METHODICAL APPROACHES TO EVALUATION OF ASSORTMENT AND QUALITY STRUCTURE OF FOREST STANDS IN CONDUCTING OF SEVERANCE FELLINGS

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One of the methods for evaluation of assortment and quality structure of forest stands during taxation of cutting areas is presented. On the example of the stand allocated for severance felling, the principles of models of pine sampling and the procedure for determining of the assortment structure for standing wood are described.

Taxation of cutting areas, model trees, assortment and quality structure

Introduction. Study of issue of rational use of forest harvesting fund management is always characterized by a great relevance because the correct application of scientifically based methods for evaluation of assortment and quality structure (AQS) of forest stands makes it possible to increase economic efficiency and profitability of forestry. Most effective use of harvesting fund of forestry enterprises, including the rational harvesting of cutting areas and operational control of the output of various assortments, both in bulk and in money terms, allows to improve profitability by optimizing of economic regulation, use and reproduction of forest resources. In Ukraine a significant contribution to the study of this issue was made by O.V. Polyakov and M.A. Polyakov [8, 9, 10].

An analysis of the issue showed, that an important aspect of the economic efficiency of forestry enterprises improving is introduction of assortment timber accounting at enterprises. It means that at the stage of forest cutting area

allocation it is necessary to determine in addition to the total timber volume, divided into groups of thickness (large, medium and small) and by category (merchantable wood, fuelwood), also the presence of today liquid marketed assortments, with their distribution by grades of merchantable timber and names of firewood by purpose, as well as the most profitable diameter groups. After such assortment evaluation of standing wood it is necessary to carry out book keeping and set prices in the enterprise just for those timber groups by types and diameter sizes of that have been defined during taxation of cutting areas and stated in the appropriate form.

We should note, that the existing standards for the evaluation of assortment and quality structure it is difficult to use for stems distribution by size and quality categories due to discrepancy with standards. Also in these standards there is no data on thickness groups, names and characteristics of assortments that are in demand in today's economy [4].

For the economic analysis of enterprises activity and adaptive planning on the base of features of harvesting fund of a particular enterprise, it is necessary to improve methods of evaluation of AQS of forest stands.

Materials and methods. Our study carried out in forestry enterprises of Kharkiv region aimed in improving of methods of evaluation of assortment and quality structure of growing forest stands by using of modern technologies.

For assortment of forest stands various methods can be used: determination of assortment structure of individual trees, model trees, sample plots, assortment and yield tables. In production activities it is advisable to use two ways of assortment evaluation of standing wood – assortment by using data from the available assortment structure and assortment based on bucking of model trees [4].

Assortment evaluation by using of the available assortment structure on the base of accounting records of the results of rational bucking actually obtained during the previous period on specific cutting area that is a kind of sample plot. Data may be obtained from completed cutting areas both clear cuts and selective logging on forest plot, for thinning and other cuttings in similar forest stands by the main taxation peculiarities (species, age, average height and

diameter, type of site conditions). When applying this method the appropriate form is filled – a document for planning of assortments output for individual plot. It allows taking into account the effect on the assortment output characteristics of the stands: structure, prevailing site conditions and defects, and other specific features of single forestry unit.

Assortment evaluation by method of model trees is carried out by taking into account the distribution of trees by diameter classes and categories of technical quality. Selected models may bee felled and rationally bucked in accordance with specified assortment structure for timber harvested in current year for specific forestry enterprise, or measured by using of programme and instrumental complex Field-Map, that gives the possibility to measure model trees remotely and apply virtual bucking of models [12].

Classic method of model trees felling gives accurate results, which is very important in evaluation of the marketability of valuable species, especially in case of high-quality assortments, in forest stands with significant or hidden defectiveness. It also can be used for control of marketability evaluated by other methods. In accordance to the proposal of V.K. Zakharov [3] the method of average model, which is widely used to determine standing wood volume can also be used for evaluation of it assortment structure. Meanwhile, the average model should be selected by the steps or classes of thickness. Selected model trees by diameter and uniform quality categories should represent not only the average forest taxation attributes, but also the average quality characteristics of uniform quality groups of trees, selected at enumeration: merchantable, semi-merchantable and fuelwood, i.e. represent the average content of each of these categories. The author also notes in case of 12-15 models the difference in the output of basic assortments doesn't exceed ± 10%. Specified amount of models should be distributed by stages of thickness, proportionally to stem quantity in them.

