Improvement of automation process of forest resources renewal using innovative landing material

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Abstract. The Russian Federation has vast reserves of forest resources. Our country is the world’s leader in terms of wood reserves (more than 80 billion cubic meters), and it exceeds the USA 2 times, China - 6 times, Sweden - 25 times, Finland - 35 times. Production capacities of the timber industry complex are quite comparable with the oil industry. A serious state policy is needed to create research centers around which the work on the introduction of innovations into production would be concentrated. Budget funds allocated for solving scientific and technical problems of the industry are scattered among scientific organizations to solve minor, private issues, which does not allow solving problems of strategic nature for innovative development of the timber industry complex. On the one hand it ultimately leads to ineffective use of budgetary funds, and on the other, it leads to stagnation of scientific organizations and loss of their scientific potential. The development of the industry will contribute to the use of biotechnology. Russian biotechnological methods are still at the stage of scientific research and are just beginning to be implemented in practice. They are used, for example, when carrying out selection work. Special attention should be paid to the problem of provision of timber industry complex with forest regeneration equipment.

1. Introduction
Considering the tools and mechanized technical devices used in the prevention and extinguishing of forest fires contributing to the restoration of lost forest resources, it can be noted that, according to various researchers, the current state of the industrial base of manufacturing enterprises for the production of forest and forestry machinery is characterized by total destruction. The reasons for the destruction of the production base are connected with liquidation of tractor factories in such regions as the Altai Territory, the Syktyvkar Territory, the Krasnoyarsk Territory, the Perm Territory and several others. To date, the production of timber industry equipment on a tractor basis is carried out in such cities as Yoshkar-Ola, Onega, and Yekaterinburg. Production at these enterprises is carried out not in series, but in small batches. It is worth noting that qualitative component of the manufactured timber industry equipment, fire protection devices in Russia does not correspond to modern world and scientific levels in a number of indicators. It is inferior to imported counterparts to different extents. It can be noted that failure and unsatisfactory condition of sector research and development base for the development of forestry machinery in the timber industry complex is recognized at the authorities' level. It is possible to observe the loss of the existing base of service and maintenance of manufactured domestic mechanized timber products in these circumstances [1, 2].
Under these conditions, imported machines are being actively acquired in the timber industry complex (mainly on the wheelbase), which are not adapted to the difficult operating conditions. At the same time, there is an increase in the presence of imported second-hand machinery in the Russian timber industry complex.

Reforestation machinery includes various machines and units, for example, mounted mulcher heads and mulcher plants, forest plows, mechanical saws for cutting branches, forest cultivators, planting machines, planters for forest crops, brush cutters, specialized forestry tractors, etc. Such companies as Bracke Forest, Bandit, Altaiselmash, Dorvector, Lidselmash, Onezhsky Tractor Plant, Sarapulsky electric generator plant, etc. are known among the manufacturers [3, 4].

Bandit 3 500 mulchers with a mass of 7.9 tons clean up the area and remove trees, stumps, and shrubs, processing them into small pieces. With their help, trunk pipelines are laid and roads are being alienated and a clearing for the installation of power lines is created. The review of reforestation equipment includes models with basic technical characteristics and photographs of leading world manufacturers. Table 1 provides information on the brands of forest restoration equipment.

| Forest restoration equipment | Field of use                  | Weight, kg | Overall dimensions, mm |
|------------------------------|--------------------------------|------------|------------------------|
| Bandit Brut Mower            | Mounted mulcher head           | 1750       | 1850/1000/1400         |
| Bandit 3 500                 | Mulcher plant                  | 7900       | 5187/2336/2692         |
| Bandit 4 000                 | Mulcher plant                  | 21000      | 6810/2570/3300         |
| Altaiselmash PLL -1.4        | Lightweight forest plow         | 160        | 1200/1250/1100         |
| Dorvector PDM -4             | Saw for pruning branches       | 250        | 2200x640x700           |
| Lidselmash L-129             | Forest furrow cultivator       | 510        | 910/710/510            |
| Lidselmash L-218             | Planting machine               | 900        | 2200/2000/2200         |
| Lidselmash PKL -70D          | Forest plow                    | 500        | 2500/1750/1600         |
| OTP KR-2                     | Rotary brush cutter            | 10300      | 6520x2450x2690         |
| OTP FTT-100                  | Forestry tracked tractor       | 11700      | 6450x2575x3000         |
| OTP FTT -55                  | Forestry tracked tractor       | 9400       | 6450x2360x2560         |
| SEGP MKR-1900                | Brush cutter                   | 12.5       | 1900 (length)          |

Mechanized planting of seedlings by Bracke Forest planting units is carried out with the help of a special planting head placed on the boom of the machine. The head has a rotating mechanism with sets for planting (up to 180 pcs). The versatility of the head also makes it possible to use it in soil and planting seedlings preparing, watering, applying fertilizers and pesticides parallel to planting. It works in areas of any size and any soil (from light fertile soil to soil which is rocky or polluted with forest residues). Working bodies are adjustable in width and angles, pressure parameters for the soil and pressure on separation [5, 6].

