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THE TECHNICAL AND ECONOMIC MATURITY OF SPRUCE STANDS

Multipurpose use of forests determines the need of the organization comprehensive forestry and reasonable, continuous, inexhaustible, rational and balanced forest harvesting. Standard of forest cutting is cutting age. The most important factor influencing the cutting age is the maturity age. In our article the analysis possible losses from late delivery of stands in the cutting on the basis of the technical and economic maturity. The age of this maturity determined by some growth tables of spruce stands on site index. After calculation the average increase of large and medium timber, but also the average increase of the cost of the wood volume is defined age of maximum the both increase using the methods at smoothing the empirical dependences. To calculate a possible loss of forest harvesting was used the growth tables of modal stands of V. F. Baginskiy. The use of modal tables in calculation will correspond to the real state of forest fund. As a result of calculation we can conclusion those minimum losses in exploitable forests for the most beneficial growing conditions occur in the beginning of the age of maturity, with the increase the site index increases the cutting age with minimum losses, which can reach a maturity senior class. The economic maturity begins about 10 years later than technical maturity. This is due to the fact that the age of economic maturity affects the quality of the timber. The use of these materials will evaluate the plan of cutting and minimize losses in his planning.

Key words: forest harvesting, technical maturity, economic maturity, growth tables, losses, cutting plan.

Introduction. Properly organized forestry should be continuous, non-depleting and rational. Only in this case it will be able to satisfy the annual demand for wood.

In Belarus the standard of forest cutting is the cutting age of the tree stand, at which it can normally come to the end-use to meet the objectives of the economy. Currently, the term “cutting age” refers to the minimum age at which you can cut down a tree stand. The most important factor affecting the amount of cutting age is forest maturity. Many biological and economic factors affect the age maturity, and hence the cutting age [1, 2].

Problem of determining the cutting ages constantly interested forestry specialists. This is due to the fact that the cutting age is one of the most important indicators, which determines the value of the allowable cut.

The maximum effect from the forest growing is observed when cutting crops come to felling at the age of their maturity which is the target of the management section. Deviations in either direction will inevitably lead to losses [3].

In forest management the following maturity classes are taken into account: natural, renewing, quantitative, technical, economic and special [1].

The aim of our work is to analyze the possible losses in volume and in value terms from the late delivery of spruce stands for felling on the basis of technical and economic maturity of the forest.

Technical maturity characterizes the age of the tree stand, in which it has the highest average increase by the basic assortment groups. The age of the maximum average increase in the value of wood, in

its turn, reflects the occurrence of forest economic maturity [1, 4].

Main part. To calculate the age of technical maturity and economic growth of forests the following tables of growth (TG) of spruce stands: normal stands of V. S. Miroshnikov and O. A. Trull (Option 1); modal stands of V. F. Baginsky (Option 2); normal stands of V. F. Baginsky, F. P. Moiseenko (Option 3) and normal stands of F. P. Moiseenko (Option 4) were used.

The calculation of the output of wood of various size categories of spruce stands was done on the bonitet class. The amount of output of large, medium and small-scale timber and firewood for each TG (by class 1 of marketability) was obtained. On the basis of the existing forest taxes (calculations were made on the 1st category of taxes) the cost of each category of timber size was calculated. Currently, the cost of large timber by the the 1st category of taxes is 173,100 rubles, the medium – 100,000 rubles, small – 44,500 rubles and firewood – 1,000 rubles.

With the help of a technique for smoothing the empirical relationships [5] smoothed values of both increases in age were obtained. The values of the average growth of the large and medium wood, the average increase in value of the total stock at the age of 81 and 120 years, as well as the maximum value of data growth and the age of maximum growth for each table were brought to a common form (Tables 1 and 2).

The Tables show that the value of increments in the tables of growth of normal forest stands are higher than the TG of the modal stands. However,

the age of achieving a maximum average increase of large and medium wood and the average increase in the value of wood in the tables of growth of normal stands of Miroshnikov, Trull and modal stands of Baginsky is comparable. In addition, with Baginsky's TG, unlike Miroshnikov's and Trull's we can calculate possible losses in cutting of spruce stands after 120 years (what in the first

group of forests corresponds to the senior class of maturity).

Using tables of growth of modal stands in the calculations will correspond to the real state of the forest fund. Therefore, to calculate the losses from delays in the collection of the stand we are going to use the table of growth of modal stands by site class of V. F. Baginsky.

Table 1

The average increase in large and medium wood according to the tables of growth of various authors

Average increase in large and medium wood, m ³ /year		Site class					
		I ^a	I	II	III	IV	V
Option 1	at the age of 81	6.63	5.22	3.88	2.64	1.65	–
	at the age of 120	5.52	4.58	3.68	2.76	1.93	–
	maximum average increase	6.73	5.22	3.96	2.84	1.96	–
	maximum achieving age	72	82	92	102	107	–
Option 2	at the age of 81	4.04	3.28	2.57	1.66	0.83	–
	at the age of 120	3.19	2.76	2.25	1.66	1.07	–
	maximum average increase	4.13	3.28	2.59	1.74	1.07	–
	maximum achieving age	70	79	86	98	116	–
Option 3	at the age of 81	6.14	4.92	3.65	2.17	1.16	0.67
	at the age of 120	5.63	4.81	3.95	2.80	1.70	0.71
	maximum average increase	6.15	5.05	4.02	2.80	1.73	0.72
	maximum achieving age	84	95	105	120	130	140
Option 4	at the age of 81	7.50	5.69	4.01	2.37	1.16	0.67
	at the age of 120	6.68	5.46	4.33	3.01	1.75	0.72
	maximum average increase	7.51	5.79	4.40	3.02	1.81	0.72
	maximum achieving age	77	92	106	126	140	120