Results. For determination of assortment and quality structure of main tree species in pine forest stands in allocation of cutting area for severance felling the following steps were proposed. During sampling of models it is necessary to consider trees distribution by stages of thickness and technical quality. The order

of evaluation and sampling in nature of trees of a particular category of technical quality does not affect the results of evaluation of assortment and quality structure of standing wood. Within each category of technical quality determination of the number of model trees by diameter classes should be carried out according to their share in the estimated number of models of the relevant category. Within each category of technical quality the order of models selection in nature and assigning them numbers does not affect the results of AQS of standing wood. It should be noted that the leading assortment, according to [13] on the cutting area should be roundwood with the length 4.0 m, as well as technological raw materials for processing length 4 m. Based on the content of the standards [2] and [3] merchantable trees with diameter (at breast height) 8 and 12 cm are not taken into account when evaluating the assortment structure, because roundwood of them are poles (100% of volume of merchantable small wood from cutting area), which has only II grade. Names and groups of thickness of timber are defined in Order of State Committee of Forest Management of Ukraine [7].

Later the new changed form of "Statements on enumeration of trees ..." was introduces in accordance with the Order of State Agency of Forest Resources of Ukraine [6]. Assuming that in future the form of statements can be changed to avoid future necessity of adaptation of this statements to calculate the number of sample trees, N.V. Lyubchich has developed the "universal" form of "Statements on calculation of model trees for evaluation of assortment and quality structure..."..

Based on the above, given the experience of evaluation of AQS of standing wood on the previous sample plots (cutting areas) and taking into account the necessity of determination of the standing stocks of all assortments in the context of the above-mentioned groups of thickness and grades [4] the following order of models selection (at the example of pine stand in Rubezhansky forestry unit allocated for severance felling) is proposed (Table. 1):

1. Statement of the calculation of model trees to evaluation of AQS of cutting area

$d_{1,3}$, cm	Models on categories of technical validity and thickness stages												Totally trees	Models		
	merchantable				semimerchantable				Fuelwood					By thickness stages		
	trees	%	N, pcs.		trees	%	N, pcs.		trees	%	N, pcs.			%	minimum amount	
8	–	–	–	–	–	–	–	–	14	–	–	–	14	–	–	–
12	–	–	–	–	–	–	–	–	11	–	–	–	11	–	–	–
16	51	27	1,6	2	6	11	0,2	–	71	43	2,2	2	128	29	3,8	4
20	84	44	2,6	3	25	45	0,9	1	46	28	1,4	1	155	36	4,7	5
24	40	21	1,3	1	20	36	0,7	1	28	17	0,9	1	88	20	2,6	3
28	15	8	0,5	1	5	9	0,2	–	20	12	0,6	1	40	9	1,2	1
32	1	–	–	–	–	–	–	–	12	7	0,4	–	13	3	0,4	–
36	1	–	–	–	–	–	–	–	3	–	–	–	4	1	–	–
40	–	–	–	–	–	–	–	–	6	–	–	–	6	1	–	–
44	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
48	–	–	–	–	–	–	–	–	2	–	–	–	2	–	–	–
52	–	–	–	–	–	–	–	–	–	–	–	–		–	–	–
56	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–
Bucked models:				7		*		2		*		5		*		*

We first determine (rounding values to integers) proportion of trees in each stage thickness, excluding trees of 8 - 12 cm, in total of others (462 pcs.) allocated trees. Then we set the amount of models for each degree of thickness, rounding obtained numbers to integers. Trees with diameters of 32-56 cm are not considered in evaluation of AQS as their share in the total number of trees with a diameter of 16-56 cm is small (0.4 models or less). Thus, in subsequent calculations appropriate trees with thickness of 16-28 cm will be used. Proportion of number of calculated trees of each thickness stage is calculated by dividing the number of trees of each stage thickness of each category technical quality on

the number of trees of appropriate category, rounded to integers. The share of the number of models of calculated trees of corresponding thickness degrees of each category technical quality is calculated by multiplying the proportion of number of calculated trees of each thickness stage of each category corresponding to the total number of models in each category with the following rounding obtained values to tenth. Number of models in terms of degrees of thickness of all categories of technical quality calculated by rounding. Thus, the number of models is: from fuelwood – five, semi-merchantable – two, merchantable - seven (Table. 2).

