RESEARCH REGARDING THE DRAFTING OF A COMPILATION OF LOCAL TABLES REQUIRED TO DETERMINE THE BASE DIAMETER OF TREES DEPENDING ON THEIR DIAMETER MEASURED AT THE STUB

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Keywords: diameter at breast height, sessile oak, English oak, common beech, common hornbeam

ABSTRACT

The researches have been conducted in exploitable stands of hill mixed hardwood forestlocated in the north-eastern part of Olteţ Piedmont, with the purpose of drafting a compilation of local tables required to determine more precisely the diameter at breast height of trees depending on their diameter measured at the stub, in order to eliminate some systematic errors for particular cases encountered in practice (trees with advanced age and large diameter at the stub, with strongly developed lateral roots, apparent etc.).

The results of the researches have materialized in determining the correlative associations between the diameters, in the form of linear regression equations, in which the regression coefficients have been obtained by processing the field data in the Excel application.

INTRODUCTION

In forest maintenance practice there are cases that require the determination of the diameter at breast height of trees felled and sent out of the forest (often as a result of illegal acts) to determine their volume.

In such cases, the starting point is the diameter measured at the stub, by applying one of the following three methods of determination:

- general tables procedure;
- local tables procedure;
- diameter average procedure.

All three working procedures are based on the correlative association between the diameter at breast height of the trees (at a height of 1,30 m above the ground, in the upstream) and their diameter measured at the stub (considering the felling height is at 0,30 m above the ground, in the upstream). This correlation, linear or slightly parabolic, is presented in *table 6* from **Giurgiu, V., et al., 2004** which, considering the logic presented above, represents the procedure of general tables of determination.

These tables have a general nature and a relative accuracy, containing systematic errors **(Giurgiu, V., et al., 2004)**, due to the manifestation of particular cases: trees grown from sprouts, trees with exaggerated root-swellings at root collar etc.

Furthermore, general tables can not be applied to trees with large sizes and advanced age or trees with diameters measuredat the stub of more than 100 cm.

In addition, general tables have, as a starting point in the determinations that are made, strictly the diameter measuredat the stub at the height of 30 cm, considering that, frequently, in practice this height is a lot smaller (at the moment the maximum stub height is limited to 1/3 of the diameter, and until 2011 it was limited to maximum 10 cm), which leads to inherent overestimations of calculated diameter at breast height and implicitly, of the volume of extracted trees.

As a result, the general tables can not be used for precise determinations that are specific toscientific research works, to technical expertise and others like that.

To solve individual cases, but also to ensure the required accuracy of determining works, the other two procedures are recommended to be applied: local tables procedure and diameter average procedure.

Local tables procedure, applicable to homogeneous stand in terms of tree provenance, age and form and in terms of stationary conditions, implies measuring the diameter at the stub and the diameter at breast height for a number of trees that is large enough (minimum 150), followed by automatic data processing. By computer data processing, correlative association is established between the two rows of diameters, association which is expressed by adequate linear regression (possibly parabolic) equations.

Diameter average procedure is applicable to a small number of extracted trees, their diameter at breast heightbeing determined as an average of the diameters of three-four existing trees of the same species and provenance and from the same stand, having diameters measured at the stub that are equal or adjacent to diameter measured at the stub of felled trees.

Considering the above mentioned, this paper aims to determine the most appropriate correlative association between diameterat breast height and the diameter measured at the stub for a few important forest species, including some stubs having heights that are by far lower than the standardized ones or derived from trees that have form abnormalities in the area of the stub.

The paper also aims to solve the problem of trees that have large sizes and advanced age and for which there are no general tables elaborated yet.

PLACE OF RESEARCH

The present research was conducted in mixed stands of hill mixed hardwood forest, located in the north-eastern part of Olteţ Piedmont, within Băbeni Forest District, from Vâlcea County Forest Administration, stands that were considered as being representative for the studied area.

These stands have a plurien structure, they are characterized by advanced age and large sizes of the component trees and the trees are frequently characterized by abnormalities in form and structure.

