2.74	6.9	6.7	1.3	2.2	3.2
31	other	19.87	314.1	265.8	199.7	53.1	13.0
38	Tatar maple	0.01	0.1	0.1	0	0.1	0.0
32	Shrubs, including	79.50	1,372.9	1,053.5	937.3	109.3	6.9
33	rosehip	0.07	1.2	1.2	1.0	0.2	0
34	sea-buckthorn	0.09	0.4	0.4	0	0.1	0.3
35	currant	0.45	1.9	1.4	0.9	0.3	0.2
36	viburnum	2.02	17.8	15.1	6.8	7.8	0.5
37	hazel	0.17	1.1	1.1	0.1	0.7	0.3
39	chokeberry	9.94	21.4	21.4	1.1	19.9	0.4
40	privet	2.32	18.7	17.7	14.0	3.6	0.1
41	dogwood	0.29	2.8	2.8	0.5	1.3	1.0
42	honeysuckle	0.14	2.1	2.1	1.4	0.7	0.0
43	spirea	0.99	20.9	16.9	9.4	7.5	0.0
44	elderberry	0.10	0.1	0.1	0.1	0	0
45	cherries	0.63	20.7	15.0	14.3	0.6	0.1
46	other	62.28	1,263.7	958.2	887.7	66.5	4.0
TOTAL		386.89	5,143.6	3,639.7	2,874.6	603.0	162.1

Source: developed by the authors of this study based on reporting data from the State Statistics Service of Ukraine (Reports on the availability..., 2012-2019)

As the data presented in Table 2 suggests, in 2019, the largest area in forestry nurseries (about 60%) was occupied by seedlings of coniferous trees. The proportion of the area of large-

sized planting material of deciduous species was about 24%. Seedlings of shrubs were grown on the remaining areas of forest nurseries. Among the coniferous species, the largest area

of nurseries (about 28%) was occupied by representatives of the genus *Thuja*. At the same time, the area of spruce, juniper, and Crimean pine (*Palasciana*) cultivars was significant. In terms of the number of seedlings in the coniferous forest nurseries, species and decorative forms of *Thuja*, spruce, and juniper were predominant.

Among the seedlings of deciduous trees, the largest area in the forest nursery departments of the SFRA nurseries of Ukraine was occupied by linden, hanging birch, mountain ash and maple, and among shrubs – by chokeberry, privet, viburnum, and spirea.

In general, the range of ornamental woody plant seedlings grown by forestry enterprises is considerably inferior to the range of the best Ukrainian private and foreign nurseries. The majority of their products are species-level woody plants, which are in much lower demand on the green market than seedlings of decorative forms and varieties. This shows that to increase the competitiveness of ornamental nursery products of forest nurseries, it is advisable to substantially expand the range of woody plants grown, primarily with competitive forms

and varieties. Particular attention should be paid to cultivars that are in steady demand among landscape architects and are currently imported to Ukraine in significant volumes.

Another way to increase the competitiveness of ornamental nursery products of forestry enterprises and their profitability is to make adjustments to the size structure of planting material, which is realised by increasing the share of large-sized planting material in total volumes. In 2019, the share of seedlings up to 0.7 m in height among the planting material of coniferous and deciduous trees intended for sale was 75%, and the share of much more profitable seedlings, 0.8-1.8 m and over 1.9 m in height, was 19% and 6% (Table 2). An analogous distribution was observed in previous years (Fig. 4). For branch tree nurseries, with significant land areas that are not always rationally used for their intended purpose, such size distribution cannot be considered normal. Considering the cultivation of ornamental shrubs, the ratio between tree seedlings of different sizes is close to the optimum: about 50% – up to 0.7 m, 35% – 0.8-1.8 m, and 15% of plants 1.9 m and above.