2. Distribution of model trees by diameter classes

№ Model	Diameter class	Category
1	20	merchantable
2	20	merchantable
3	24	merchantable
4	16	merchantable
5	28	merchantable
6	16	merchantable
7	16	Fuelwood
8	16	Fuelwood
9	20	merchantable
10	20	Fuelwood
11	20	Semi-merchantable
12	24	Semi-merchantable
13	24	Fuelwood
14	28	Fuelwood

Results of bucking of defined above models are input in statement (Table. 3).

3. Statement (Field) to evaluation of assortment and quality structure

№ model	d, cm	Category of technical quality	Roundwood: length – 4.0 m, diameter in cm.				
			Sawlog				poles
			14-18 cm		20-24 cm		6-13 cm
			II	III	II	III	II
1	20	merchantable	–	18	–	–	13;11;9
2	20	merchantable	16	18; 16	–	–	13
3	24	merchantable	18; 16	14	–	–	12: 8
4	16	merchantable	–	–	–	–	13;11;9;8
5	28	merchantable	18	16; 14	20	22	
6	16	merchantable	–	–	–	–	13;11;10; 7
7	16	merchantable	–	–	–	–	
8	16	fuelwood	–	–	–	–	–
9	20	merchantable	–	18; 14	–	–	13;11;8
10	20	fuelwood	–	–	–	–	–
11	20	Semi-merchantable	–	14	–	–	12; 10
12	24	Semi-merchantable	–	18; 16; 14	–	–	12
13	24	fuelwood	–	–	–	–	–
14	28	fuelwood	–	–	–	–	–

Continuation of table 3.

№ model	d, cm	Category of technical quality	Rowmaterials for processing, length. - 4.0 m, diameter – in cm		Fuelwood length 1m, diameter in cm
			4 cm and > on wood chips	14-18 cm	

1	20	merchantable	–	–	24(2m); 4(2m)
2	20	merchantable	9	–	12(2m); 11(2m);8
3	24	merchantable	–	–	4(2m)
4	16	merchantable	–	–	3(2m); 6(2m)
5	28	merchantable	–	–	13(2m); 11; 7(2m)
6	16	merchantable	–	–	5(2m); 4
7	16	merchantable	–	–	16(2m); 14(2m); 12(2m); 10(2m); 8(2m); 7(2m); 6(2m);3
8	16	fuelwood	–	–	16(2m); 14(2m); 13(2m); 11(2m); 8(2m); 7(2m); 5(2m);3
9	20	merchantable	–	–	7(2m); 5
10	20	fuelwood	–	–	20(2m); 18(2m); 14(2m); 12(2m); 10(2m); 10(2m); 8(2m);6(2m)
11	20	Semi-merchantable	–	16	10;8;6;4
12	24	Semi-merchantable	10	–	10; 7(2m)
13	24	fuelwood	10; 12	18; 16	24(2m); 22(2m); 6(2m)
14	28	fuelwood	–	–	14(2m); 12(2m); 10(2m)

Volumes of assortments estimated at the cutting area by categories and grades are given in the statement (Table. 4).

4. Statement (cameral) for evaluation of assortment and quality structure

№ model	d, cm	Category of technical quality	Roundwood (m^3) : length 4 m					
			Total	sawlog				poles
				14-18 cm		20-24cm		6-13 cm
				II	III	II	III	II
1	20	merchanta	0,24		0,09	–	–	0,14

		ble			5			
2	20	merchantable	0,38	0,095	0,22	–	–	0,062
3	24	merchantable	0,40	0,220	0,073	–	–	0,11
4	16	merchantable	0,17	–	–	–	–	0,17
5	28	merchantable	0,62	0,120	0,170	0,15	0,18	–
6	16	merchantable	0,17	–	–		0,17	–
7	16	fuelwood	-	–	–	–	–	–
8	16	fuelwood	-	–	–	–	–	–
9	20	merchantable	0,36		0,190		0,170	–
10	20	fuelwood	-	–	–	–	–	–
11	20	semimerchantable	0,163		0,073		0,090	–
12	24	semimerchantable	0,34		0,290		0,053	–
13	24	fuelwood	–	–	–	–	–	–
14	28	fuelwood	–	–	–	–	–	–
Total:		m^3	2,84	0,435	1,11	0,15	0,18	0,965
		%*	56,559	8,610	22,126	3,03	3,64	19,216
Total at cutting area, m^3								