Thus, to sustain the aerial part, characterized by large, globular, sometimes asymmetrical treetops, the referred trees have developed an adequate root-system, with primary roots that are strong and apparent, which sometimes extend above the root collar, on the trunk, which determined a high increase in diameter at the base of the trees **(picture 1)**, appearing the most frequent form abnormalities: flute, ovality and root swelling **(picture 2)**.

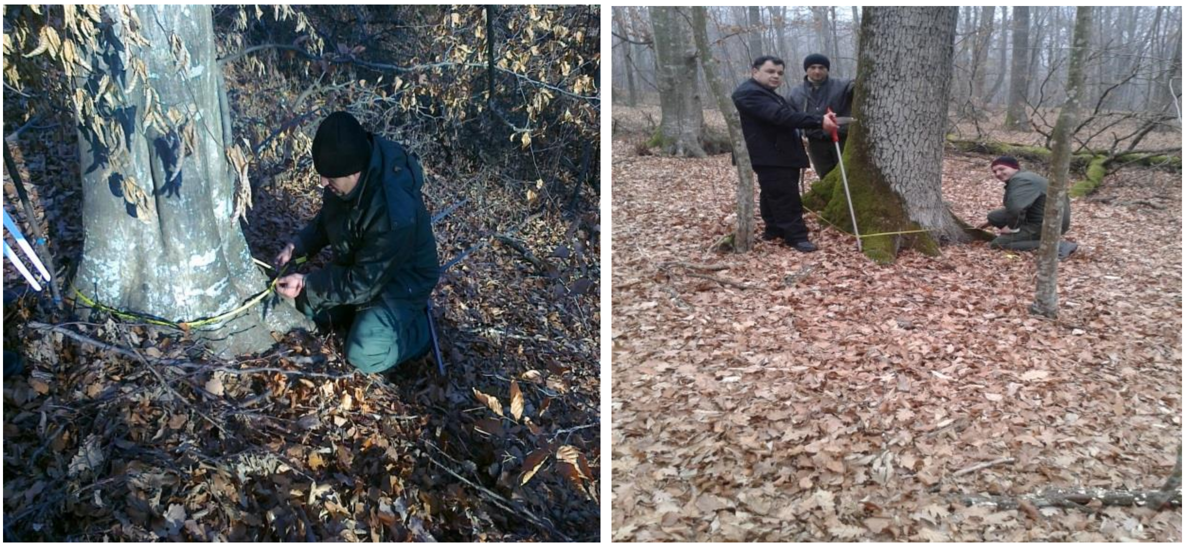
Picture 1. Trees characterized by advanced age and large sizes, with irregular forms and form and structure abnormalities

Picture 2. Stubs of small heights, having form abnormalities: flute, ovality, root swelling

MATERIALS AND METHODS OF RESEARCH

For making the determinations, it was realized a sample consistingof a total of 411 trees from species that are most commonly found in the stands composition of the studied area: English oak, sessile oak, common beech and common hornbeam.

There were determined the diameters at the height of 0,10 m and 0,30 m (diameter measured at the stub) and diameters at the height of 1,30 m (diameter at breast height) of the trees that constitute the sample. To determine the diameter measured at the stub, tree circumference was measured with a metric measuring tape, graduated every centimeter, and to determine the diameter at breast height,it was used the caliper, graduated every two centimeters **(picture 3)**.



Picture 3. Measuring the diameters at the stub (left) and measuring the diameters at the stub and diameters at breast height (right)

Based on the size of the circumference measured in this manner, the diameter at the stub was obtained by applying the equation:

$$dc = C / \pi \quad (1),$$

where:

dc = diameter measured at the stub (cm);

C = stub circumference (cm);

π = 3,1416

RESULTS AND DISCUSSIONS

Data were processed using Excel application. After processing them and realizing the graphic representation, local correlative associations were obtained between the diameter at breast height and the diameter measured at the stub at the height of 0,10 m and 0,30 m for four forest species that were considered in this study. The fields of data that were obtained were balanced by linear regression curves, expressed by the following regression equation:

