



Reforestation in Belarus: From the history up to the present time

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Abstract

The forest has always played a big part in Belarus. At present it covers about 40% of area of the country's territory. Predominantly the forests are of natural origin. The main species are *Pinus sylvestris* L. (Scotch pine), *Betula pendula* Roth (European white birch) and *Picea abies* (L.) Karst. (Norway spruce). The other valuable species are *Quercus robur* L (English oak), *Alnus glutinosa* (L.) Gaertn. (European alder), *Larix decidua* Mill. (European larch), *Abies alba* Mill. (Silver fir). The history of the forest management in Belarus showed that over last 150 years the enormous damage to the qualitative and quantitative composition of forests had been made by wars and reconstruction of destroyed industry. The taken reforestation measures allowed to increase the forest area significantly, however, the work on improving of forests' quality requires further development. At present the artificial forest regeneration prevails in the republic. Over the past five years the volumes of established forest plantations range from 21 to 25 thousand hectares annually, the areas of assistance to the natural regeneration – from 4 to 6 thousand hectares annually. By now there are about 1,700 ha of the forest seed orchards, 2,795 plus trees and 1,125 ha of the plus stands in the republic. The cultivation of planting stock for needs of reforestation is carried out on 73 forest tree nurseries with a total area of 1,440 ha. Annually over the last five years there were grown from 270 to 317 million seedlings and transplants, among them 30-35 million seedlings were grown in greenhouses and about 6 million were container seedlings. In order to improve the gene resource and thereby to increase the productivity and quality of future forests, the tendency of forest plantations' prevalence in the reforestation process of Belarus should remain, but in this case the volumes of partial forest plantations should be increased.

Keywords

Belarus; Reforestation; History; Current State; Forest Seeds; Forest Planting Stock; Forestry Education

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1 Introduction

The forest has always played a big part in human's life. It provided people with valuable building materials, was the place of harvesting of berries, mushrooms, honey, medicinal plants and other products, served as a shelter during wars and raids of enemies. It's role was especially important in countries with high level of forest area.

In Belarus by the beginning of the second millennium the forests covered about 70% of area of its contemporary territory (Fig. 1).

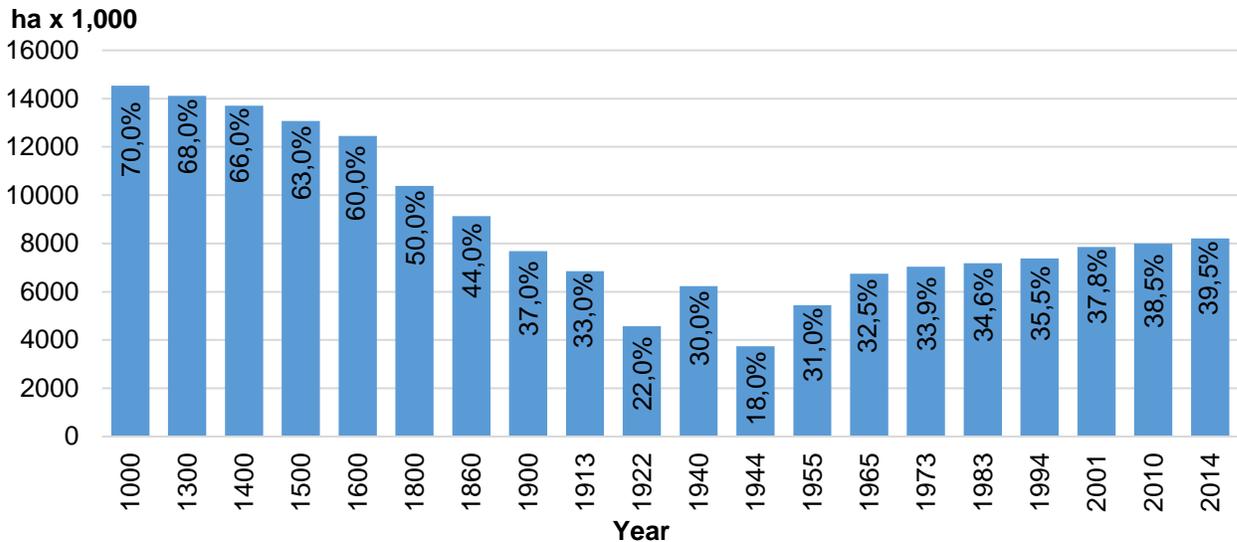


Figure 1. The dynamics of forest cover of the territory of the Republic of Belarus (Baghinsky 2014, data of the Ministry of Forestry).

