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FOREST REGENERATION IN BLACK ALDER FORESTS IN BELARUS

In the forest fund Belarus alder forests occupy 694.5 thousand hectares, which is 8.6% of the forested area. Among black alder forests we can distinguish primary and secondary ones. Primary black alder stands grow in hydromorphic peat-bog soils and secondary ones – in sod-podzolic automorphic and semi-hydromorphic soils where other species can grow (pine, spruce, oak).

Cutting areas of primary black alder forests must be left for natural regeneration. Clear cutting sites of secondary black alder forest plantations are advisable to create pine plantations being the most productive ones. Depending on site conditions, annual economic impact of this operation ranges from 1.4 to 2.6 million rubles/hectare, and forest productivity increases by 6–7 times. Establishment of forest plantations of black alder is not recommended, since annual loss of forest amounts to about 3 million rubles/hectare.

Introduction. Forest regeneration can be natural or man-made. Natural regeneration is divided into seed and coppice. Man-made regeneration or reforestation can be carried out by promoting natural regeneration or forest planting.

It is a priority task of foresters to increase forest productivity. This task requires formation of high-productive forest stands maximally adapted to growing conditions. Productivity and species composition of forests largely depend on reforestation by planting. Man-made forest stands are known to be superior to the natural ones [1]. This superiority largely depends on matching the species composition of forest plantations with their growing conditions and is subject to the equal distribution of trees across the area and to the increased density in terms of the final felling age.

Main part. Black alder forests occupy 694.5 thousand ha of the total forest fund of Belarus thus covering 8.6% of its forested area [2]. The black alder forest association comprises nine types of forest: wood-sorrel, goutweed, nettle, iris, meadowsweet, bog-ferny, sedge and willow [3]. The black alder forests are divided into secondary and primary.

The secondary forests include stands of wood-sorrel, goutweed, nettle and ferny types. They grow in sod-podzolic, automorphic and semihydromorphic soils where main forest forming species can develop (pine, spruce, oak). According to the forest-typological tables [3] secondary black alder forests are characterized by increased productivity up to growth classes I and Ia.

According to the classification of forest soils [4] automorphic soils are those sod-podzolic soils of upland areas where forest stands get moisture from precipitation. Semihydromorphic soils are sod-podzolic soils with organic horizon (forest floor) up to 15 cm where forest stands get moisture from underground water and atmospheric moistening. Hydromorphic soils are peat-bog soils forming under excessive moistening with organic horizon of over 15 cm.

Primary black alder forests grow in peat-bog soils under excessive moistening. Having said that the black alder is a hydrophyte, it tends to plant on microelevations (hillocks). Due to excessive moisture black alder forests are characterized by reduced productivity (growth classes IV-II). Under such conditions other wood species (pine, spruce, oak) are not able to form forest stands.

The PhD thesis [2] dwells upon the study of natural and man-made black alder forests of growth classes Ia-Ib, rarely I. Unfortunately the thesis doesn't cite the classification of forest soils and doesn't give any data on groundwater depth which could be useful for classifying secondary and primary types. Therefore the growth classes (bonitets) make us conclude that the studied black alder forests are secondary ones.

By scoring we define [4] that a normal-growing pine stand of the main felling age of growth class Ib is assessed as100, a spruce stabd as 89 and black alder stand as 28. The same stands of growth class Ia are assessed as 92, 80 and 25 scores respectively, those of growth class I are assessed as 79, 66, 21 respectively, the score of oak stand being 73. It should be taken into consideration that oak stands under similar conditions show productivity which is ranked 1-2 growth classes lower than those pine, spruce and black alder stands. For instance, under the best conditions oak stands develop to growth class I while others amount to growth class Ib.

According to forest taxes of 2012, one score of forest stands assessment was equal to 10.3 BYR. Keeping in mind this amount, we can roughly calculate stumpage value of wood. Annual stumpage value of pine stands makes 1.03 million BYR per 1 ha (100·10.3), that of spruce stands is 916.7 (89·10.3), that of oak stands is 751.9 (73·10.3), that of black alder stands is 288.4 (28·10.3) thousand BYR.

Therefore the scoring assessment makes us conclude that pine stands are the most productive ones. Spruce and oak stands show a slightly lower productivity and the productivity of black alder stands is the lowest. This calculation method can be used for evaluating the efficiency of different forestry operations.

At present the standing forest taxes are governed by market prices. Thereby the wood price is dependent not only on its quality but on the quantity of the marketed wood. For example, for the lots of 100 and 1000 m^3 the price of the former can be higher.

We have calculated the stumpage value of normal-growing stands of black alder, pine, spruce and oak at their main felling age (black alder – 50 years, pine and spruce – 80 years, oak – 100 years) by taxes of 2012 (Resolution of the Council of Ministers of the Republic of Belarus No. 1787 from 30.12.2011). The results obtained are presented in Table 1.

The total average increment and merchantability were determined by stand development tables and stand assortment tables [5]. It was assumed that pine and spruce stands are of merchantability class I, black alder and oak stands have merchantability class II.

The economic effect was calculated in accordance with recommended practice [6]. By multiplying the stumpage value of total average wood increment by the felling age we obtained the stumpage value of wood of main felling age (Table 2). To present values of asynchronical money flows (costs of forest planting and evaluation of the wood stock of main felling age) by a certain point of time, a discount coefficient (C_d) is applied which is calculated according to the formula below:

$$C_d = \frac{1}{(1+E)^t},$$

where E is a discount rate (in forestry it is accepted within 0.01-0.05); t is felling age.

The discount rate being 0.03 we have obtained the following discount coefficients: for black alder – 0.23; for pine and spruce – 0.09; for oak – 0.05.

By multiplying the estimated wood stock of the main felling age by the discount coefficient we have obtained the presented stock estimation.

