Prospects of Growing the Fast-Growing Energy Crop Pavlovnia in Russia in the Context of Sustainable Development and Closed-Cycle Economy

Nikonorova P.P. [1], Kim A.A. [2], Volkov A.R. [3], Igumnov M.A. [4]
ITMO University, St. Petersburg, Russia
p.nikonorowa@yandex.ru, kim-anastasia@bk.ru, volkovra@yahoo.com, sim4ikgood@mail.ru

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Abstract: Climate agenda, sustainable development and circular economy have multiple interconnections. The key areas of transformation of various economic sectors such as energy, construction and industrial sectors are the reduction of greenhouse gas emissions into the atmosphere, as well as minimization of negative environmental impact. In this paper we analyzed the existing problems in the timber industry of the Russian Federation, which limit its development, studied the characteristics of the fast-growing tree variety "Pavlovnia", thanks to which it is possible to obtain high-quality wood in a short time, evaluated the prospect of growing Pavlovnia in Russia as a multipurpose renewable resource, and proposed the use of Pavlovnia as the main species for carbon farming, carbon dioxide capture and carbon offsetting, as well as the use of carbon dioxide sequestration and carbon sequestration.

1 INTRODUCTION

The UN predicts that the world population will reach 8.5 billion by 2030, 9.7 billion by 2050 and 10.4 billion by 2100. To maintain an optimal standard of living for this number of people it will require a volume of resources that can be produced by a total of 3 planet Earths. These resources include not only essential resources such as food, but also energy and building materials, which are the raw materials for many factories and industries. In addition to the energy and production sectors, the concept of sustainable development and decarbonization policies have also affected the construction sector. More and more innovative building materials that can be called sustainable are appearing on the market. These include materials made from recycled plastic or other waste materials, green concrete used after demolition of old buildings. But in addition to new materials, one of the traditional, yet sustainable and renewable resources is still wood.

In 2022, wood processing and production of wood products in Russia decreased by 10% YoY, while logging reached its lowest level in the last 9 years, down 13% YoY to 194.6 million m³. At the end of 9 months of 2023, timber production decreased by 6% y/y to 2022. At the same time, there is a growing demand for timber and various timber products; at the state level, there is a tendency to increase the share of timber industry in the country's GDP by increasing the production of cellulose, paper and cardboard products, sawn timber and furniture, which, accordingly, generates the problem of a shortage of quality raw materials and an increase in their cost.

Thus, we can conclude that in the next decade Russia needs to develop and implement effective mechanisms for reforestation and cultivation of fast-growing woody crops in order to provide sawn timber for the construction and manufacturing sector, while taking into account sustainability requirements in the context of the climate agenda.

[1] https://orcid.org/0009-0002-5058-3091
[2] https://orcid.org/0009-0007-7493-1755
[3] https://orcid.org/0000-0002-1671-6236
[4] https://orcid.org/0009-0000-3733-8062

2 MAIN PART

The geographical location of the Russian Federation has a number of advantages for growing timber for various needs, but there are no effective mechanisms for sustainable forest reproduction in already developed areas, which leads to the fact that the availability of raw materials is decreasing, which means that the costs of forest development are increasing, respectively, the price of quality wood and wood products is also increasing. And if under favorable market conditions it is possible to solve this problem through supplies from remote corners of our country, then under unfavorable conditions such wood for many industries will be economically inaccessible due to the high cost of its transportation, which will lead to a shortage of raw materials and as a consequence either to a shortage of wood products, or to a decrease in their quality, or to a strong increase in prices for these products.

In addition, we can identify several other problems in the timber industry complex of Russia, which limit its development:

1. An extensive model of forest development, which consists of cutting down wild forests, rather than planting and further cutting down forests specifically for production purposes, as is already being done in countries where there is a state-level moratorium on cutting down wild forests;

2. The world's lowest rate of timber removal per 1 hectare of area, despite the large number of areas occupied by forests;

3. Low profitability, as there is a high volume of waste and a low level of recycling;

4. Low efficiency of reforestation. Effective reforestation in already developed areas is absent or partially applied. Often the process of reforestation is recognized as unprofitable, as the costs can be recouped only after 40-60 years (provided that coniferous tree species are used for reforestation);

5. A large number of forest fires, as well as an inefficient system of forest inventory, which results in a high level of illegal logging, lead to Russia losing up to 500,000 hectares of forest annually;