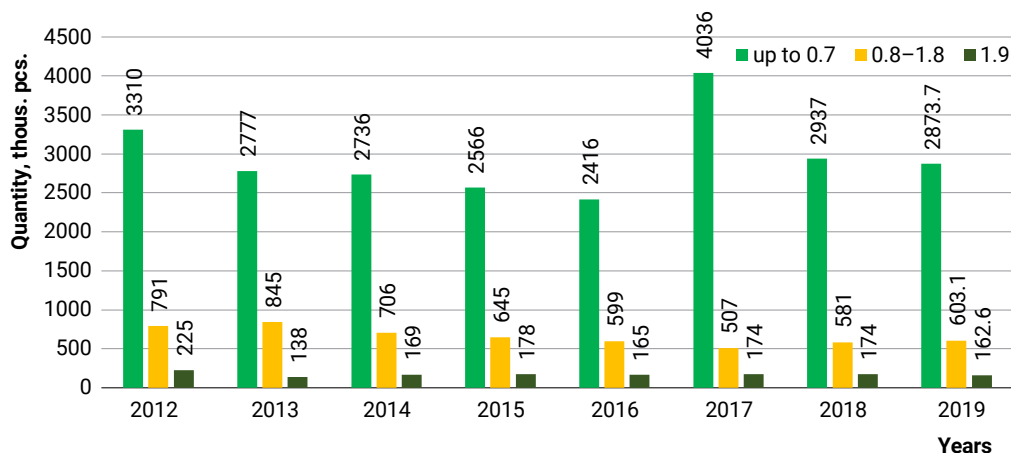


Figure 4. Dynamics of the volume of ornamental seedlings of different heights in the nurseries of the State Specialised Economic Enterprise “Forests of Ukraine”

Source: developed by the authors of this study based on reporting data from the State Statistics Service of Ukraine (Reports on the availability..., 2012-2019)

V.M. Maurer *et al.* (2019) found that an increase in the share of large-sized ornamental planting material would not only make it possible to use the production area of forestry nurseries more rationally and increase the profitability of their activities, but also help to attract investment funds that are essential for strengthening and modernising the nursery base and modernising the technologies used.

One of the ways to modernise the nursery base and upgrade the technologies used is to introduce various types of planting material into the practice of nursery production by industrial enterprises, specifically microclonal propagation of woody plants and the cultivation of seedlings and saplings with a closed root system. In this context, the creation of a sectoral biotechnology centre with departments of microclonal reproduction and genetic engineering of woody plants deserves special attention. Such a centre would combine the efforts of scientists and practitioners in the field of genetics, breeding and mass production of regenerative plant material for the production of forestry and ornamental planting material that meets modern requirements (Bojanowski Szkółka, n.d.). As for the appropriateness of increasing the share of production of ornamental seedlings with a closed (non-injured) root system in the total volume, G. Krussmann *et al.* (1997) concluded that due to the numerous advantages of such planting material (the possibility of planting during the entire growing season, almost 100% survival rate, organisation of efficient production in regions with different soil and climatic conditions, etc.), it will also contribute to the industrialisation of the process of growing all types of planting material and the uniform load of labour and machinery and tools for mechanisation of work throughout the year.

Special attention should be paid to the issue of scientific substantiation of the ratio of growing planting material with a closed and

open root system in regions with differing natural conditions. Considering the specific soil and climatic conditions of natural zones, the share of planting material with a closed root system should be higher in nurseries in Polissia (with poor soils) and in the Steppe (with arid conditions). In the Forest-Steppe and Carpathian regions with fertile soils, it is worth growing seedlings with an open and clumped root system.