At the beginning of the 19th century already half of the country's territory was covered by forests. By the middle of the 20th century the industrial development as well as wars, which took place on the territory of Belarus, had led to the reduction of the forest area till 18%.

Currently the share of forest lands as well as lands with tree and shrubbery vegetation accounts for 9,510.4 thousand ha or 45.8%. Forests occupy an area of 8,239.8 thousand ha or 39.7% of the total area. All forests are in the state ownership. The forest management is performed predominantly by the Ministry of Forestry, which is in charge of 88% of all forests. The part of forests is under jurisdiction of the Presidential Property Management Directorate (7.9%), the Ministry for Emergency Situations (2.3%), the Ministry of Defense (0.9%). The insignificant forest area belongs to the Ministry of Education, the National Academy of Sciences, local government bodies. Predominantly the forests are of natural origin. The share of the artificial forest stands accounts for 24.3 % of the total area of forests. (The condition of the natural... 2016).

The share of the coniferous stands amounts to 59.8%, hard-wooded broadleaved stands – 4.1%, soft-wooded broadleaved stands – 36.1% (Fig. 2). Slightly more than half of forest area is covered by *Pinus sylvestris* (50.5%), followed by *Betula pendula* (23.3%) and *Picea abies* (9.3%).

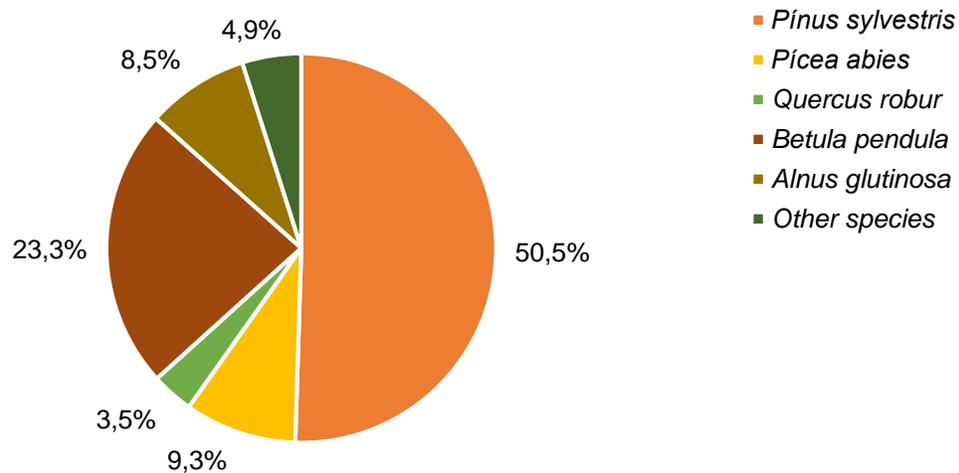


Figure 2. The distribution of forests according to species.

At the beginning of 2016 the volume of growing stock of principal species accounted for 1,739 million m³, having increased in the amount of 25.6 million m³ owing to the incomplete use of the annual increment. 81% of this volume is available for exploitation. In 2015 the rated wood cutting area for all tree species was 11,259.4 thousand m³ (in 2014 – 11,037 thousand m³). In 2015 it's utilization accounted for 80.8% (in 2014 – 72.6%) (The condition of the natural... 2016).

Prior to January 2017 in Belarus the forests used to be divided in two groups: the first group is formed by forests, fulfilling definite ecologic and protective functions, where the restricted conditions of forest use are applied; the second group is formed by exploitable forests. At the beginning of 2016 the forest area of the first group amounted to 52.2% of the total forest area. However, the new Forest Code, which took effect in 2017, stipulates the classification of four categories of forests' protectiveness instead of the first group that will increase the areas of exploitable forests up to 57.7% (Rozhkov 2015).

2 The history of reforestation in Belarus

The reforestation is closely connected with processes of harvesting of wood, and felling operations. And if the natural reforestation can take place without any connection with felling operations, then the forest plantation development is carried out preferably in areas of felled stands. At that the historical analysis of special aspects of forest harvesting as well as its impact on the productive capacity and stability of the established stands is necessary for the correct assessment of the contemporary methods of reforestation.