6. Deficit of accessible forest areas with valuable timber species. The problem is solved by sourcing them from remote areas, which leads to high prices for such tree species, as well as increased transportation costs for companies;

7.The forest industry is not attractive for investors due to the long turnover of funds, and state support cannot cover all companies in the industry, which leads to slow modernization of existing production facilities and few openings of new ones. In addition, advanced equipment and spare parts are often purchased abroad, which leads to high costs;

8. Russian products are inferior to foreign products in some parameters, as in our country in this sector of the economy there is physical and moral deterioration of the main equipment, which leads to an increase in resource and energy intensity of production, as well as to a decrease in quality and, consequently, greater lagging behind the quality standards approved abroad.

According to Roslesinforg, a total of 38.9 million m³ of sawn timber was produced in Russia in 2023, of which 20.7 million m³ was exported. In the geography of foreign shipments, Asian markets, in particular China, Uzbekistan and Kazakhstan, accounted for a 98% share. At the same time, the key sawn timber products were planks and beams made of coniferous trees such as pine, spruce and larch used for construction purposes.

In 2023, the Siberian Federal District accounted for 44.7% or 9.2 million m³ of sawn timber exports. The Northwestern Federal District ranked second with 5.3 million m³, the Far Eastern Federal District with 2.8 million m³, the Urals Federal District with 1.5 million m³, and the Volga Federal District with 1.2 million m³

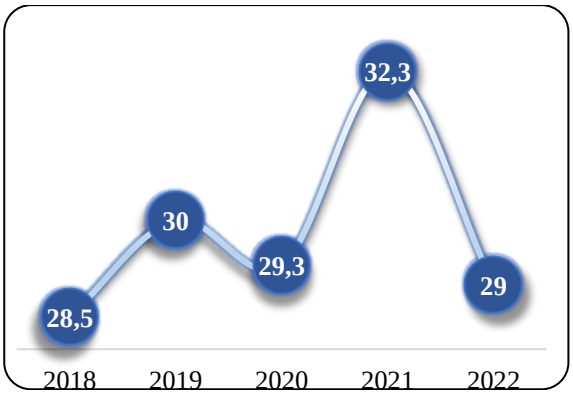

Figure 1: Dynamics of sawn timber production in Russia, mln. cu. m.

Among fast-growing crops in Russia, the most common today are black poplar and hybrid willow, characterized by annual growth of 2.5-3.5 m and 1.5-4 m, respectively. According to the data shown in Table 1 and Figure 3, the maximum height is characteristic of pine, a widespread tree crop in Russian forests, but the annual growth in the first years after planting, as well as in other conifers, is extremely low. It is known that the phase of active growth in conifers begins only 6-7 years after planting

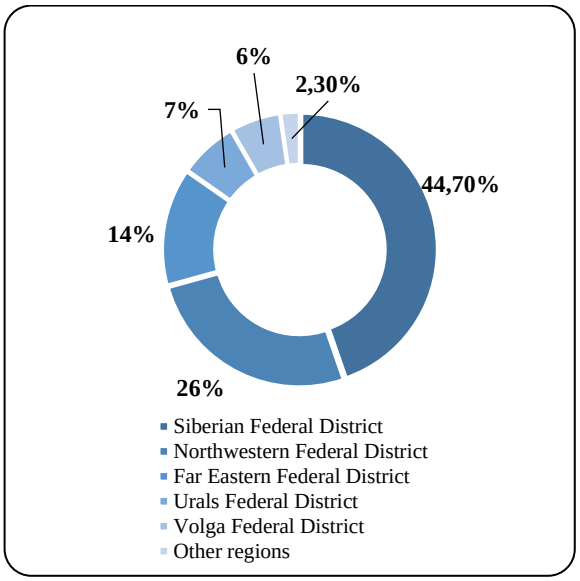

Figure 2: Share of sawn timber exports by constituent entities of the Russian Federation.

Table 1: Comparative table of increments and maximum height of tree crops.

Species	Annual growth in height	Height of three-year old tree	Maximum height of an adult tree
Paulownia	3-5 m	10,5-15,5 m	15-28 m
Hybrid willow	1,5-4 m	7,5-12 m	15-25 m
Black poplar	2,5-3,5 m	9-12 m	20-25 m
Larch	0,3-0,6 m	1-2 m	40-50 m
Pine	0,2-0,5 m	1-2 m	50-60 m
Spruce	0,2-0,4 m	0,6-1 m	40-50 m

Black poplar and hybrid Willow are also widely used as raw material for sawn timber and unlike conifers, they are characterized by higher growth rates in the first years. However, comparative analysis revealed that Pavlovnia shows higher performance in the context of annual growth and growth during the first three years, i.e. faster and more efficient biomass growth.