Most of the forestry industry's current permanent forest nurseries were designed and established in the second half of the 20th century, at a time when forestry operations were extensive. Therefore, despite the presence of forest nurseries in their organization, they were focused mainly on growing a wide range of seedlings of both major and minor and shrubby tree species. Their production activities were carried out with sufficient budget funding (European Nurserystock Association..., 2019). As a rule, the ornamental planting material was produced for one's own needs, rather than to raise extra-budgetary funds. According to M.S. Mahmud *et al.* (2023), the main products of forest nurseries were and still are seedlings, seed and cuttings with an open root system. Therewith, in recent years, forestry has seen an intensification of efforts to introduce innovative agricultural technologies that are now widely used in advanced countries. This primarily concerns the cultivation of forest planting material with a closed root system using industrial technologies.

The scientific and practical significance of the generalisations made based on the research results regarding the current state, capacities of the ornamental seedling production base of the industry enterprises and its potential production capabilities is important.

The implementation of prospects and tasks for increasing the volume and improving the production of ornamental planting material in forest nurseries should be based on a

scientifically sound concept that considers the best foreign practices (Salaš, 2002; Radoglou *et al.*, 2008; Mattsson *et al.*, 2010), as well as the state and achievements of Ukrainian private nursery production. Therewith, they believe that the forest industry's ornamental nursery can only be effective if it produces competitive planting material using innovative technologies and modern related materials that are not inferior in quality to imported planting material.

Considering the proposals of the above-mentioned scientists and the results of the conducted research, the wide introduction of decorative nursery planting requires factoring in the characteristic features of the modern state of forest nurseries in the industry. Among these are the lack of specialized tools, equipment, related materials, modern automated lines and funds necessary to produce decorative planting material for their purchase. Other significant factors include the depletion of the soil of production departments as a result of long-term use and insufficient observance of the basics of agricultural technology (scientifically sound crop rotation, soil cultivation, fertiliser application, etc.); lack of a formed chain of study of the demand for decorative planting material of woody plants and established ways and methods of its implementation.

On the other hand, to effectively use the current capabilities of Ukrainian forest nursery to increase production and improve the cultivation of ornamental planting material, it is necessary to make the most of the experience of foresters and available reserves. Particular attention should be paid to the following:

- ◆ an unjustified trend towards a decrease in productive areas and an increase in the share of cultivated land of permanent forest nurseries of the country's industry enterprises that are used for other purposes;

- ◆ there are reserves and considerable potential for introducing modern, cost-effective

production of ornamental planting material in forest nurseries;

- ◆ the need to expand the range of cultivars of ornamental plants and the range of types of ornamental planting material (seedlings from closed root system, regenerated seedlings, architectural forms, hedges, etc.);

- ◆ the expediency of wider introduction of modern industrial technologies for the production of seedlings of ornamental woody plants with a closed root system in container culture and the modernisation of agricultural technologies for growing planting material with an open root system;

- ◆ the need to increase the share of large-sized tree and shrub seedlings in the total production of woody planting material to increase the profitability of ornamental nursery farming;

- ◆ the appropriateness of introducing an industry network to monitor the demand for ornamental planting material of woody plants and the ways and means of its sale.

In general, the wider introduction of modern technologies for the production of ornamental planting material into the practice of forest nursery will not only increase the flow of extra-budgetary funds, which are extremely necessary for enterprises in the industry, but will also contribute to the modernisation of the process of growing forest seedlings and improve their quality.

Conclusions

Due to the reduction in the forest area, the increase in the production of forest planting material with closed root systems have led to a reduction in the need for seedlings and the release of land in sowing departments. Additionally, because of the availability of free and unused land, the industry's nurseries have favourable conditions for expanding or introducing new profitable production areas. This includes the cultivation of ornamental seedlings

of woody plants, the cultivation of which in forest nurseries does not require significant capital investment, as it has many organisational and agro-technological features in common with the cultivation of seedlings.

The introduction of this type of planting material makes it possible to use the production of decorative planting material to attract extra-budgetary funds, especially in the absence of budgetary funding for forestry, and the need to improve the supply of the Ukrainian market with seedlings for landscaping and gardening and reduce the share of imported products. In this context, it is important to search for reserves and capacities, the use of which would not only substantially increase the share of Ukrainian ornamental planting material of tree species in the total volume of landscaping work in the country, but also export it to neighbouring countries.

