The Silviculture Conference

Forest tending in Hungary

by Oscar Sziklai

Introduction

The objective of conventional, intensive forestry practice is the sustainable production of the largest and the most valuable quantity of timber during the shortest period of time, at the lowest possible cost. To achieve this objective the following five measures, complimentary to each other are implemented: (1) establishing, (2) tending, (3) protecting, (4) managing, and (5) harvesting and utilizing the forest.

The establishment — naturally or artificially — and the harvesting usually require a short time period, while the tending, protection and management are continuing activities during the rotation cycle of the forest.

The extensive forestry practice during the "frontier" society stage — when the natural forest resource seems so abundant as to be inexhaustible — concentrates only on harvesting and utilization. The development from extensive to intensive forestry involves implementation of additional measures, and stand tending is usually the last one implemented to complete the progression.

The long-term goal of forest tending is (Schadelin 1942) to improve the quality and value of the stand during the rotation cycle and to provide the optimum growing conditions by selecting the most promising trees during the cleaning and the thinning operations. Before sensible forest tending could be implemented the genetic variation, the growth characteristic, the site condition and the response to different treatment of the species in question needed to be known.

I intend to present to you the tending operations practiced on *Pinus silvestris* in Hungary (Solymos, 1978) during the last 70 years.

The Species

Pinus silvestris occupies close to 150,000 ha or 9.6% of the forest. Historically only sporadic native stands and occurrences were documented. The present stands in Hungary were established from imported seed during the last 80 - 90 years.

Two distinct varieties occur in the forest; one grows on the foothills of the Alps and Carpathian mountains, the other on the lower elevation of the plains. The first is characterized by a straight, cylindrical stem, and a narrow long crown with light branches, the plains variety rarely develops a straight stem, has heavy branches and a wide crown, but exhibits more vigorous growth than the foothills variety. The tree breeding program was developed during the late 1940's, and seed orchards are producing the desired number of seed for artificial reforestation.

Pinus silvestris is a fast growing species (Fig. 1); mean annual increment is maximized between 20 and 40 years and varies between 3 and 18 m³ ha on the various sites, but reaches 10 m³ ha even on the III site class.

(A) Growth Characteristics of Individual Trees

The height, basal area and volume growth of an average 85-

Figure 1. Mean annual increment on the ten site classes.

Table 1. Height growth of an average 85 year old tree

Age (years)	Height growth					
	cm	percent				
0-5	152	6.2				
6-10	367	14.8	21.0			
11-15	305	12.3		43.3		
16-20	249	10.0	22.3			
21-25	186	7.6			69.3	
26-30	186	7.5	15.1			
31-35	150	6.1		26.0		
36-40	118	4.8	10.9			90.5
41-45	156	6.3				
46-50	108	4.4	10.7			
51-55	134	5.4		21.2		
56-60	127	5.1	10.5			
61-65	81	3.3			30.3	
66-70	64	2.6	5.9			
71-75	46	1.9		9.1		9.1
76-80	32	1.3	3.2			
81-85	12	0.4	0.4	0.4	0.4	0.4
Total	2473	100	100	100	100	100

year-old tree are portrayed in Tables 1 to 3. Height growth is most rapid between 6 and 16 years, when yearly elongation can reach 70 to 80 cm; growth slows to 20 - 30 cm, and after 60 years, it varies between 6 and 16 cm. On average, 43.3 and 69.3 per cent of height growth is attained by ages 20 and 40 years, respectively. Basal area development is maximized between 20 and 40 years; during this period 41 per cent of the total basal area is produced. Volume production generally culminates between 30 and 50 years; production is nearly equal during 20 to 40 years (30.2 per cent) and 40 - 60 years (32 per cent).

(B) Growth Characteristics of Stands

Yearly height growth is the fastest between 5 and 25 years; on better sites maximum height growth is reached earlier than on the poorer sites (Table 4).

Basal area culminates between 10 and 30 years; annual growth at this time is 0.4 to 1.4 m²/ha. Between 40 and 50 years, basal area growth declines and levels off between 70 and 80 years.

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Table 2. Basal area development of an average 85 year old tree

Age (years)	Basal area					
	m ²	percent				
0-5						
6-10	0.00342	3.5	3.5			
11-15	323	3.3	7.7	11.2		
16-20	429	4.4				
21-25	769	7.9	19.8		52.2	
26-30	1154	11.9				
31-35	1138	11.8	21.2	41.0		
36-40	912	9.4				
41-45	786	8.2	15.0		78.9	
46-50	665	6.8				
51-55	461	4.8	11.7	26.7		
56-60	670	6.9				
61-65	448	4.6	8.4		42.7	
66-70	357	3.8				
71-75	364	3.8	7.6	16.0		16.0
76-80	372	3.8				
81-85	490	5.1	5.1	5.1	5.1	5.1
Total	0.09680	100	100	100	100	100