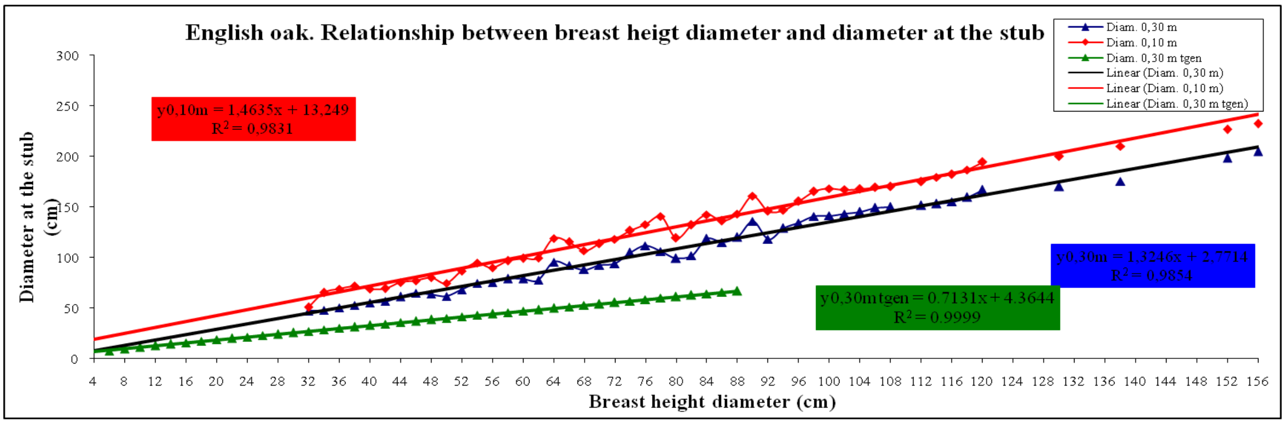
$$d_c = a + bd_b \quad (2),$$

where:

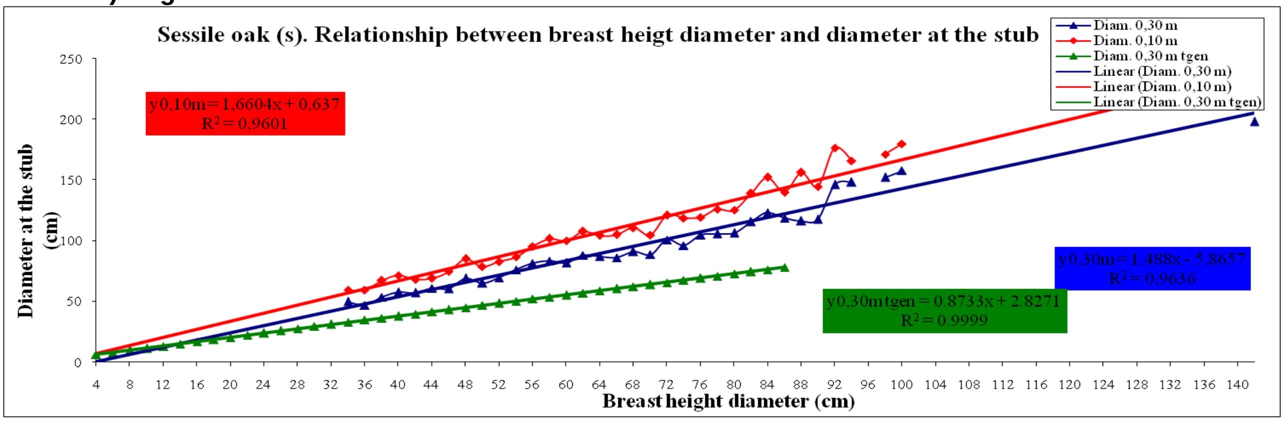
a, b = coefficients of linear regression;

d_b = diameterat breast height (cm).