Starting from the middle of the 19th century in Belarus the increase in deforestation had begun simultaneously with the rapid industrial development. At that time the demand for the Belarusian wood material, particularly on the part of the English and German companies, increased. The intensive forest clearance with harvesting of the large-sized timber in the first place, had begun, which continued practically until the beginning of the First World War. By the middle of the 19th century

the volumes of annually harvested timber amounted to 4.1 million m³, and by the beginning of the 20th century this volume had grown up to 7.3 million m³ per year (Baghinsky 2013). Over the first decade of the 20th century the volumes of only exported wood material amounted to 4.2 million m³ per year (Baghinsky 1996). As a rule the selective cuttings were carried out, when the best, the largest trees were selected, since they had the guaranteed sale and met the requirements of the foreign companies. The forest was considered to be the self-renewing free-of-charge benefit. That is why almost nobody was engaged in the intentional reforestation. The natural forest reproduction prevailed, which accounted for 98-99% of the total reforestation's volume.

However, the attention to the forest plantation development had been increasing. Starting from 1849 the forest tree nurseries with area of 2-4 ha had been established in all units of government forests. The government paid out money reward for planted trees. Notwithstanding this only 8-10% of the felled areas of the government forests were restored artificially. The afforestation was carried out in small volumes, but it was mandatory in government forests, where the plantings were performed on forest meadows and grassy glades (Yanushko 2001). The situation in private forests, which share accounted for almost 88% of the total forest areas, was even worse. Only large forest proprietors had forest tree nurseries and developed forest plantations in small volumes. On the whole for the period from 1883 to 1914 only 12.5 thousand ha of the forest plantations or about 400 ha per year had been created on the territory of Belarus (Table 1), that resulted in reduction of forest area from 44 to 33%.

Table 1. Forest plantation development over the period up to 2005 (Baghinsky 1996; Kruck 2011).

| Years | The quantity of stands, felled on the average per year, thousand ha | The quantity of forest plantations, established on the average per year, thousand ha | Percentage of forest plantation development from the felling volume |
|------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| 1883–1914 | 25.8 | 0.4 | 1.6 |
| 1922–1932 | 41.2 | 14.9 | 36.1 |
| 1933–1941 | 66.6 | 21.2 | 35.8 |
| 1944–1945 | 34.0 | 1.7 | 5.0 |
| 1946–1955 | 49.3 | 45.3 | 91.8 |
| 1956–1965 | 41.4 | 44.6 | 107.7 |
| 1966–1970 | 41.1 | 54.0 | 131.4 |
| 1971–1975 | 30.9 | 40.7 | 131.7 |
| 1976–1980 | 29.8 | 31.0 | 104.0 |
| 1981–1985 | 30.5 | 25.3 | 86.2 |
| 1986–1990 | 29.9 | 25.6 | 85.6 |
| 1991–1995 | 23.8 | 20.1 | 84.4 |
| 1996–2000 | 25.3 | 24.3 | 96.0 |
| 2001–2005 | 33.0 | 38.0 | 115.3 |
| 2006–2010 | 24.6 | 37.9 | 153.9 |
| 2011–2016* | 29.2 | 23.1 | 79.1 |

The First World War caused serious damage to the forests of Belarus. The intense cuttings were carried out on the occupied territory. About 4.5 million m³ of fine wood had been exported during 2 years only from the Belovezhskaya Pushcha.

The situation on the rest of the territory was not better. Enormous number of the forest was used for needs of the front. Beyond that the private proprietors were permitted to cut down from 5 till 10 annual yields (Yanushko 2001). The volumes of unsanctioned cuttings increased, when the best trees were extracted (Baghinsky 2013). The high contamination of forests led to the massive fires, resulted in destruction of 10% of all country's forests during 1920-1921 (Baghinsky 1996). In total during the period from 1913 to 1923 2 million ha of forests had been destroyed and cut down, upon that the intensity of annual cutting amounted to 40-50 million m³ (Baghinsky 2013). The artificial regeneration was practically not performed during this period. Over the period between 1921 and 1925 only 0.5 to 3 thousand ha of the forest plantations were established annually (Tarasenko et al. 2004). The level of the forest area dropped to 22%.

In the early 1930s the principle of steadiness and inexhaustibility of the forest exploitation was admitted to be the anti-Soviet one. They started to perform the forest harvesting on the basis of the national economy's needs, which were very high at that moment. During certain years it was felled up to 25 million m³ (Baghinsky 1996; Yanushko 2001). The considerable part of forest products was exported. The volumes of the artificial forest regeneration increased up to 12-20 thousand ha per year that amounted to not more than one-third of the total deforested area. They started to establish the forest plantations also on abandoned peasant holdings that resulted in some increase in the forest area.