The introduction of the production of ornamental planting material for woody plants in permanent forest nurseries, given the availability of free space, specialists, appropriate agricultural techniques, and the strong interest of farms in attracting extra-budgetary funds and the appropriate attitude of the industry's management, is not only possible but also highly advisable.

Given that large-sized ornamental planting material is more efficiently grown on permanent nurseries with an area of more than 5 ha, the best conditions for its production are in Polissia at the enterprises of the Volyn

Forestry and Hunting Range Administration, in the Forest-Steppe – in Vinnytsia, Khmelnytskyi, Kharkiv, and Cherkasy, in the Carpathians – in Chernivtsi, and in the Steppe – on the farms of almost all regional administrations.

An important reserve for increasing demand for ornamental seedlings in forest nurseries is the expansion of the range of woody plants grown with many varieties and quality characteristics, which are substantially inferior to the range of foreign and Ukrainian private nurseries.

An important way to increase the competitiveness of ornamental nursery products of forestry enterprises and the profitability of their activities in this area is to make adjustments to the size structure of planting material by increasing the share of large-sized planting material in total volumes.

In the future, it will be necessary to investigate the use of modern agricultural technologies to produce ornamental seedlings, primarily the cultivation of planting material with a closed (uninjured) root system, which is being actively introduced to industrialise the process of producing forest planting material at modern seed and nursery complexes in Ukraine.

Acknowledgements

None.

Conflict of Interest

The authors of this study declare no conflict of interest.

References

- [1] Bojanowski Szkółka. (n.d.). Retrieved from <https://www.bojanowskiskolka.pl/>.
- [2] European Nurserystock Association. (2019). ENA, the European Nurserystock Association, held the General Assembly in Ukraine. Retrieved from <https://www.enaplants.eu/news-ena-summer-2019-meeting-ukrain>.
- [3] Kosenko, Y.I. (2015). *Current state and agrotechnical bases of perfection decorative nursery of Ukraine* (PhD thesis, National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine).

