SMART HORNBEAM STANDS (*CARPINUS BETULUS* L.) FROM THE WEST PLAIN

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Abstract. Hornbeam is a forest tree species widespread in our country's plain and hill areas. Hornbeam forests can also be found in the West Plain and can be classified as smart forests. This concept, used during the last decade in worldwide silviculture, involves the existence of forests with an exceptional ecologic purpose. The present article intends to establish a set of clear and easy to identify and catalogue criteria that can be used to recognize smart hornbeam forests from the West Plain together with their characteristics. In order to achieve this, 14 site and stand characteristics were established, each with five evaluation classes.

Smart hornbeam stands from the West Plain are distributed especially in Lunca Timisului, Oradea and Timisoara forest districts, at altitudes of 90-100 meters, on preluvisol and eutric cambisol. In addition, they are also present in forest plain station and in meadows, being characterised by relatively even-aged and relatively uneven-aged structures, ages between 60-70 years and by conservation forests and seed reservations production subunits.

1. INTRODUCTION

The West Plain is composed of three layers: high plain (over 100 m), horizontal plain (with sand accumulations) and low plain (in which rivers have a swamp tendency). The forest vegetation is composed of broad-leaved stands, including numerous hornbeam elements. The main soils are chernozem, phaeozem and preluvisol (Crișan et al., 2017; Dincă et al., 2019a).

Six associations that contain hornbeam were identified in the Czech Republic (Knollova, 2004). In Slovakia, the entire hornbeam leaf canopy (over storey and under storey canopy) is a large sink of CO₂ in good forest light conditions (Elias et al., 1989). In Poland, the decomposition rate of plant litter fall coefficients were of 1.06 for hornbeam leaves (Dziadowiec, 1987). In Sweden, soil acidity leads to a large extent of field-layer vegetation floristic composition in oak/hornbeam forests (Tyler, 1989).

Forestry is the only sector of the economy that acts as a net sink for CO₂. Terrestrial ecosystems in Europe already sequester 7% to 12% of the anthropogenic CO₂ emissions, even though the potential of forests is not fully utilized (Janssens et al., 2003; Luyssaert et al., 2010). Climate-smart forestry includes reducing emissions of greenhouse gases, building resilience in existing forests, and increases in forest productivity. Climate-smart forestry seeks synergies with other policies such as the enhancement of biodiversity, the provision of forest ecosystem services, and the establishment of a strong bio-economy (Jandl et al., 2018). Climate-smart forestry is sustainable adaptive forest management and governance to protect and enhance the potential of forests to adapt to, and mitigate climate change; it should enable both forests and society to transform, adapt to and mitigate climate-induced changes (Bowditch et al., 2020).

The purpose of this article is to establish the smart hornbeam forests from the West Plain, similar with the stands from the Southern Carpathians that are composed of alder (Blaga et al., 2019) or Norway spruce (Dincă et al., 2019b).

2. MATERIALS AND METHODS

The present article uses data from forest management plans realized during 1995-2008 for all national forests located in the West Plain (11 forest districts have stands that contain hornbeam in their composition). All hornbeam stand elements were analysed for species older than 50 years (3155 elements of hornbeam stands). As such, 14 parameters specific to the stand or station were taken into consideration (table 1). Each parameter was graded from 1 to 5, based on the species's ecological and silviculture requests, as follows: 1 = very low; 2 = low; 3 = average; 4 = high; 5 = very high. A total grade was obtained by adding all values that correspond to a stand and it was used to order and classify hornbeam stands from the West Plain.

Table 1. Grades assigned on the stand's characteristic

Nr crt	Characteristic	Grade				
		1	2	3	4	5
1	Pruning	0.3	0.4	0.5	0.7	0.6
2	Vitality	5	4	3	2	1
3	Average diameter (cm)*	10-16	18-20	22	24	26-90
4	Average high (m)*	9-16	17-18	19	20	21-42
5	Production class	5	4	3	2	1
6	Current growth (m ³ /year/ha)*	0.1-0.4	0.5-0.7	0.8-1.3	1.4-2.7	2.8-7.2
7	Structure		1	2	3	4
8	Consistency	0.3-0.4	0.5; 1.0	0.6-0.9	0.7	0.8