Its powerful four-row rippers are mounted on large tractors and are able to work in the most difficult areas, preparing the soil for the best living conditions of seedlings and seeds.

2. Materials and methods

Exploring the state of the country's timber industry complex, we can note the fact that forest biotechnologies are actively used in forestry activities in the period of the last few years. The use of forest biotechnologies can be observed in practical scientific activities, namely, in reproduction and protection of forests, and in the development of scientific innovative forms of woody plant genotypes. The necessary features are taken into account, introducing forest biotechnologies, as well as the degree of introduction of innovations into the development of new production technologies of innovative types of planting material, the formation of forest stands by the method of plantation growing with a smaller
logging interval. The use of forest biotechnology plays a significant role in the disposal of timber industry waste and in the production of wooden housing.

Analyzing the main aspects of the development strategy of the timber industry complex of the Russian Federation until 2030, we can conclude that the directions of improvement and the development of innovative methods aimed at obtaining a highly productive and fast-growing forest with the required quality properties based on the use of biotechnologies are priority tasks of the innovative development of the complex. Therefore, it is necessary to develop and apply practice-oriented innovative approaches based on the use of biotechnologies in the forest industry. It is worth noting that the values of growth indicators of innovation activity in the sectors of the economy in this direction are interconnected with the vector of practice-oriented development of scientific and technological basis, taking into account the research carried out within biotechnological framework and bringing them to the world market. Here, the need to secure state support over biotechnological production, improvement of regulatory and legal documentation in the field of biotechnology innovation regulation is of great importance [7, 8].

The result of the application of innovative biotechnologies in the timber industry complexes is the provision of competitive advantages, an increase in the level of innovation activity in the complexes, based on the production of “fast” tree stands based on plantation forestry by selection method, and an increase in prices for timber products. You can also get wood raw materials of better quality.

The use of biotechnologies in the timber industry complex provides an innovative breakthrough in the issues related to the preservation of biological diversity of woody species, as well as in reproduction of highly productive forest resources in the shortest possible time with minimal costs.

The study proposes a methodology for clonal micropropagation, considered as a fundamentally innovative way of obtaining the latest genetically improved forms of forest tree species, which includes the necessary set of methods for regeneration, accelerated growth of woody plants in vitro, the methodology of genetic transformation and labeling at molecular level. Based on this approach, a large amount of uniform planting material can be produced in the shortest possible time. Forest biotechnology is considered as a massive clonal reproduction of tree crops in the structure of tissues and cells. It is a process in which the obtained forms of tree species are genetically identical to the original specimen [9–11].

3. Results and discussion

Creation of forest stands with planting material with a closed root system using in vitro microclonal propagation technology is a progressive trend in forestry practices, landscaping, ornamental horticulture and fruit growing. This direction has been developed since the end of the 50s from the simplest methods of genetics and selection in North-European and South-American countries, Canada, and the USA. The greatest experience has been gained in the Scandinavian countries, where up to 80% of reforestation is carried out using this technology. The use of seedlings with a closed root system opens up wide possibilities for automating the processes of growing and planting, providing better survival and more intensive development of crops, excluding losses during transportation.

Risutec PM60 can be noted considering the technical devices used in reforestation (Figure 1, a). It is an inexpensive planting head for small amounts of reforestation. There is no need to connect to the hydraulic, pneumatic or electrical system of the base machine due to completely mechanical design. The planting machine has a capacity of 60 seedlings, weight of 550 kg [12]. Its modification of Risutec PM60E is also fully mechanical machine, but it is distinguished by the presence of press rollers for better planting of seedlings and greater loosening depth of up to 450 mm [13, 14].

Planting head Bracke P11.a (Figure 1, b) is made for planting on any type of soil (from light fertile soils to rocky areas) cluttered with cutting waste. It can be applied both on small sites and on larger areas. Functions for treating seedlings with insect repellents are available. Fertilizing directly on planting is possible if it is necessary.