- [4] Kosenko, Y.I. (2017). [The current state of ornamental nurseries of Ukraine and prospects of its development](#). *Scientific Bulletin of the National University of Life and Environmental Sciences of Ukraine*, 266, 170-177.
- [5] Krussmann, G., Heinz, T.E., & Wennemuth, G. (1997). *Die Baumschule*. Berlin: Blackwell Wissenschafts-Verlag.
- [6] Kushnirenko, M.M. (2012). Problems of green zones formation in the cities at the present stage. In *Current problems of settlement landscaping: Education, science, production, the art of landscaping* (pp. 9-11). Bila Tserkva: International Scientific Conference.
- [7] Law of Ukraine No. 3116-XII "On Protection of Rights to Plant Varieties". (1993, April). Retrieved from <https://zakon3.rada.gov.ua/laws/show/3116-12>.
- [8] Law of Ukraine No. 411-IV "On Seeds and Planting Stock". (2002, December). Retrieved from <https://zakon.rada.gov.ua/laws/show/411-15#Text>.
- [9] Levon, F.M. (2004). [Biological and ecological bases of creation of green plantings in the conditions of the urbanogenic and technogenic environment](#) (Doctoral dissertation, Ukrainian State Forestry University, Lviv, Ukraine).
- [10] Mahmud, M.S., Zahid, A., & Das, A.K. (2023). Sensing and Automation technologies for ornamental nursery crop production: current status and future prospects. *Sensors*, 23, article number 1818. doi: 10.3390/s23041818.
- [11] Mattsson, A., Radoglou, K., Kostopoulou, P., Bellarosa, R., Simeone, M.C., & Schirone, B. (2010). Use of innovative technology for the production of high-quality forest regeneration materials. *Scandinavian Journal of Forest Research*. 2010, 1-7. doi: 10.1080/02827581.2010.485825.
- [12] Maurer, V.M. (2019). [Woodland nursery of the forest industry of Ukraine: state, problems and ways to improve the cultivation of forest and ornamental planting material](#). In *Forest reproduction and forest reclamation in Ukraine: origins, current state, current challenges, main tasks and prospects in the Anthropocene* (pp. 45-77). Kyiv: National University of Life and Environmental Sciences of Ukraine.
- [13] Maurer, V.M., Kosenko, Yu.I., & But, A.A. (2016). [Ornamental nursery of Ukraine: The current state, problems and prospects](#). Kiev: RVC NUBiP.
- [14] Maurer, V.M., Pinchuk, A.P., Kosenko, Y.I., & Boboshko-Bardin, I.M. (2019). *Modern technologies of forest seed production and tree nursery*. Kyiv: NULES of Ukraine.
- [15] Nature-oriented solutions for your city. (2019). Retrieved from <https://www.minregion.gov.ua/napryamki-diyalnosti/zhkh/teritory/stan-sfery-zelenogo-gospodarstva-za-2019>.
- [16] Order of the Ministry of Construction, Architecture and Housing and Communal Services of Ukraine No. 105 "On Approval of the Rules for the Maintenance of Green Spaces in the Settlements of Ukraine". (2006, April). Retrieved from <https://zakon.rada.gov.ua/laws/show/z0880-06#Text>.
- [17] Permanent forestry nursery SE "Trostyanetsky forestry". (2019). Retrieved from <https://is.gd/SJoHPq>.
- [18] Radoglou, K., Dini-Papanastasi, O., Kostopoulou, P., & Spyroglou, G. (2008). [Forest regeneration material: State of the art and a new European approach for pre-cultivated planting stock production](#). In *Forestry in Achieving Millennium Goals* (pp. 23-29). Novi Sad, Serbia.
- [19] Reports on the availability of seedlings in nurseries and plantations (form 15) of the State Agency of Forest Resources of Ukraine for 2012-2019. (2019). Retrieved from <https://forest.gov.ua/en>.

- [20] Roshani, Sajjad, H., Kumar, P., Masroor, M., Rahaman, M.H., Rehman, S., Ahmed, R., & Sahana, M. (2022). Forest vulnerability to climate change: A review for future research framework. *Forests*, 13, article number 917. doi: 10.3390/f13060917.
- [21] Salaš, P. (2002). New technologies and improvement of nursery stock quality. *Horticultural Science – Prague*, 29(4), 153-160.
- [22] Shepeliuk, M., Andreieva, V., & Kychyliuk, O. (2021). The current state of tree nurseries in the Volyn region. *Notes in Current Biology*, 1(1), 54-63.
- [23] Sheremeta, Z.Y., & Tikhomirova, H.V. (2019). Techniques of landscaping in dense urban development of the International scientific-practical conference. In *International scientific and practical conference “Current state and prospects of development of landscape architecture, gardening and park management, urban ecology and phytomelioration”* (pp. 71-74). Lviv: NLTU of Ukraine.
- [24] Shumyk, M.I. (2016). Evolutionary component of green plantations in urbanized ecosystems and its role in ensuring sustainable development. In *All-Ukrainian scientific-practical conference “Modern landscape design, formation, preservation”* (pp. 71-72). Kyiv: National University of Life and Environmental Sciences of Ukraine.
- [25] State target program “Forests of Ukraine” for 2010-2015. (2009). Retrieved from <https://www.kmu.gov.ua/npas/242334419>.
- [26] University of Plymouth. (2018). *Europe’s lost forests: Coverage has halved over 6,000 years*. Retrieved from www.sciencedaily.com/releases/2018/01/180116111121.htm.
- [27] Vasylyshyn, R., Lakyda, I., Lakyda, M., & Blyshchyk, V. (2023). Net primary production of forest vegetal biomass in Kyiv region. *Ecological Engineering and Environmental Technology*, 24(1), 38-45. doi: 10.12912/27197050/154908.
- [28] Vereshchagina, P.M. (2014). Ornamental horticulture and floriculture. Mykolaiv: Mykolaiv National Agrarian University.
- [29] Yezhov, V.M., & Grinyk, I.V. (2017). Plant growing of ornamental crops. Kyiv: PE “Commercial Enterprise Ukr Sich”.
- [30] Yukhnovska, V.P. (2013). Import decorative planting material: current status and dynamics. *Scientific Bulletin of the National University of Life and Environmental Sciences of Ukraine*, 187(1), 147-153.