The enormous damage to forest plantations was caused by the Second World War. In total, according to the data of scientists, about 1.5 million ha of forest-covered areas was destroyed by cuttings, military operations and fires. The territory's forest area came down to the record low value of 18% (Berezenko et al. 1969).

The intensive deforestation continued during the first postwar five-year plan, which was due to the necessity of reconstruction of destroyed industry and housing stock. However, already in 1948 the Council of Ministers of the BSSR defined 507,000 ha, where it was necessary to carry out the reforestation work during 1946-1950 (Kruck 2008). Altogether during the period from 1946 to 1950 198.4 thousand ha of forest plantations or 68.9% of the felled areas were established. The share of sowing amounted to 26.4% of the total volume. During the period from 1951 to 1955 it was established 246.3 thousand ha or 118.8% of the felled area. The sowing was carried out on 19.4% of the area (Kruck 2008). At that time the population was actively involved in harvesting of cones for further seed extraction. Upon that the process was often not under control from the point of view of quality indicators of forest seeds' source.

Over the first postwar decade the assistance to the natural regeneration was carried out on the territory of 178.0 thousand ha that amounted to almost 40% of the established forest plantations' area. However, approximately 2/3 of the stands, which were destroyed and cut down during the war and postwar period, restored practically without human participation (Baghinsky 1997). As a result the forest area of the territory practically reached the level that existed before the First World War.

The problems with availability of wood products for population during postwar years resulted in situation when in the 50s and 60s of the 20th century there had been observed the outburst of the timber harvesting without authorization. The volumes of illegal cuttings achieved 2 million m³ per year (Baghinsky 2014). Upon that mainly the

best trees from the forest allotment were cut down, which subsequently were used for construction of rural population's houses and farm buildings.

The intensive forest plantation development was observed up to 1975. Annually there were created from 40 to 54 thousand ha of the artificial forest stands. Starting from the 60s of the 20th century and until the end of the 80s the volumes of the established forest plantations exceeded the area of deforestation. The stands were established in considerable volumes on barren lands of collective and state farms, including the protective stands and the stands on unproductive sandy lands. If in the beginning of the 60s such stands amounted to about 10% of the total forest plantations' volume, then by the early 70s these areas had increased up to 25%. The stands' planting prevailed. Its share was from 81 to 85%.

The second massive cession of the marginal lands of collective and state farms took place in 2004–2009 so that the area of the forest plantations, established, for example, in 2006, exceeded the clear felling areas 1.8 times.

Summing up what has been said, the history of the forest management in Belarus showed that over last 150 years the enormous damage to the qualitative and quantitative composition of forests had been made. Both natural and artificial regenerations were carried out on the basis of the remaining specimens, the fact of which correspondingly had a negative impact on qualitative composition of stands as well as their productive capacity. The taken measures allowed to increase the forest area significantly, however, the work on improving of forests' quality requires further development.

3 The current state of reforestation in Belarus

3.1 The main areas of activities of reforestation in Belarus

According to the Forest Code of the Republic of Belarus, approved in 2015 (The Forestry Code... 2015) the reforestation has to be carried out within three years, starting from the moment of stands' felling. The main methods of reforestation, applied in Belarus, are the forest plantation development (artificial regeneration), assistance to natural regeneration and the natural regeneration without assistance measures.

Table 3. Ratio between reforestation practices in percent (Kruck 2011).

| Type of reforestation | Years | | | | | | | |
|-------------------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-------|-------|-------|
| | 1966–1987 | 1988–1993 | 1994–2001 | 2002–2008 | 2009–2010 | 2013* | 2014* | 2015* |
| Forest plantations | 69.2 | 36.6 | 29.9 | 50.0 | 52.0 | 53.2 | 55.1 | 53.0 |
| The assistance to natural regeneration | 5.5 | 5.0 | 3.8 | 5.0 | 7.0 | 12.9 | 12.4 | 12.5 |
| The natural regeneration without assistance measures | 25.3 | 58.4 | 63.3 | 45.0 | 41.0 | 33.9 | 32.5 | 34.5 |

* – according to the data of the Ministry of Forestry of the Republic of Belarus

At present the artificial forest regeneration prevails in the republic. Over the past five years the volumes of established forest plantations range from 21 to 25 thousand hectares annually. However in 2016 in connection with the necessity of

restitution of the wind-broken trees the volumes of established forest plantations was increased up to 29.73 thousand hectares. The areas of assistance to the natural regeneration grow in absolute terms (2010 – 4,308 ha, 2012 – 5,055 ha, 2015 – 5,839 ha); the annual areas, left for the natural regeneration without assistance measures, are increasing. The ratio between types of reforestation practices is presented in Table 3.