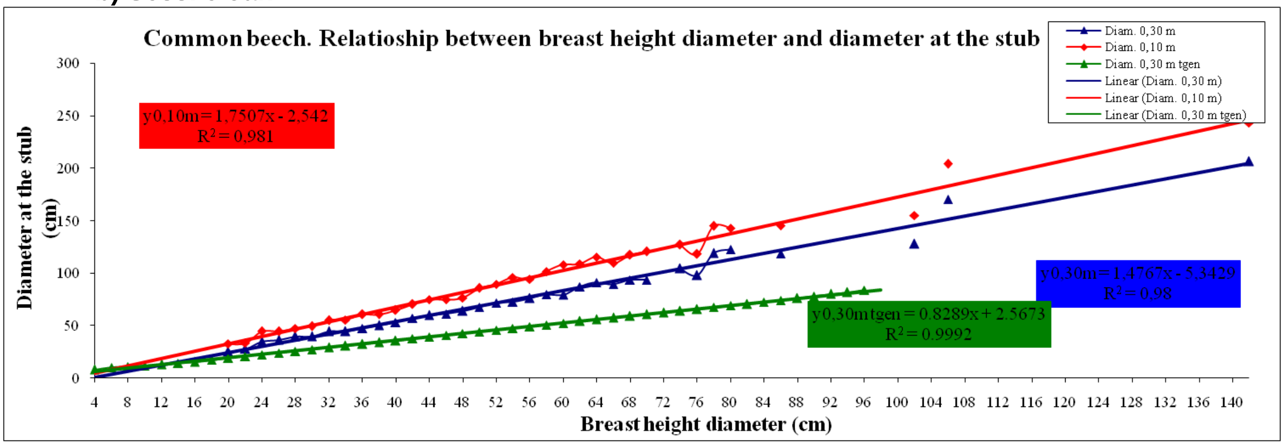
Correlative associations determined by species are plotted in **figure 1.**



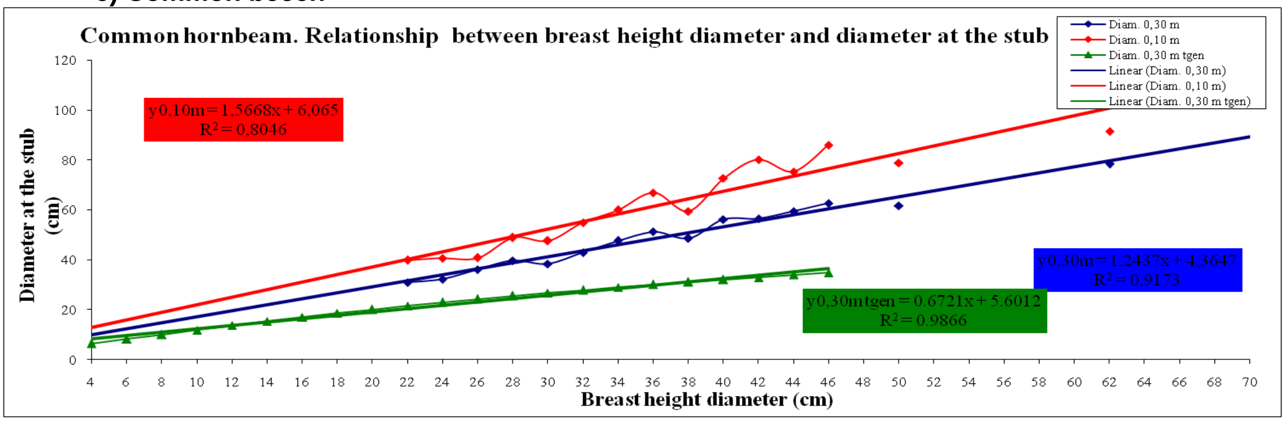
a) English oak



b) Sessile oak



c) Common beech



d) Common hornbeam

Figure 1. Correlative associations between diameter at breast height and diameter measured

at the stub for English oak, sessile oak (seed), common beech and common hornbeam

For each of the four species, the relations between the diameters measured at the stub and diameter at breast height were represented in red and blue.