Стан і перспективи виробництва декоративного садивного матеріалу в розсадниках лісової галузі в Україні

Віктор Мельхіорович Маурер

Кандидат сільськогосподарських наук, професор
Навчально-науковий інститут лісового і садово-паркового господарства
Національний університет біоресурсів і природокористування України
03041, вул. Горіхуватський шлях, 19, м. Київ, Україна
<https://orcid.org/0000-0002-8019-7207>

Ірина Миколаївна Бобошко-Бардин

Кандидат сільськогосподарських наук
Навчально-науковий інститут лісового і садово-паркового господарства
Національний університет біоресурсів і природокористування України
03041, вул. Горіхуватський шлях, 19, м. Київ, Україна
<https://orcid.org/0000-0001-8519-4067>

Андрій Петрович Пінчук

Кандидат сільськогосподарських наук, доцент
Навчально-науковий інститут лісового і садово-паркового господарства
Національний університет біоресурсів і природокористування України
03041, вул. Горіхуватський шлях, 19, м. Київ, Україна
<https://orcid.org/0000-0003-1256-9838>

Анотація. У зв'язку зі скороченням потреби у сіянцях, сформувалися передумови для запровадження нових рентабельних напрямків виробництва таких як вирощування декоративних саджанців деревних рослин. Тому виникла необхідність у вивченні нових шляхів підвищення рентабельності вирощування декоративних рослин. Метою роботи було дослідити та оцінити потужність і стан бази розсадництва лісової галузі, виявити його головні проблеми, наявні резерви та окреслити основні шляхи підвищення його ефективності за умов самофінансування. Методологічною основою слугували загальнонаукові методи аналізу, синтезу та узагальнення, які дозволили дослідити звітні матеріали підприємств лісової галузі та статистичні дані Державного агентства лісових ресурсів. Охарактеризовано стан розсадництва підприємств лісової галузі та тенденції динаміки його виробничих потужностей у період дії Державної цільової програми «Ліси України» на 2010-2015 роки (останні 4 роки 2012-2015) та після її завершення (2016-2019 рр.). Вказано на сприятливі умови та доцільність збільшення обсягів виробництва декоративного садивного матеріалу. Було визначено перспективи ширшого запровадження виробництва декоративного садивного матеріалу у розсадниках лісової галузі. Запропоновано та обґрунтовано шляхи осучаснення декоративного розсадництва підприємств лісової галузі і підвищення його рентабельності. Підкреслено, що збільшення обсягів виробництва декоративного садивного матеріалу в розсадниках і запровадження рекомендованих заходів дозволить не тільки збільшити надходження позабюджетних коштів, а і сприятиме осучасненню процесу вирощування лісових сіянців, у тому числі. і із закритою кореневою системою, та покращенню їх якості. Отримані результати сприятимуть прискоренню науково обґрунтованого вирішення завдань, пов'язаних з модернізацією та підвищенням ефективності виробництва декоративного садивного матеріалу у розсадниках. Це в свою чергу сприятиме залученню додаткових фінансових ресурсів підприємствами лісової галузі

Ключові слова: сіянець; саджанець; продукуюча площа; шкільне відділення; саджанці деревних рослин; асортимент