Thus during more than 10 years in the republic the ratio between naturally and artificially regenerated forests has been maintained almost one-to-one.

In the quality of the assistance to the natural regeneration the scarification of the soil under the stand canopy, the enclosing of felling areas, the sowing and replanting in the amount of up to 10% of the possible quantity of trees can be used while establishing forest plantations. In the main the soil scarification on the area from 4 to 6 thousand ha is carried out. The reservation of the young growth during the felling is being kept at the level of 350–400 ha annually during past 10 years. It is planned by the government program “The Belarusian Forest” to bring the volumes of partial cuttings till 20% of the total felling areas up to 2020 that would increase the share of the natural regeneration. However, at present in the forest management of the republic there has been observed some cases, resulted in insufficient reforestation after partial cuttings, expressed in poor quantity of plants of the principal species or in unadvisable replacement of species at the forest allotment.

The natural regeneration without assistance measures is carried without human participation. It is performed on the forest allotments, where the usage of other methods of reforestation is impossible or impractical. In Belarus the allotments with excessive moistening are designated for such methods; on these allotments mainly soft-wooded broadleaved species are regenerated. However, the further development of technique and technology of the artificial forest regeneration could lead to reduction of such allotment's area.

For the artificial forest regeneration mainly the coniferous and hard-wooded broadleaved species (pine tree, spruce, oak) are used, which share amounts to 95.8% of the total volume of established forest plantations. The remaining areas are allocated for planting of birch, alder and linden. But these species are intensively used as an additive planting to coniferous and hard-wooded broadleaved species. In 2016 the mixed forest plantations were created on 87.8% of area that is 30% more than 15 years ago.

During the forest plantation development the *Pinus sylvestris* seedlings of 1 or 2-year-old, the *Quercus robur* and *Larix decidua* seedlings of 1-year-old are used. Since the spruce forest plantations are created predominantly in rich conditions with very high competition of undesirable vegetation, only the transplants of 3 or 4-year-old are used for planting. In rich growing conditions, when using the *Picea abies* transplants as well as the *Quercus robur* seedlings, no less than 2.5-3.0 thousand plants per one hectare are set out. In poorer conditions, when using the *Pinus sylvestris* seedlings as well as the *Betula pendula* seedlings, this quantity increases up to 3.4-6.6 thousands. The most commonly used density of established forest plantations for the *Picea abies* is 3.5-4.0 thousand pieces per hectare, for the *Pinus sylvestris* – 5.0-7.0 thousand pieces per hectare.

The main method of forest plantation development is the planting. The sowing is almost not practiced. At that the share of the mechanized sowing and planting is

negligibly small. The mechanized soil cultivation is carried out on a mandatory basis on all allotments. The most widespread method is ridge tillage.

In Belarus the volumes of afforestation are inconsiderable and vary from 800 to 1,500 ha per year. Generally it is carried out on poor soils, which were handed over by agricultural enterprises.

The volumes of the establishment of plantation artificial stands are also not high. Annually it is planted from 300 to 700 hectares, mainly for the production of chip fuel. However, there is a large quantity of unclaimed wood in Belarus, therefore it was decided to suspend the development of forest plantations.

3.2 The harvesting and processing of forest seeds

The usage of selective planting stock holds a prominent place in the artificial regeneration. The 60s years of the past century could be considered as the beginning of work on selection of forest trees in Belarus, when the plus trees and stands began to be marked out as well as the first forest seed orchards were established. By now in the republic there are about 980 ha of the forest seed orchards of the first generation and 673 ha of the forest seed orchards of the second generation. 2,795 plus trees and 1,125 ha of the plus stands are marked out. However, at least one third of the orchards are approaching to the limit age of their exploitation. Correspondingly the question of present interest is their further exploitation, conversion or replacement as well as increasing of the existing orchards` productivity. The enterprises of the forest industry are actively engaged in establishment of new orchards. There were established from 21 to 33 ha annually over the past five years, at that approximately 70% of them were accounted for the orchards of the second generation. In 2016 the forestry enterprises of the industry made a stock of almost 26 ton of forest plants` seeds (12.1 ton of acorns, 6.3 ton of conifers` seeds and 7.5 ton of other species), of which 8.5% is accounted for selective forest seed material. In the long view it is planned to increase annual area of forest orchards` establishment up to 50-60 ha as well as enter the orchards of the third generation.