Forest planting is expensive but as it is a single operation over the cutting cycle and is critical to the productivity of the new stands, this stage of forest growing should be given careful attention. Cost account and economic effect of forest growing are essential to forest growing.

The cost of forest plantations depends on the growing conditions and technology applied when planting the forest. The below mentioned technology is applied to forest planting.

Strip cultivation is done by means of soil loosening with a rotary cultivator because when trench planting the seedlings develop their root system towards interfurrow tracts. This development of the root system reduces the trees resistance to windfall afterwards.

The seedlings are delivered by a truck to the planting area and are then heeled in. The planting of seedlings is done manually using the Kolesov's planting iron since tree planting machines cannot be used because of stumps.

One-year seedlings of pine and alder and two-year seedlings of spruce are planted. Oak plantations are created by dropping acorns as seedlings usually have their tap root cut and stands are subject to windfall later on.

Additional planting is done in the second and the third subsequent years, the quantity of seedlings making up 20% of the planting holes. This operation should be performed most carefully as poor additional planting can form stands of reduced density and therefore low productivity.

Table 1

Stumpage value of normal-growing stands at the main felling age

Growth class	Total average increment, m^3/ha	Stumpage value of wood, thousand BYR				
		large	medium	small	fuelwood	total
Black alder forests (50 years)						
Ib	13.5	119.52	100.85	5.39	1.88	227.64
Ia	12.0	55.16	106.50	9.71	1.81	173.18
I	10.1	46.32	89.55	8.22	1.53	145.66
Pine forests (80 years)						
Ib	12.5	615.65	277.47	10.40	0.22	903.74
Ia	11.5	492.52	297.82	9.58	0.20	800.12
I	9.9	265.53	323.72	16.14	0.23	605.62
Spruce forests (80 years)						
Ib	12.6	530.32	258.80	15.15	0.20	804.47
Ia	11.2	450.81	205.85	24.29	0.18	681.13
I	9.3	252.53	246.38	20.20	0.15	519.26
Oak forests (100 years)						
I	7.3	1377.0	117.14	4.79	1.66	1500.59

Table 2

Economic efficiency of forest stands regeneration, thousand BYR

Growth class	Stumpage wood value at the main felling age	Estimated wood stock	Costs of forest planting	Economic effect
Black alder forests				
Ib	11 382.0	2617.9	3870.3	–1252.4
Ia	8659.0	1991.6	3906.0	–1914.4
I	7283.0	1675.1	2986.0	–1310.9
Pine forests				
Ib	72 299.2	6506.9	3870.3	2636.6
Ia	64 009.6	5760.9	3906.0	1854.9
I	48 449.6	4360.5	2986.0	1374.5
Spruce forests				
Ib	64 357.6	5792.2	4063.8	1728.4
Ia	54 490.4	4904.1	4101.3	802.8
I	41 540.8	3738.7	3135.3	603.4
Oak forests				
I	150 059.0	7503.0	2836.7	4666.3

Tending operations are planned by machine mowing of grass and by restoration of soft-wooded broadleaved species. There are two tending operations for growth class I and three operations for growth classes Ia and Ib.

The location and density of forest plantations is determined by growing conditions [4].

To calculate costs of forest planting we applied current tariffs and rates. Apart from direct costs, the forest planting costs include general production costs which on average make up 16% of direct costs. As a result it turned out that the production costs of planting 1 ha of stands varies from 2836.7 (oak) to 4101.3 (spruce, growth class Ia) thousand BYR.

The reduced costs of oak planting can be explained by acorns dropping, the increased costs of spruce planting result from using two-year seedlings. The costs of forest planting under growth class Ib conditions are lower than those of growth class Ib because of the lower density of stands.

The economic effect of forest restoration is equal to difference between the presented wood stock estimation and the costs of forest planting. The costs of black alder planting exceed the presented wood stock estimation that makes it an unprofitable forestry operation.

Pine plantations demonstrate maximum economic effect varying from 1374.7 to 2636.6 thousand BYR depending on growing conditions. The same figures for spruce plantations are about half as that.

Increased economic effect of oak planting results from the high stumpage value of oak wood established in 2012 on the basis of market prices. In the previous years the stumpage values of oak wood were 1.3 times higher than those of pine wood coming up to be 2.3 times higher in 2012. Due to this possible variation of wood stumpage value it is advisable to apply the above scoring of stands when planning forestry operations.

At present black alder plantations are annually created on the area of 200 ha [2]. At the same time the loss equals to the sum total of negative effect of alder planting and positive effect of pine planting. This value varies from 2685.4 (growth class I) to 3889.0 thousand BYR (growth class Ib). Therefore the annual loss in the forestry sector makes up about 600 million BYR (3.0 mln.·200 ha), this value amounting to 30.0 billion BYR over a cutting cycle (50 years).

Felling sites of secondary black alder forests may be left for natural reforestation. Supposing the black alder stands will have a reduced density and of coppice origin. Let's assume the presented wood stock estimation of the natural stands of the main felling age will be half as much as the estimation of the man-made stands.

This value for the stands of growth class I will equal to 837.6, for those of growth class Ia – 995.8 and for those of growth class Ib – 1309.0 thousand BYR. If we compare these values with the economic effect, the benefits of pine plantations become obvious. With fostering natural reforestation on the felling sites black alder plantation will appear on them. As the costs of planting are relatively low, a small economic effect can be observed but it will be considerably lower compared to pine plantations.

Conclusion. It proves reasonable to plant pine stands on the felling sites of black alder forests with automorphic and semihydromorphic soils. Besides, the forest productivity is 6-7 times as high as that of black alder forests. Black alder plantations are unprofitable for the forestry sector. Felling sites of primary black alder forests are to be left for natural reforestation.

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