Regeneration of forest resources by the method of plantation forest cultivation acquires great importance in the timber industry complex in various countries of the world. So, a number of advantages are achieved in the process of formation of innovative forest plantations showing a lower level of the
cost of raw materials obtained with intensive technologies as compared with the classical forest lands, obtained using the approaches to artificial and natural growing.

![Figure 1. Mechanical planting outfit, a – Risutec PM60E; b – Bracke P11.a.](image)

Consequently, the process of creating specialized innovative forest plantations requires the use of innovative planting material, improved at the genetic level (species of forestry tree species with improved characteristics of sustainability and productivity) which enables one to create innovative forest plantations with the formation of high-quality assortment composition and shortened terms of reforestation and forest growing [15].

**Table 2. Summary list of costs of creation of the innovative forest center using innovative infrastructure of FGBOU IN “VGLTU”**

| List of costs, thousand rubles. | Sum, thousand rubles, for the period |
|--------------------------------|-------------------------------------|
|                                | Total | 2019-2020 | 2020-2021 | 2022-2023 |
| 1. Purchase of the necessary fixed assets for the creation of an innovative forest base. | 8 000.0 | 2 600 | 2 600 | 2800.0 |
| 2. Purchase of inventories, thousand rubles. | 81 488.5 | 18567 | 27850.5 | 35071.0 |
| 3. The costs connected with the maintenance of the property complex. | 805.2 | 183.47 | 275.2 | 346.6 |
| 4. Costs connected with other works, services. | 303.1 | 97.4 | 97.4 | 108.3 |
| 5. Costs connected with the implementation of research and development. | 1 592.7 | 447.00 | 532.00 | 613.7 |
| 6. Costs connected with professional development and professional retraining in the field of biotechnology. | 223.8 | 51.00 | 76.5 | 96.3 |
| 7. Costs connected with the formation of information and analytical database of forest biotechnologies. | 723.6 | 210.5 | 242.1 | 271.0 |
| 8. Administrative and management control over the functioning of the Center. | 128.8 | 36.00 | 43.2 | 49.6 |
| 9. Volume of innovative planting material. | 4 937.5 | 1125.00 | 1687.5 | 2125.0 |
| 10. Plantation area, ha | 1 975.0 | 450.00 | 675.00 | 850.0 |
| **Total cost, thousand rubles** | **96 240.7** | **22192.37** | **31716.9** | **42331.5** |
It is proposed to create innovative forest centers to implement this mechanism. In vitro bank of the best forest genetic resources will be formed in these centers. Selection and genetic studies to grow the necessary innovative planting material with the aim of accelerating reforestation and improving the quality characteristics of tree species when creating innovative forest plantations have been held (table 2).

According to table 2, it can be concluded that the total amount of capital investment needed for creation of innovative forest center based on an existing laboratory in the first year is 22,192.37 thousand rubles for the planned production of 750 thousand pieces of innovative planting material per year for the plantation area of regenerated forest resources of 300.00 hectares. Thus, the creation of a network of innovative forest centers enables quicker regeneration of the lost forest resources and improvement of the qualitative composition of tree species. As a result, the quality of raw wood for forest industry enterprises increases.

4. Conclusion

Innovative forest centers can be created on the basis of already established laboratories which are ready to apply modern innovative technologies of in vitro clonal micropropagation. On the basis of the laboratory under study, it has been revealed that (for plantation forest growing) it is necessary to increase the capacity of the existing laboratory 17 times, bringing production volume to 750 thousand pieces per year. The required amount of funding for the cultivation of innovative planting material and creation of the center is 22,192.37 thousand rubles in the first period (2019-2020). The amount of funding will be 96,240.00 thousand rubles in a 4-year planned period.

One of the priorities of innovative forest center is the development of the material and technical base. This requires the purchase of innovative genetic and selection materials (basic components of forest crops, soil with the necessary substrates, auxiliary materials) for an overall amount of 18,567.00 thousand rubles and necessary production and laboratory equipment for an overall amount of 8,000 thousand rubles. An increase in power is possible over the entire period in the future due to additional conditions. The necessary expenses are recalculated in accordance with the rate of inflation and the rise in price of the necessary raw materials for 2019. This equipment enables reproduction of the latest forms of tree species with given morphological characteristics and grow high-quality innovative planting material.

5. Acknowledgments

The reported study was funded by RFBR according to research project № 18-010-00318_A.

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