The processing of conifers` cones is performed by four specialized enterprises, situated in different regions of the country: the Republican Forest Selection and Seed Center (the equipment of the company "Nomeko"), Gluboksky, Schuchinsky and Ivatsevichsky forestry enterprises (the equipment of the company "BCC").

Also it is important to receive the high-yielding varieties of the principal forest forming species. The scientists of the Belarusian State Technological University for the first time in Belarus developed the new variety of the *Pinus sylvestris* "Negorelskaya", named after the educational and experimental forestry enterprise of the Belarusian State Technological University. The work on the variety began in 1959, when the forest trials of different climatic types of Russia and Belarus were laid out. In 1982 as a result of observation and selection the first hybrid seed orchard was laid out and in 2014 the evidence of a new variety was received. The height of the variety plants is 10-23% and the diameter is 12-24% larger in comparison with the control plants of the pine. It has heavy and early fruit bearing, forming racemes from 5-8 cones (Fig. 3) starting already from the age of 5 years old that for the local pine is absolutely not characteristic (Poplavskaya et al. 2011).



Figure 3. The cone bearing of the *Pinus sylvestris* "Negorelskaya". Photo: Tupik P. V.

However it should be taken into account that at the present stage it is envisaged to use one half of the planting stock, grown from seeds, which had been harvested from forest seed orchards, and the second half, grown from the seeds, harvested in the best wild stands, while establishing the forest seed orchards. Subsequently the forest seed breeding should be developing in two directions: plantation and population ones with approximately equal shares in the process of reforestation. And if in our republic the plantation seed breeding is developing, that is reflected in continuously growing volumes of the forest plantation development with the help of selective planting stock (for example, during last 10 years the share of such planting stock has increased from 11.0 % up to 40%), then the population seed breeding is not paid so much attention, largely owing to the difficulty of seed harvesting in growing forest stands. The best option is the establishment of population and clonal forest seed orchards, which are able to combine the genetic diversity of the best wild stands with the simplicity of harvesting and early fruit bearing of the conventional forest seed orchards. It is here where the reserve is hidden, which in future would allow to influence positively on productivity and quality of being restored forests without disturbing ratio between plantation and population seed breeding.

3.3 The cultivation of the forest planting stock

The cultivation of planting stock for needs of reforestation, including the selective one, is carried out on 73 permanent forest tree nurseries with a total area of 1,440 ha. The nurseries' area varies from 5 to 40 ha. Some nurseries, mainly the ones of the big area, have already been in use for 40 years that result in immense impoverishment of fertile soil layer as well as in realization of expensive procedures concerning thickening of humic layer.

Annually over the last five years there were grown from 270 to 317 million seedlings and transplants in the forest tree nurseries, at that from 16.2 to 22.2% of them were grown from selective seeds (Fig. 4). Apart from the forest planting stock the ornamental plants are grown in all nurseries for their further realization to population and enterprises. In total 285 species and forms of woody plants are grown in the nurseries of the Ministry of Forestry.



Figure 4. The one-year-old seedling of the *Pinus sylvestris* in the forest tree nursery of Smorgonsky experimental forestry enterprise. Photo: Nosnikov V.V.

The forestry enterprises actively use the technology of growing seedlings in greenhouses. In the forestry enterprises of the republic 323 greenhouses with a total area of about 14 hectares are put into operation, where up to 34.39 million seedlings were grown in 2016. In spite of difficulties as well as some lack of understanding of this technology's advantages on the part of forest workers at the initial stage, currently the volumes of seedlings, grown in the greenhouses, keep steadily growing. Over the last five years the share of participation of such planting stock has increased from 4.0% up to 12.6%, i.e. more than 3 times. The high-moor peat or the mixture of high-moor and low-moor peats are used as a substrate in the greenhouses. Predominantly one-year-old seedlings of the *Pinus sylvestris* (Fig. 5) or the *Picea abies* are being grown, however it is possible to encounter the plantings of *Betula pendula* and *Alnus glutinosa*.



Figure 5. The one-year-old seedling of the *Pinus sylvestris* in the forest tree nursery of Smorgonsky experimental forestry enterprise. Photo: Nosnikov V.V.

The special place from the point of view of rational procurance and usage of selective planting stock belongs to the technology of planting stock's growing in containers, which allows not only to obtain one seedling from practically one seed, but also provides almost 100% capacity for seedlings' survival while being used during establishment of artificial stands.

