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Economic and qualimetric assessment of pine and spruce species in the Vologda Oblast

The Vologda Oblast is among the wooded regions of Russia. Wood requirements of our region, neighboring territories and other countries have been covered for many decades due to the intensive exploitation of forests. At present, the Vologda Oblast that increases production volumes is a leader in wood felling and processing. Intensive forest exploitation has deteriorated the quality and species of wood and reduced the share of valuable coniferous plantations. It is possible to solve these problems due to growing economically valuable species of wood in the logged areas. Economic and qualimetric analysis of pine and spruce species in the Vologda Oblast proves that it is reasonable to grow spruce species in the southern taiga subzone in order to produce pulp wood. This will increase the pulpwood productivity of forest plantations and efficiency of timber production in the region.

Economic and qualimetric assessment, forestry species, cellulose, wood, forest cultivation, pulp and paper industry.



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The Vologda Oblast has been famous for its forest resources for a long time. Vologda timber was shipped to England under Ivan the Terrible; it was used to build the Russian

navy under Peter the First. The Vologda Oblast with three-quarters of its territory covered with forest was called Siberia near Moscow [5].

Nowadays, the Vologda Oblast that increases production volumes is a leader in wood felling and processing. According to the Oblast's Forestry Department, wood felling increased by 3.4% for 2011 (in comparison with 2010), the production of timber increased by 10.2%, plywood – by 6.3%, wood-particle board – by 21.1%, fibreboards – by 10.1%, factory-built wooden houses – by 14.8%, cellulose – by 7.5%, paper – by 5.9%, paperboard – by 19.2%. Twelve priority investment projects with the total investment of more than 10.0 billion rubles are being implemented in the region.

Wood and paper products are exported to over 50 countries worldwide. According to the press service of the Vologda Customs, regional timber companies exported wood products to the amount of 172.6 million dollars in 2010 and 203.9 million dollars in 2011. The main types of exported products are plywood, saw timber, wood chips, fuel wood briquettes, joinery products, paper, chipboard, match-wood. In summary it should be noted that the regional forests were intensively exploited; logging volume is increasing today.

The intensive exploitation of forests has resulted in the wood quality and species deterioration and reduced the share of valuable coniferous plantations in the transport accessible and economically sound part of the forest fund. This important issue is studied in the works of a number of researchers [2, 7], and the employees of forestry enterprises that operate in the territory of the Vologda Oblast touch on this question (JSC Holding Company "Vologda Timber Merchants", CJSC "Investlesprom", JSC "Vologdalesprom Corporation", etc.).

It is possible to solve these problems due to sowing or planting of wood species in the logged areas. Experience shows that science-based selection and the adherence to forest growing technology allow us to form high-yield plantations of economically valuable coniferous species (pine and spruce). A retrospective analysis of literature shows that silvicultural

theory and practice, as well as growing pine and spruce plantations in the area of more than 0.3 million hectares are wide-spread in the region.

The cultivation of forest species should be based on profound theoretical and validated knowledge of the growth and development of woody plants in the logged areas.

This article deals with the problem of priority selection of wood species for the cultivation of pulpwood to meet the needs of pulp and paper industry in the scope of economic and qualimetric analysis. The fundamental principles of economic and qualimetric assessment of forest plantations are laid by O.I. Poluboyarinov and R.B. Fedorov [6]. In this case the problems of timber quality (qualimetry) are in the limelight. It is very important in the economic substantiation to consider the fact that it is not the cost of wood that is assessed, but the cost of the final product (cellulose), obtained from one hectare of forest area.

It should be noted that, historically, spruce was the main wood species for the pulp and paper industry. It is characterized by the slight gumminess of wood. This feature has a positive impact on the process of pulping and the quality of cellulose. However, a significant share of companies consuming spruce wood predetermines a shortage of raw wood that has recently caused the reduction of sulfite spruce pulping and the implementation of sulfate spruce and pine pulping. The pine, as opposed to the spruce, has a higher density of wood; this feature allows the producers to increase the yield of pulp from a cubic meter of raw wood. These wood species take priority when creating forest plantations in the Vologda Oblast. The analysis of the status and development of the pulp and paper industry proves that pine and spruce remain the main sources of raw wood for pulp production.

Here are the results obtained due to the monitoring of 48-year-old pines and spruces in the Vologda Oblast (southern taiga subzone).

The species are created in the similar conditions according to the same technology and at the same level of investment in their production. The seedlings were planted in the logged areas. Three thousand trees were planted per a hectare. There was no care for pines and spruces before.