The relation between diameter measured at the stub (0,30 m) and diameter at breast height (1,30 m), that underlay the elaboration of general tables, was represented in green **(Giurgiu, V., et al., 2004).**

The correlation coefficients that were obtained are characterized by values between 0,8046 (common hornbeam) and 0,9831 (English oak) in case of determining the diameter at breast height based on diameter measured at the stub at the height of 0,10 m, and between 0,9173 (common hornbeam) and 0,9854 (English oak) in case of determining the diameter at breast height based ondiameter measured at the stub at the height of 0,30 m, which proves that determined correlative associations have a high and very high significance level, especially for species that are very important through their weight and economic value (English oak, common hornbeam, common beech).

Applying the correlative associations expressed in linear regression equationsthat are specificto every species and each of the two situations (diameter measured at the stub at the height of 0,10 m and 0,30 m), it was possible to calculate the values of the diameter at breast height based on the stub diameter and the elaboration of local tables for four studied species.

The results are presented in *table 1*, being compared with those registered in general tables **(***table 6* from **Giurgiu, V., et al., 2004)**.

Table 1

Determination of diameter at breast height (d_b) **based on diameter at the stub** (d_c)

d_c (cm) at 0,30 m	d_b (cm) from general tables+				d_b (cm) calculated (local tables)				d_c (cm) at 0,10 m	Db (cm) calculated (local tables)			
	Species				Species					Species			
	English oak	Sessile oak (s)	Common beech	Common hornbeam	English oak	Sessile oak (s)	Common beech	Common hornbeam		English oak	Sessile oak (s)	Common beech	Common hornbeam
0	1	2	3	4	5	6	7	8	9	10	11	12	13
8	7,7	6,2	7,6	6,4	3.9	9.3	9.0	2.9	0		4.4	6.0	1.2
10	9,6	7,7	9,8	8,2	5.5	10.7	10.4	4.5	8		5.6	7.2	2.5
12	11,4	9,9	10,6	10,0	7.0	12.0	11.7	6.1	10		6.8	8.3	3.8
14	13,0	11,1	11,6	11,8	8.5	13.4	13.1	7.7	12	0.5	8.0	9.4	5.1
16	14,5	12,9	12,7	13,6	10.0	14.7	14.5	9.4	14	1.9	9.3	10.6	6.3
18	15,9	14,9	13,8	15,4	11.5	16.0	15.8	11.0	16	3.2	10.5	11.7	7.6
20	17,5	16,7	15,2	17,0	13.0	17.4	17.2	12.6	18	4.6	11.7	12.9	8.9
22	18,8	18,4	16,9	18,5	14.5	18.7	18.5	14.2	20	6.0	12.9	14.0	10.2
24	20,2	20,2	18,6	20,0	16.0	20.1	19.9	15.8	22	7.3	14.1	15.2	11.4
26	21,6	22,0	20,3	21,5	17.5	21.4	21.2	17.4	24	8.7	15.3	16.3	12.7
28	23,0	23,8	22,0	22,9	19.0	22.8	22.6	19.0	26	10.1	16.5	17.4	14.0
30	24,4	25,7	23,6	24,2	20.6	24.1	23.9	20.6	28	11.4	17.7	18.6	15.3
32	25,8	27,6	25,3	25,5	22.1	25.4	25.3	22.2	30	12.8	18.9	19.7	16.6
34	27,2	29,4	27,0	26,7	23.6	26.8	26.6	23.8	32	14.2	20.1	20.9	17.8
36	28,6	31,1	28,7	27,8	25.1	28.1	28.0	25.4	34	15.5	21.3	22.0	19.1
38	30,2	32,8	30,4	28,9	26.6	29.5	29.4	27.0	36	16.9	22.5	23.2	20.4
40	31,6	34,6	32,1	30,0	28.1	30.8	30.7	28.7	38	18.3	23.7	24.3	21.7
42	33,0	36,2	33,8	31,0	29.6	32.2	32.1	30.3	40	19.6	24.9	25.4	22.9
44	34,4	37,9	35,4	32,0	31.1	33.5	33.4	31.9	42	21.0	26.1	26.6	24.2
46	35,8	39,6	37,1	32,9	32.6	34.9	34.8	33.5	44	22.4	27.3	27.7	25.5
48	37,2	41,4	38,8	33,9	34.1	36.2	36.1	35.1	46	23.7	28.5	28.9	26.8
50	38,6	43,2	40,5	34,7	35.7	37.5	37.5	36.7	48	25.1	29.7	30.0	28.0
52	40,0	44,8	42,3		37.2	38.9	38.8	38.3	50	26.5	30.9	31.2	29.3
54	41,5	46,6	43,8		38.7	40.2	40.2	39.9	52	27.8	32.1	32.3	30.6
56	43,0	48,4	45,5		40.2	41.6	41.5	41.5	54	29.2	33.3	33.4	31.9
58	44,4	50,1	47,2		41.7	42.9	42.9	43.1	56	30.6	34.5	34.6	33.1
60	45,8	51,9	48,8		43.2	44.3	44.2	44.7	58	31.9	35.8	35.7	34.4
62	47,2	53,6	50,4		44.7	45.6	45.6	46.3	60	33.3	37.0	36.9	35.7
64	48,6	55,2	52,1		46.2	47.0	47.0	47.9	62	34.7	38.2	38.0	37.0
66	50,0	56,9	53,8		47.7	48.3	48.3	49.6	64	36.0	39.4	39.2	38.3