The cultivation of forest planting stock in containers started in 1977, when the «Paperpot» seedling line was installed in Gluboksky experimental forestry enterprise. With the help of the received planting stock the artificial stands were established, which could confirm the effectiveness of this technology. However, the share of planting stock in containers in the total volume of established forest plantations amounted to fractions of percent. The technology received further development in 2002, when the Republican Forest Selection and Seed Center (Fig. 6) was created, one of the functions of which was the cultivation of such a planting stock.

The cassettes' filling and seed sowing line, produced by the Finnish company "Lanen", was installed at the forest seed center. The company's BCCF64 cassettes were used in order to receive one-year-old seedlings of the *Pinus sylvestris*, BCCF35 cassettes –two-year-old seedlings of the *Picea abies*. In 2014 the new line of the Italian company "Mosa Green S.r.l." was purchased. The old line was handed over to Mogilevsky forestry enterprise. These two lines perform the seed sowing into the cassettes for all Republic.

At the present time the planting stock in containers are grown on the basis of the Republican Forest Selection and Seed Center as well as of almost all forestry enterprises of the republic. Two greenhouses of total area 0.28 hectares are built at the forest center, where up to 1.5 million pieces of seedlings in containers are grown annually. Generally they grow from 50 to 200 thousand seedlings in containers of the *Pinus sylvestris*, the *Picea abies* (Fig. 7) and the *Quercus robur* in each forestry enterprise. There are installed 1-2 greenhouses with the area from 100 to 500 m² with the stationary irrigation system. The strong influence of the human factor, sometimes ill-considered designs of greenhouses and irrigation systems result in the unequal quality of planting stock.



Figure 6. The greenhouses of the Republican Forest Selection and Seed Center.
Photo: Nosnikov V. V.



Figure 7. The planting stock of the *Picea abies* in containers. Photo: Nosnikov V.V.



Figure 8. Two-year-old seedling of the *Picea abies* in container. Photo: Nosnikov V.V.

In 2015 “The industry program regarding growing of the planting stock with closed root system at the enterprises of the Ministry of Forestry of the Republic of Belarus for the period until 2020 year” was adopted, which provides the construction of four modern enterprises for growing of the planting stocks in containers as well as the modernization of two existing enterprises. The program envisages the gradual increase of the quantity of the planting stock, grown in containers. If in 2013 there were cultivated only about 1.5 million plants, then in 2015 there were already 5.6 million pieces, in 2016 – 10.2 million pieces, among them of *Pinus sylvestris* – 4.6, *Picea*

abies – 3.7, *Quercus robur* – 1.3 and *Larix decidua* – 0.6 million pieces. The key issues are optimization of the substrate, regimes of irrigation and mineral nutrition, sowing terms of different rotations, particular aspects of storage and planting of seedlings in containers. At present the question regarding terms of growth of the *Picea abies* seedlings is being discussed. On the one hand, the strong competition in reach conditions from the side of undesirable vegetation forces to grow two-year-old seedlings with the height of aboveground part, which could reach 50-60 cm (Figure 8). On the other hand, the usage of one-year-old seedlings will let significantly reduce expenses for cultivation of spruce's planting stock.

In general while establishing forest plantations it is planned to use 30% of seedlings in containers, 30% of seedlings from the greenhouses, 40% of seedlings and transplants from the open fields of forest tree nurseries. Namely container planting stock could be the foundation for the increasing of productivity and quality of future forests in Belarus. Such seedlings and transplants, grown from the seeds, harvested from forest seed orchards, preferably of the second generation, could be used not only for establishment of ordinary forest plantations, but also as the integral part of the forests, established on the basis of natural regeneration (Nosnikov 2015). It will allow to improve the gene resource and thereby to increase the productivity and quality of future forests, retaining the level of genetic diversity.

4 The forestry education and science

In Belarus the specialists in the forest management are trained by two universities - the Belarusian State Technological University (Fig. 9) and Francisk Skorina Gomel State University as well as by 4 colleges – in Polotsk, Vitebsk, Bobruisk and Gomel.



Figure 9. The oldest building of the Belarusian State Technological University (Minsk).
Photo: BSTU.

The Belarusian State Technological University was founded in 1930 as the Forestry institute. The forestry faculty is the oldest one from eight existing faculties and annually graduate 70 to 90 specialists in the field of forestry. In 2007 the University was granted the status of a basic higher educational institution of the CIS in the fields of forestry and forest industry. In 2009 the Quality Management System was introduced, corresponding to the requirements of the Belarusian certification system STB ISO 9001-2009 and of the German certification system DIN EN ISO 9001:2008.