Table 2

The average increase in the stock of wood for the tables of the growth of various authors

The average increase in cost of wood, mln. roubles/year		Site class					
		I ^a	I	II	III	IV	V
Option 1	at the age of 81	0.99	0.74	0.53	0.35	0.23	–
	at the age of 120	0.89	0.71	0.54	0.39	0.26	–
	maximum average increase	1.0	0.76	0.56	0.39	0.26	–
	maximum achieving age	84	93	102	107	109	–
Option 2	at the age of 81	0.61	0.46	0.35	0.22	0.12	–
	at the age of 120	0.51	0.43	0.33	0.24	0.15	–
	maximum average increase	0.61	0.47	0.36	0.24	0.15	–
	maximum achieving age	80	90	94	107	126	–
Option 3	at the age of 81	0.85	0.65	0.47	0.30	0.18	0.10
	at the age of 120	0.86	0.71	0.56	0.38	0.23	0.10
	maximum average increase	0.89	0.72	0.56	0.38	0.23	0.11
	maximum achieving age	99	109	120	129	130	110
Option 4	at the age of 81	1.10	0.81	0.55	0.32	0.17	0.10
	at the age of 120	1.05	0.84	0.65	0.43	0.24	0.11
	maximum average increase	1.11	0.86	0.65	0.44	0.25	0.11
	maximum achieving age	91	102	114	131	140	124

As a result, using V. F. Baginsky's TG of modal stands volume losses were calculated (Tables 3 and 4) on the 5 years beginning with the age of 70 years. Losses were calculated by the following formula [3, 6]:

$$L = A_f (P^{\text{average, max}} - P^{\text{average, } A_f}),$$

where A_f – cutting age of the stand, year;
 $P^{\text{average, max}}$ – average increase in large and medium

wood or maximum average increase in cost of wood m^3/year (mln. roubles/year); $P^{\text{average, } A_f}$ – average increase in large and medium wood or average increase in cost of wood at the age of cutting m^3/year (mln. roubles/year).

Analyzing Tables 3 and 4, we can conclude that the age of technical maturity of pine is in the range from 70 to 116 years, which is about 10 years earlier than the age of the average maximum increase in the value of wood (economic ripeness).

Table 3

The volume of losses of large and medium timber at different ages according to site class felling

Age, years	Quantitative loss of wood according to site class, m^3				
	I ^a	I	II	III	IV
70	–	5	13	21	25
75	1	2	6	14	23
80	6	–	2	7	20
85	14	2	–	3	16
90	23	5	1	1	12
95	35	10	4	–	8
100	48	18	8	–	4
105	62	27	15	1	2
110	77	39	22	2	–
115	94	51	31	6	–
120	113	62	41	10	–
125	131	78	51	15	1
130	152	92	64	21	3
135	174	108	76	27	4
140	199	125	88	35	7

Table 4

The amount of losses in the cost of wood stock at different ages according to site class felling

Age, years	Cost losses of timber by site class, mln. roubles				
	I ^a	I	II	III	IV
70	0.91	2.45	2.94	3.08	2.87
75	0.23	1.43	1.95	2.48	2.70
80	–	0.64	1.12	1.92	2.48
85	0.26	0.17	0.51	1.36	2.21
90	0.99	–	0.09	0.90	1.89
95	2.00	0.19	–	0.48	1.52
100	3.40	0.70	0.20	0.20	1.30
105	5.04	1.37	0.74	0.11	1.16
110	7.04	2.42	1.43	0.11	0.99
115	9.32	3.68	2.42	0.23	0.58
120	12.00	5.16	3.48	0.60	0.24
125	15.00	6.75	4.50	1.00	–
130	18.07	8.58	5.59	1.56	0.13
135	21.06	10.67	6.89	2.43	0.68
140	23.80	13.02	8.68	3.22	1.54

To get the lowest losses of large and medium timber the felling in I^a–II site class is better to do at the beginning of the age of maturity (2nd group of forest). With a further increase in the value class cutting age should be increased by 10–15 years. For the first group of forests at I^a–III site class with minimal loss of target assortments cutting should be carried out at the beginning of the age of maturity (at least 101 year old), and for class IV – in 110–120 years.

If we consider the total loss of stock value, then for production forests at the beginning of the age of maturity minimal losses from untimely stands entering for the cutting are observed in I^a site class, and with increase of site class the age of cutting should be increased gradually, by about 10–20 years.

For the first group of forests similar trend can be seen, that in assessing the loss of large and medium timber. However, at the beginning of the age of maturity minimal losses are observed only in I^a–II quality class.

It is worth noting that the determining the cutting age for the first group of forests special social functions performed by them in a growing state were taken into account, and receiving the largest amount of wood in this group is not the most important goal of forest growing. Economic maturity includes an economic assessment of cultivated as-

sortments and is characterized by a higher age than technical, because the age of the economic maturity is significantly affected by the quality of wood [2].

Conclusion. Substantiation of the optimal age for harvesting various tree species is crucial.

The most significant maturity in our time is the technical maturity. All cutting ages in production forests are now determined based on technical maturity.

Minimal volumes of losses of large and medium timber in production forests at the beginning of the age of maturity are observed in spruce stands of I^a–II quality class. In III site class while minimizing losses cutting should be carried out in the period from 95 to 100 years, and in IV – from the middle of the senior class of maturity (110 years).

Cost losses of total stock of production forests in I^a site class will be minimal at the beginning of the age of maturity.

With the increase in site class, and, consequently, the deterioration of the conditions of growth, the cutting age, in which the minimum loss of value of the stock of wood will also be observed, will gradually increase by 5–10 years. The difference between classes III and IV will be about 20 years.

The use of these materials will allow to evaluate the plan of felling and to minimize losses in its drafting.

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