68	51,4	58,6	55,5		49.2	49.6	49.7	51.2	66	37.4	40.6	40.3	39.5
70	52,8	60,4	57,1		50.8	51.0	51.0	52.8	68	38.8	41.8	41.4	40.8
72	54,2	62,1	58,7		52.3	52.3	52.4	54.4	70	40.1	43.0	42.6	42.1
0	1	2	3	4	5	6	7	8	9	10	11	12	13
74	55,6	63,8	60,3		53.8	53.7	53.7	56.0	72	41.5	44.2	43.7	43.4
76	57,0	65,4	62,0		55.3	55.0	55.1	57.6	74	42.9	45.4	44.9	44.6
78	58,5	67,2	63,7		56.8	56.4	56.4	59.2	76	44.2	46.6	46.0	45.9
80	60,0	69,0	65,4		58.3	57.7	57.8	60.8	78	45.6	47.8	47.1	47.2
82	61,4	70,8	66,1		59.8	59.0	59.1	62.4	80	47.0	49.0	48.3	48.5
84	62,8	72,6	67,8		61.3	60.4	60.5	64.0	82	48.3	50.2	49.4	49.7
86	64,2	74,4	68,5		62.8	61.7	61.9	65.6	84	49.7	51.4	50.6	51.0
88	65,6		72,2		64.3	63.1	63.2	67.2	86	51.1	52.6	51.7	52.3
90	67,0		73,8		65.9	64.4	64.6	68.9	88	52.4	53.8	52.9	53.6
92			75,7		67.4	65.8	65.9	70.5	90	53.8	55.0	54.0	54.8
94			77,6		68.9	67.1	67.3	72.1	92	55.2	56.2	55.1	56.1
96			79,5		70.4	68.5	68.6	73.7	94	56.5	57.4	56.3	57.4
98			81,5		71.9	69.8	70.0	75.3	96	57.9	58.6	57.4	58.7
100			83,5		73.4	71.1	71.3	76.9	98	59.3	59.8	58.6	60.0
102					74.9	72.5	72.7		100	60.6	61.0	59.7	
104					76.4	73.8	74.0		102	62.0	62.3	60.9	
106					77.9	75.2	75.4		104	63.4	63.5	62.0	
108					79.4	76.5	76.8		106	64.7	64.7	63.1	
110					81.0	77.9	78.1		108	66.1	65.9	64.3	
112					82.5	79.2	79.5		110	67.5	67.1	65.4	
114					84.0	80.6	80.8		112	68.8	68.3	66.6	
116					85.5	81.9	82.2		114	70.2	69.5	67.7	
118					87.0	83.2	83.5		116	71.6	70.7	68.9	
120					88.5	84.6	84.9		118	72.9	71.9	70.0	
122					90.0	85.9	86.2		120	74.3	73.1	71.1	
124					91.5	87.3	87.6		122	75.7	74.3	72.3	
126					93.0	88.6	88.9		124	77.0	75.5	73.4	
128					94.5	90.0	90.3		126	78.4	76.7	74.6	
130					96.1	91.3	91.7		128	79.8	77.9	75.7	
132					97.6	92.7	93.0		130	81.1	79.1	76.9	
134					99.1	94.0	94.4		132	82.5	80.3	78.0	
136					100.6	95.3	95.7		136	83.9	81.5	79.1	
138					102.1	96.7	97.1		138	85.2	82.7	80.3	
140					103.6	98.0	98.4		140	86.6	83.9	81.4	
142					105.1	99.4	99.8		142	88.0	85.1	82.6	
144					106.6	100.7	101.1		144	89.3	86.3	83.7	
146					108.1	102.1	102.5		146	90.7	87.5	84.8	
148					109.6	103.4	103.8		148	92.1	88.8	86.0	
150					111.1	104.7	105.2		150	93.4	90.0	87.1	
152					112.7	106.1	106.6		152	94.8	91.2	88.3	
154					114.2	107.4	107.9		154	96.2	92.4	89.4	
156					115.7	108.8	109.3		156	97.5	93.6	90.6	
158					117.2	110.1	110.6		158	98.9	94.8	91.7	
160					118.7	111.5	112.0		160	100.3	96.0	92.8	
162					120.2	112.8	113.3		162	101.6	97.2	94.0	
164					121.7	114.2	114.7		164	103.0	98.4	95.1	
166					123.2	115.5	116.0		166	104.4	99.6	96.3	
168					124.7	116.8	117.4		168	105.7	100.8	97.4	
170					126.2	118.2	118.7		170	107.1	102.0	98.6	
172					127.8	119.5	120.1		172	108.5	103.2	99.7	
174					129.3	120.9	121.4		174	109.8	104.4	100.8	
176					130.8	122.2	122.8		176	111.2	105.6	102.0	
178					132.3	123.6	124.2		178	112.6	106.8	103.1	
180					133.8	124.9	125.5		180	113.9	108.0	104.3	