9	SUP	O; C	A; Q	V	K	M
10	Functional group + Functional category	2,1C	2,1B	1,1B; 1,1C; 1,2I; 1,4J	1,2A; 1,2B ; 1,2L; 1,4B	1,3C; 1,5H
11	Litter	1	2	3	4	5
12	Flora	42	44; 45; 67	41; 63; 66	51; 62	61; 71; 81
13	Soil type	2405; 2410	2407	2401	2101; 2201; 2212	2102; 3101
14	Station type	6122	6131; 6142	5142; 5152; 5242; 6132; 6252	5132; 5153; 6143	6253; 7333

*The entire value range was divided for these characteristics in 5 categories, 1 = the lowest (ex: average diameter between 10-16 cm), 5 = the highest (ex: current growth larger than 2.8 m³/year/ha) and grades were given for these categories. The category division was realized to respect the analysed biometric characteristics but also to ensure a balanced division as value numbers for each category.

The meaning of terms used in Table number 1 is rendered below:

Vitality: 1=very vigorous; 2=vigorous; 3=normal; 4=weak; 5=very weak.

Structure: 1= even-aged stands; 2= relatively even-aged stands; 3= relatively uneven-aged stands; 4= uneven-aged stands.

Production/protection subunits (SUP) (excerpt): A= regular forest, common assortments: wood for timber, constructions, celluloses; C=Conversion; K=Seed reservations; M=Forests under the extreme conservation regime; O=Fields that will be removed from the forest fund; V=Forests with recreation functions through hunting in which forest regeneration cuttings are allowed.

Functional group (GF) and functional category (FCT) (excerpt): 1,2A= Forests located on cliffs, debris, on fields with depth erosion, on fields with a slope higher than 35 degrees and on flysch, sand or gravel with a slope higher than 30 degrees; 1,2L= Forests located on fields with lithological substratum very vulnerable to erosion and landslide; 1,3C= Oak forests from field areas under the conservation regime; 1,4B= Forests from around counties, cities and villages as well as forests located in their construction area; 1,4J= Forests with an exceptional game interest; 1,5H= Forests established as reservations for the production of forest seeds and the conservation of the forest genofund; 2,1B= Forests destined to mainly produce voluminous trees of superior quality for timber.

Litter: 1=missing litter; 2= slim interrupted litter; 3=slim continuous litter; 4=normal continuous litter; 5=voluminous continuous litter.

Flora: 41= *Asperula-Asarum*; 42= *Carex pilosa*; 44= *Festuca altissima*; 45= *Luzula albida*; 51= *Asarum-Brachypodium*; 61= *Asarum-Stellaria*; 66= *Festuca heterophylla*; 67= *Poa pratensis-Carex caryophyllae*; 71= *Erachypodium-Geum-Pulmonaria*; 81= *Arum-Pulmonaria*.

Soil type: 2101= rodic preluvisol; 2102= mollic rodic preluvisol; 2201= preluvisol; 2212= mollic marnic preluvisol; 2401= luvisol; 2405= lithic luvisol; 2407= stagnic luvisol; 2410= planic stagnic luvisol; 3101= eutric cambisol.

Station type: 5132= Bm hill holm, preluvisol and luvisol with mesophyte gramineae flora; 5242= Bm hill common beech stand, average edaphic eutric cambisol with *Asperula-Asarum*; 6143= Bs hill oak stands (holm stands) and hill highroads, high edaphic stagnic preluvisol with *Carex pilosa*; 6253= Bs hill oak stands with common beech stand of inferior limit, high edaphic eutric cambisol; 7333= Bs hill oak stands with oak, high edaphic stagnic preluvisol.

3. RESULTS AND DISCUSSIONS

Taking into consideration the fact that smart forests represent up to 10% of the total forests from an area, this category contains forests with a grade higher than 54, namely 30 stands in the case of the West Plain. These numbers were obtained by the decreasing classification of the grades obtained by each stand. The following aspects were identified by analysing certain characteristics of these 30 stands (table 2):