Continuation of table 4

№ mod	d, cm	Category of technical quality	Rowmaterials for processing (m^3), length. 4 m				Fuelwooda ($м^3$), lemgth 1m and 2m	Total (m^3) marketable
			4 cm and > on	14-18 cm	20-24 cm	Total		

el			wood chips					
1	20	merchantable	–	–	–	–	0,01	0,25
2	20	merchantable	0,032	–	–	0,032	0,06	0,47
3	24	merchantable	–	–	–	–	0,004	0,404
4	16	merchantable	–	–	–	–	0,01	0,18
5	28	merchantable	–	–	–	–	0,05	0,67
6	16	merchantable	–	–	–	–	0,006	0,176
7	16	fuelwood	–	–	–	–	0,15	0,15
8	16	fuelwood	–	–	–	–	0,171	0,171
9	20	merchantable	–	–	–	–	0,01	0,37
10	20	fuelwood	–	–	–	–	0,29	0,29
11	20	Semi-merchantable	–	0,095	–	0,095	0,02	0,28
12	24	Semi-merchantable	0,037	–	–	0,037	0,02	0,40
13	24	fuelwood	0,09	0,22	–	0,31	0,23	0,54
14	28	fuelwood	0,095	–	0,51	0,61	0,08	0,69
Total:		m^3	m^3	0,32	0,51	1,08	1,11	5,03
		%*	5,0	6,4	10,1	21,5	22,1	100
Total at cutting area, $m^{3\epsilon}$			10	13	21	44	46	149

Note: during bucking of model tree No. 5 with diameter "28 cm" no any large-sized assortment was obtained that is why 2 m^3 of large-sized wood determined by monetary value we include to calculation of AQS to average volume.

When using a software-tool set Field-Map with laser inclinometer rangefinder TruPulse 360B with built-in scale for remote diameter measurement it is possible to calculate tree stem volumes on the base of remotely measured stem profiles of model trees without felling (see Fig. 1).

Fig. 1. TruPulse 360B with built-in scale for remote measurement of stem diameters

Stem profile is built by using of 6-point method developed by IFER, Czech Republic [12]. Diameter measurement is carried out at stump level, at heights 1.3 and 2 m, also tree height is measured. Places for remote measurement of two diameters depend on tree crown length:

- If the base of live crown is between 1/3 and 3/5 of tree height, it is necessary to measure diameters at the crown base and in the middle of stem (half of the height from the crown base);
- If the base of live crown is lower than 1/3 of tree height, diameters are measured at crown base and at 3/5 of stem height;
- If the crown base is higher than 3/5 of tree height then diameters are measured at 1/3 and 3/5 of tree height.

The data on trees measurements are used in software Field-Map StemAnalyst for parameterization of stem profile equations. On the basis of obtained model it is possible to calculate the tree volume only by using two parameters: the diameter at breast height and height of the tree.

In the program Field-Map StemAnalyst it is possible to perform virtual assortment structure of cutting area: for each tree the stem volume and user predefined assortments that you can get from this tree are calculated, priority and cost of assortments are also defined by the user. Priority and value of assortments can also be specified by the user. The software can be used to simulate various empirical models, in particular – thickness of bark crust models, models of availability of false core and probability of stem rot.

Conclusions. The most appropriate method of evaluation of assortment and quality structure is selection of models on the basis of proportional representation-stage considering their distribution by categories of technical quality. It allows increasing the accuracy of AQS evaluation of standing wood and provides efficient use of forest resources. Using of software and instrumental complex Field-Map makes it possible to calculate the volume of tree stems and evaluate AQS without felling of model trees. Such non-destructive method for assessing of AQS of standing wood is promising in terms of monetary valuation of cutting areas and auction sale of growing wood.

References.