The training of students in the field of the artificial forest regeneration is performed by the Department of Forest Plantations and Soil Science of the Forestry Faculty. The staff members of the department also carry out the significant scientific research in the fields of forest soil science, forest genetics and selection, technology of planting stock cultivation, including in greenhouses and in containers, development of forest plantations of different designated use. They developed the variety of the *Pinus sylvestris*, patented new methods of establishment of the forest seed plantations. Also the optimal compositions of substrates for cultivation of seedlings in containers as well as new methods of mineral nutrition of seedlings and transplants at outdoor growing are being developed.

The department of silviculture is engaged in solution of questions regarding natural reproduction of forests. They develop the methods of selective cuttings as well as measures concerning reservation of naturally appeared generations of forests.

In Gomel State University the Department of Forestry Disciplines, formed in 2003, is engaged in training of specialists of forestry, including in the field of reforestation.

Apart from the Belarusian State Technological University the scientific activities are carried out by the Forest Institute of the National Academy of Science of Belarus. They achieved significant results in the fields of forest selection and, in particular, genetic analysis of forest plants, identification of diseases and wildfire control.

5 Conclusion

The analysis of the history of forestry in Belarus in the context of reforestation measures has shown that over past 150 years the enormous damage to the qualitative parameters of our forests as well as to their fertility had been made.

At present the forests of pre-war period, grown on the allotments of intensively exploited forests, are approaching to the felling age. In the next ten years the forest stands of war and postwar period, which were restored mainly without human participation and where the question of qualitative gene resource is opened, will also approach this age. The problem will be observed in future since the political and economic crisis played great part in process of regeneration of forests, which were cultivated during the First World War and then were felled in the 1990s, when the control over the harvested timber was significantly reduced that led to an increase in often illegal harvesting of large timber. Correspondingly, the problem of improvement of our forests' gene resource is the long-term planned process, which received its beginning and further development in modern forestry and, we dare to hope, will efficiently continue. Therefore the tendency of forest plantations' prevalence in the reforestation process of Belarus should remain. In this case the selective planting stock should be the basis; however it is necessary to use it in conjunction with the natural reforestation. In view of this in perspective the volumes

of partial forest plantations will increase, particularly the plantations of the *Pinus sylvestris* in poor growing conditions. Moreover, it is necessary to introduce more extended implementation of population-clonal seed orchards, which allow to reproduce the valuable, high-productive stands, including the natural ones, with the aim of their further propagation.

The work of the forester is almost always the work, aimed at future, it is the material message for children and grandchildren. And nowadays the task of the Belarusian foresters is to hand over to them not only regenerated forests, but to try to improve the forests` quality and productivity to the uttermost, not loosing at that the necessary level of their naturalness.

6 References

- Baghinsky VF, Esymchik LD (1996) The forest exploitation in Belarus: history, contemporary state, problems and prospects. Minsk: The Belarusian science.
- Baghinsky VF (1997) The problems of reforestation in Belarus. The Environmental Resources 2:64-71.
- Baghinsky VF (2013) The unsanctioned forest felling. Historical background. The Forest and Hunting Household 9:31-37.
- Baghinsky VF (2014) The state of affairs, problems and prospects of the main forest exploitation in the Republic of Belarus at the present stage. The Siberian Journal of Forest Science 2:7-21.
- Berezenko NM, Pobedov VS (1969) The forests of Belarus. Minsk: Harvest.
- Kruck NK, Ushkevich GS (2008) The forest plantations of Belarus: dynamics, species composition, methods of establishment (1944–2000). The Forest and Hunting Household 3:17-22.
- Kruck NK (2011) The current state and development trends of reforestation in Belarus. Proceedings of BSTU Forestry 1: 148–152.
- Nosnikov VV (2015) Reforestation in Republic of Belarus subject to foreign experience. Proceedings of BSTU, Forestry 1:145-148.
- Tarasenko VP, Epatjev VA, Kruck NK, Holodilova LV (2004) The history of the forest management of Belarus. Edition 2. Gomel, FI NAS B.
- The condition of the natural habitat of Belarus: the Environmental Bulletin (2016). Minsk.
- The Forestry Code of the Republic of Belarus (2015). Minsk.
- Poplavskaya LF, Rebko SV, Tupick PV (2011) The growth dynamics of plantation of common pine, specie "Negorelskaya". Proceedings of BSTU, Forestry 1:153-152.
- Rozhkov LN (2015) The dividing of forests of Belarus into categories of forests` protectiveness. The Forest and Hunting Household 6:11-16.
- Yanushko AD (2001) The forestry of Belarus – history, economics, problems and prospects of development. Minsk.: BSTU.