CONCLUSIONS AND RECOMMENDATIONS

Use of general tables presented in „*Biometria arborilor și arboretelor”* **(Giurgiu, V., et al., 1972)** and in „*Metode și tabele dendrometrice*“ (**Giurgiu, V., et al., 2004)** to determinethe diameter at breast height of the trees that were felled and taken (sent out), based on their diameter measured at the stub, is not always recommended due to low precision of the method.

In case it is required a high accuracy of determination (for research works, technical expertise), and the number of trees is large enough, it is recommended to elaborate and use local tables.

Elaboration and use of local tables is also recommended in case the felling of the trees is made by letting stubs of atypical heights, with significant deviations from standard height (1/3 of the diameter at the base of the tree), and also in case of trees with obvious form abnormalities at the base (ovality, root-swelling, flute).

Furthermore, it is mandatory to elaborate and use local tables in case of trees of advanced age and with large diameters measured at the stub, being known the fact that the use of existent general tables does not allow to make the determinations for trees with diameters at the stub larger than 100 cm.

In this case, the correlative association between diameter at breast height and diameter measured at the stub is best represented through the following linear regression equation $\mathbf{d_c = a + bd_b}$. The high value of the correlative coefficients proves that determined correlative associations have a high and very high level of significance, especially for English oak, sessile oak and common beech, species that are very important through their weight and economic value.

Considering the correlative associations established in this manner, local tables were elaborated as a result of this research in order to determine the diameter at breast height based on the diameter measured at the stub for two frequently used heights of the tree felling (0,10 m and 0,30 m) and for a number of four species that are very common in the forest.

As a result, if there is a sufficient number of standing trees from the category of extracted ones, for which we want to establish dendrometric parameters in order to accurately determine their volume, applying linear or parabolic regression equations is necessary so as to elaborate local tables, characterized by a more accurate determination in contrast with general tables.

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