Table 2. Characteristics of smart hornbeam forests from the West Plain

Nr crt	Forest district	Age (years)	Altitude (m)	SUP	Structure	Soil type	Station type
1	Livada	60	130	M	2	2401	8512
2	Lunca Timis	130	100	M	3	2102	8512
3	Lunca Timis	80	100	K	3	2212	8511
4	Lunca Timis	85	100	K	1	2212	8511
5	Lunca Timis	70	90	V	2	2102	8512
6	Lunca Timis	70	90	V	3	2102	8512
7	Tinca	80	110	K	2	9511	8512
8	Savarsin	110	425	B	2	3101	5243
9	Lunca Timis	130	100	V	3	2102	8512
10	Oradea	70	180	A	2	3101	6153
11	Oradea	70	170	A	2	3101	6153
12	Lunca Timis	75	100	V	3	2101	8511
13	Lunca Timis	75	100	K	2	2212	8511
14	Lunca Timis	80	100	V	3	2101	8511
15	Lunca Timis	90	100	K	2	2212	8511
16	Timisoara	55	160	A	2	2201	7220
17	Savarsin	60	350	M	2	2201	5153
18	Timisoara	60	170	A	2	2201	7430
19	Oradea	65	170	M	2	2407	7333
20	Lunca Timis	65	90	V	1	2102	8512
21	Oradea	70	220	A	2	3101	6153
22	Oradea	70	225	A	2	3101	6153
23	Sacuieni	70	160	V	2	2101	8430
24	Sacuieni	70	170	V	3	2201	8430
25	Lunca Timis	70	90	V	3	2102	8512
26	Timisoara	80	150	A	1	2201	6142
27	Lunca Timis	80	100	M	1	2212	8511
28	Lunca Timis	85	100	A	3	2102	8512
29	Satu Mare	90	120	K	2	6202	8336
30	Lunca Timis	125	90	V	3	2119	8512

From a geographic distribution point of view, smart hornbeam forests are present especially in Lunca Timisului, Oradea and Timisoara forest districts but

The map displays the Balkan Peninsula with various ethnic group distributions. Key locations labeled include UNGARIA, IUGOSLAVIA, CROATIA, and SERBIA. Major cities like BUDAPEST, BELGRADE, and ZAGREB are marked. The Danube River is shown flowing through the region. A legend in the bottom left corner provides symbols for ethnic groups, densities, and types of housing. The map also includes a scale bar and a north arrow.

The age of these smart forests is varied, ranging from 55 to 130. This fact proves that advanced age is not necessarily a condition for the appearance of these stands. Relatively young forests (60-70 years old) record other characteristics that situate them in this superior stand category. Furthermore, it can be observed that the majority of stands range between 55-70 years (fig. 2).

Figure 2. Distribution of smart hornbeam forests from the West Plain on ages

As an altitudinal spreading, these stands are situated between 90 and 425 meters, with preponderance for the 90-100 m altitude (fig. 3).

Figure 3. Distribution of smart hornbeam forests from the West Plain on altitudes

From a production/protection point of view, smart hornbeam forests from this area are relatively evenly distributed in the following categories: V – Forests with recreation functions through hunting, A – Regular forest, common assortments, K – Seed reservations and M – Forests under the special conservation regime (fig. 4).

The structure of these stands is mainly 2-relatively even-aged stands and 3-relatively uneven-aged stands, with the presence of 1-even-aged stands (which has recorded the lowest grade). This fact proves once again that classifying a forest as smart forest is determined by more factors.

The soil type characteristics for these stands are: 2102-mollic rodic preluvisol, 2201-preluvisol, 2212-mollic marnic preluvisol and 3101-eutric cambisol. These

soils are favourable to the local forest vegetation (Spârchez et al., 2017; Dinca et al., 2018).

The characteristic station types are 8511- Bm meadow highroad forest plain, high edaphic stagnosol and 8512 – Bs meadow highroad forest plain, high edaphic stagnosol. Besides a good protection (Constandache et al., 2018; Dincă et al., 2019c), these station types also ensure multiple ecosystem functions (Pleşca et al., 2019; Dincă et al., 2020; Enescu et al., 2020).

Figure 4. Distribution of smart hornbeam forests from the West Plain on production/protection subunits

4. CONCLUSIONS

Framing a stand in the smart forest category must take into account a sum of factors. Our study has shown that smart hornbeam forests can be established by taking into account 14 site and stand characteristics. The identification of these stands is extremely important for applying adequate silvicultural measures for their protection.

Hornbeam smart forests are present in the entire West Plain but especially in Lunca Timisului, Oradea and Timisoara forest districts. They are characterised by ages of 60-70 years, altitudes between 90-100 m, relatively even-aged and relatively uneven-aged structures and preluvisol and eutric cambisol soil types. They are situated in forest meadow highroad plain station and in production/protection subunits from the following classes: A – Regular forest, common assortments, K – Seed reservations and M – Forests under the extreme conservation regime.

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