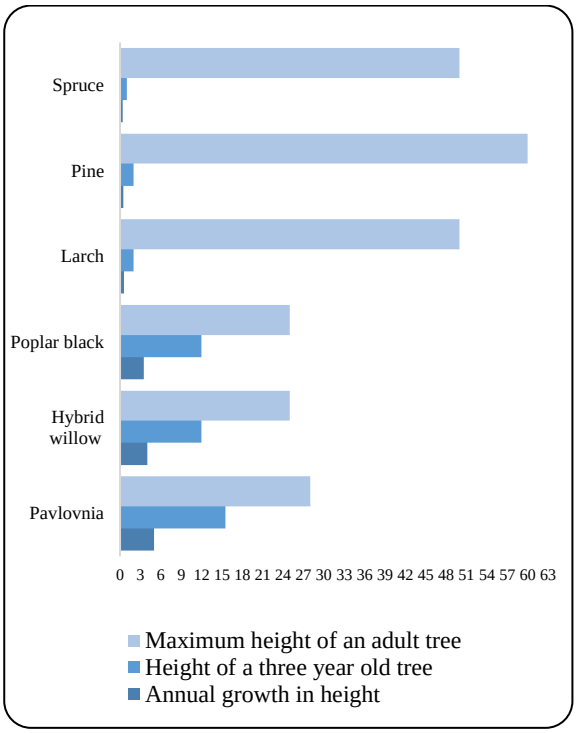

Figure 3: Comparative characteristics of different tree types.

The genus Paulownia (Paulownia) belongs to the family Paulowniaceae and is characterized by its unpretentiousness and high biomass yield. The growth rate is from 3 to 5 meters per year. All parts of the tree can be recycled and have economic value. Pavlovnia wood has low weight and density, so it is called aluminum wood, which does not rot, does not deform during drying, has high breaking strength, is easy to process, has high aesthetic characteristics, much the same as those of expensive and rare tropical species, wood such as balsa (Yavorov, 2015). Today, Pavlovnia wood is used to build yachts, produce furniture, musical instruments, snowboards, skis, window frames, doors, and finishing materials with a characteristic texture. The leaves of this tree can reach 70-80 cm in diameter and are characterized by high protein content and lack of bitterness, which makes them a valuable fodder resource for farm animals. All other parts of the tree can be processed into fuel pellets, which are a sustainable and renewable biofuel that can compete with traditional hydrocarbons. With a low concentration of sulphur, nitrogen and ash in its composition, Pavlovnia produces only half a kilogram of ash when burning 280 kilograms of wood, which corresponds to about 1 cubic meter, and 2 kilograms of pellets can be equivalent to 1 liter of diesel fuel.

The application area of Pavlovnia is quite wide, which increases the scalability of the business (Fig. 4).

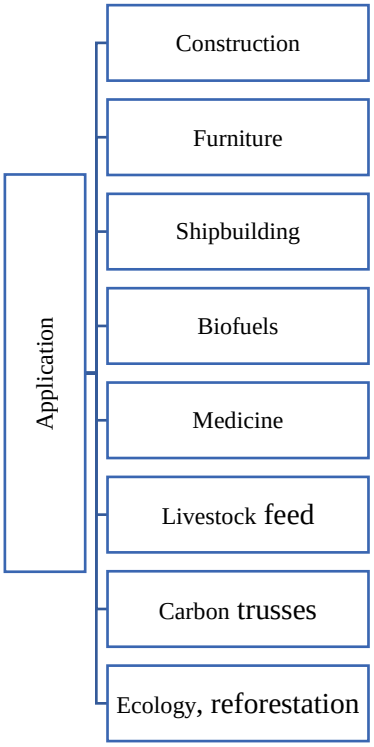

Figure 4: Applications of Pavlovnia.

In the context of the climate agenda and global decarbonization policies, Pavlovnia could be a promising crop for the formation of carbon farms, whose function is to absorb significant amounts of carbon dioxide. Pavlovnia leaves reach 70 centimeters in diameter and each tree can absorb 22 kilograms of carbon dioxide and produce 6 kilograms of oxygen. In addition, Pavlovnia can be used as an effective tool for phytoremediation, i.e. purification of soil and groundwater from a number of toxic elements such as mercury and arsenic.