The calculation of the yield of stem wood per a unit of forest area (reserve, m³/ha) was made on the base of methodological approaches that were written by N.P. Anuchin [1] and N.N. Sokolov [8]. The results showed the predominance of spruce reserves over pine at the time of study (392 m³/ha vs. 325 m³/ha).

The determination of potential raw wood yield for the pulp and paper industry (pulpwood), performed with the use of forest valuation data [4], also proves the superiority of spruce index by 50 cubic meters per one hectare of forest area (*tab. 1*).

The pulpwood productivity has been calculated for pine and spruce species. It is a rate of possible cellulose yield (tons) from the total amount of pulpwood growing in the area of one hectare. The calculation was based on the values of qualimetric indicator – pine and spruce density.

The formula for calculating the productivity of pulpwood is as follows:

$$M_p = Y/R, \quad (1)$$

Y – pulpwood yield, m³/ha;

R – wood consumption rate per one ton of produced cellulose, m³/t.

The wood consumption rate per one ton of pulped cellulose has been calculated on the base of the recommendations of L.N. Erofejev [3]:

$$R = \frac{880}{D_{base} P} \times \frac{100}{C}, \quad (2)$$

880 – the content of absolutely dry matter in one ton of raw wood with the humidity rate of 12%, kg/t;

D_{base} – basic wood density, kg/m³;

P – pulp yield, % of wood that is loaded into the boiler;

C – the coefficient of effective technological wood processing, the share in unbarked wood.

Sulfate pulp has been chosen as a final product in the calculations because it is the most important and widespread type of semi-fibrous pulp. The yield of sulfate pulp in pulping (P , %) has been adopted on the basis of published data [3, 6]: 45.04 – for pine, 49.04 – for spruce.

The coefficient of effective technological wood processing (C) has been calculated by multiplying the coefficients of technological wood yield for the individual production stages of its preparation as follows:

$$C = C_s \times C_b \times C_{c.s.}, \quad (3)$$

C_s – coefficient of wood yield when sawing;

C_b – coefficient of wood yield when barking;

$C_{c.s.}$ – coefficient of wood yield when cutting, disintegration and wood chips sorting.

$$C_{s,b,c.s.} = \frac{100 - P_{s,b,c.s.}}{100}, \quad (4)$$

P_s – percentage of wood loss and waste when sawing (it is excluded from the calculation due to supplying the pulp and paper industry with raw materials of required size);

Table 1. Forest density and pulpwood yield of pine and spruce species

Cultivated forest species	Cultivated forest density, m ³ /ha	Pulpwood yield	
		%	m ³ /ha
Pine	325	86	280
Spruce	392	84	330

Table 2. Sulfate pulp costing per one hectare of pine and spruce forest area

Forest species	Pulp yield, t/ha	Market price for one ton of cellulose, rub.	Volume of production per one hectare, thsd. rub.
Pine	48.4	17350	839.74
Spruce	58.9		1021.92

P_b – percentage of wood loss and waste when barking (1,2%);

$P_{c.s.}$ – percentage of wood loss and waste when cutting, disintegration and wood chips sorting. (6,0%).

The percentages of wood loss and waste P_b , $P_{c.s.}$ have been determined on the basis of the data published by L.N. Erofeyev [3].

These calculations prove that it is possible to produce 48.4 tons of pulp per one hectare of pine plantations and 58.9 tons per one hectare of spruce plantations. Thus, the spruce pulpwood productivity is 1.2 times higher than the pine pulpwood productivity.

Economic calculation has been carried out on the basis of market prices for market cellulose in 2011 accounting the potential pulp yield per one hectare of forest (*tab. 2*).

The calculations allow us to judge the possibility to produce sulfate pulp to the total amount of 839.74 thousand rubles from the

pulpwood per one hectare of pine plantations and to the sum of 1021.92 thousand rubles per one hectare of spruce forest areas. Thus, other conditions being equal, semi-finished products (sulfate pulp) that are produced from the spruce wood covering one hectare will cost by 20% more than the pulp produced from pine.

In conclusion, it is necessary to note that spruce wood is characterized by a relatively homogeneous structure, which has a positive effect on the process of pulp production and its quality. It should be also considered that spruce wood is not as resiniferous as pine wood. This fact prioritizes the use of spruce in pulp production. All this allows us to recommend spruce for the target pulpwood growing in the southern taiga subzone of the Vologda Oblast. This approach will improve the pulpwood productivity of forest plantations and thereby enhance the effectiveness of silvicultural production in the region.

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