Why will this product be relevant in the market? First of all, according to the strategy until 2030, wooden house building will be among the top 5 most popular areas. In addition, the Ministry of Industry and Trade has implemented a special social program to stimulate demand for wooden houses. The demand for board products and plywood is also forecast to increase.

In modern times, both ordinary people and enterprises try to pay great attention to environmental issues. It can be assumed that, according to this trend, packaging and bags made from wood products, biofuels made from wood pellets, as well as furniture and other household goods made from environmentally friendly wood will be especially relevant. The data in Table 2 confirms that at the state level the trend of increasing the production of wood products is being established, which means that it will be necessary to increase the production of quality wood.

Table 2: Dynamics of growth rates of production of types of timber industry products (forecast).

Type of FSC products	Average value for the period				
	2018	2019 - 2024	2025 - 2030	2031 - 2036	2036 to 2018
Unprocessed timber	1,9	1,1	1,0	0,9	20,0
Wood processing and wood products	5,1	2,4	1,4	1,4	35,9
Processed timber	4,3	2,4	2,0	1,8	28,3
Paper and paper products	6,8	3,6	3,8	3,8	93,9

Let's conduct a SWOT analysis to evaluate the strengths and weaknesses of the new product - Pavlovnia wood in the market.

Table 3: SWOT analysis of the fast growing trees project.

Strengths	***Weaknesses***
1. Better quality products, as a fast-growing tree is not subject to pests and rotting processes; 2. Regeneration of the tree, which reduces the cost of buying seedlings; 3. Short payback period compared to growing “classic trees”; 4. Creation of a replenishable natural resource; 5. Contributing to the changing economics of the country's timber industry;	1. Unknown product on the timber industry market, consumers will have to be educated, the product will have to be presented, which will be associated with high advertising and promotion costs; 2. Availability of an alternative product - wood and its derivatives from wild-growing trees, which is associated with difficulty in establishing relations with the main consumers and investors; 3. Logistics service, as mostly wood processing plants are often located in remote parts of our country; 4. Personnel problem - also related to the remoteness of production; 5. Risk of buying low-quality seedlings of fast-growing trees, as there are

	few seedling producers in Russia at the moment, as well as death of small trees due to climatic and other factors;
Opportunitie	***Threats***
1. Emergence of new markets for timber and its derivatives due to sanctions; 2. Foreign companies leaving the Russian timber market; 3. Development of technologies in bioengineering, which allows developing the market for biofuels from fast-growing trees;	1. The emergence of competitors using the same technology of fast-growing trees, as this niche in the market is not yet heavily occupied, which allows companies to freely enter the market and copy others' experience;

3 CONCLUSIONS

As a result of the analysis, the authors highlighted a number of unsolved problems in the timber processing industry:

1. Low timber removal from 1 hectare. This indicator is the lowest in the world, which makes the forest industry unattractive for investors, and logging in general inefficient;

2. Low efficiency of reforestation, which entails the problem of raw material shortage and high costs of forest development;

3. Low investment attractiveness of the timber industry due to the long turnover of funds, namely the growth period of trees, financial support is mainly provided only through government programs, which is reflected in the slow modernization of production and lagging behind in terms of technology.

However, at the state level the positive dynamics of the Russian LPC development is being laid down, namely the growth of the LPC share in the country's GDP, the growth of demand for sawn timber. The growing demand for wood products will stimulate modernization and expansion of existing production facilities, as well as the launch of new ones.

Pavlovnia is a promising energy fast growing tree crop carrying significant economic value. In the context of the global climate agenda, the rapid growth of the world's population, the energy crisis, the transition to a circular economy and the implementation of sustainable development strategies and concepts, major economic sectors are in the process of global transformation. Given the high carbon dioxide absorption capacity of Pavlovnia leaves, the crop can be considered as a high yielding species in the formation of carbon farms to offset the carbon footprint for organizations with an unmitigated carbon footprint, and its wood will be a quality base for the production of various wood products.

Having gained acceptance as a biofuel, the production of pellets from Pavlovnia, with its low cost and high energy efficiency, also carries high economic and social potential. As an additional, but possible, direction for economic benefits, large-scale plantations of Paulownia can be considered as a honey crop.

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