Table 3. Volume production of an average 85 year old tree

Age (years)	Volume					
	m ³	percent				
0-5	0.00102	0.3				
6-10	443	0.5	0.8			
11-15	1218	1.4		4.7		
16-20	2638	2.5	3.9			
21-25	5037	4.8			34.9	
26-30	8216	8.0	12.8			
31-35	8788	8.4		30.2		
36-40	9270	9.0	17.4		66.9	
41-45	8253	8.0				
46-50	8885	8.5	16.5			
51-55	8374	8.0		32.0		
56-60	8843	7.5	15.5			
61-65	8533	8.2			58.3	
66-70	6305	6.1	14.3			
71-75	6211	6.0		26.3		26.3
76-80	6153	6.0	12.0			
81-85	7022	6.8	6.8	6.8	6.8	6.8
Total	1.04291	100	100	100	100	100

Table 4. *Pinus silvestris* height basal area and number of trees per ha on the I - VI growth classes following stand tending measures

Age (years)	Growth classes																	
	I			II			III			IV			V			VI		
	Ht/m	BA/m ²	NO	Ht/m	BA/m ²	NO	Ht/m	BA/m ²	NO	Ht/m	BA/m ²	NO	Ht/m	BA/m ²	NO	Ht/m	BA/m ²	NO
10	9.5	21.37	2468	7.1	16.70	3884	5.3	13.05	5699	4.0	10.20	8095	2.9	7.97	11225	2.2	6.23	
15	13.9	25.89	1526	10.8	22.33	2226	8.3	19.26	3028	6.4	16.61	3964	5.0	14.32	5060	3.8	12.35	6301
20	17.6	29.21	939	14.0	26.19	1482	11.1	23.48	1976	8.9	21.05	2527	7.1	18.87	3104	5.6	16.92	3828
25	20.2	31.38	650	16.6	28.73	1024	13.6	26.31	1450	11.1	24.09	1872	9.1	22.06	2279	7.4	20.20	2733
30	22.3	32.90	509	18.7	30.49	760	15.6	28.26	1098	13.1	26.19	1462	10.9	24.27	1829	9.2	22.49	2203
35	24.1	34.10	424	20.5	31.80	604	17.4	29.66	890	14.8	27.66	1204	12.6	25.79	1541	10.8	24.05	1869
40	25.6	35.15	357	22.0	32.85	515	19.0	30.70	726	16.3	28.69	1022	14.0	26.81	1050	12.1	25.05	1674
45	27.1	35.96	317	23.4	33.64	454	20.3	31.47	641	17.6	29.44	901	15.3	27.54	1213	13.2	25.76	1539
50	28.2	36.62	291	24.7	34.27	413	21.5	32.07	577	18.8	30.01	819	16.4	28.08	1129	14.3	26.28	1448
55	29.4	37.22	273	25.7	34.81	377	22.6	32.55	536	19.8	30.44	766	17.3	28.47	1071	15.2	26.62	1393
60	30.3	37.67	259	26.7	35.22	354	23.5	32.93	507	20.7	30.79	716	18.2	28.79	1016	16.0	26.92	1322
65	31.3	38.09	246	27.5	35.59	336	24.3	33.25	480	21.5	31.07	683	19.9	29.03	972	16.7	27.13	1285
70	32.0	38.45	236	28.4	35.90	320	25.1	33.52	462	22.2	31.30	659	19.6	29.23	940	17.4	27.29	1261
75	32.8	38.73	229	29.1	36.15	310	25.7	33.74	447	22.8	31.49	636	20.2	29.39	908	17.9	27.43	1237
80	33.5	38.99	223	29.7	36.37	301	26.4	33.93	435	23.4	31.65	620	20.8	29.52	886	18.4	27.54	1213
85	34.2	39.22	218	30.3	36.57	292	26.9	34.10	424	23.9	31.80	604	21.2	29.66	866	18.9	27.66	1190
90	34.8	39.40	213	30.9	36.73	287	27.4	34.24	413	24.4	31.92	592	21.7	29.76	852	19.2	27.74	1179
95	35.2	39.56	210	31.3	36.87	283	27.8	34.36	407	24.8	32.02	581	22.0	29.84	841	19.6	27.81	1169
100	35.7	39.72	207	31.8	37.00	279	28.2	34.47	401	25.1	32.11	573	22.4	29.91	830	19.9	27.86	1160

Stand Tending

Large numbers of trees characterize the early years of a stand. Under the traditional approach 10-12,000 trees were planted on a hectare. Approximately 90 - 95 per cent of the trees are removed during tending operations by the end of rotation age. The number of trees, which trees and at what age they are removed is critical to the successful development of the stand.

During cleaning 50 per cent of the seedlings are generally removed. During the first thinning, which coincides with the classification of trees, 30 - 40 per cent of the trees, accounting for 10 - 15 per cent of the volume are cut. Subsequent thinnings either one or two, will result in the removal of only 10 - 20 per cent of the trees and 10 - 15 per cent of the volume.

In recent years fewer seedlings are planted of *Pinus silvestris* at wider spacing, than with the earlier traditional method. The density depends on site condition and the objective of the plantation. When the aim is to produce high quality saw logs, better sites are selected and the total number of seedlings/ha is 6000, with 2.8m x 0.6m spacing (Table 5).

The first cleaning or juvenile spacing is carried at the time when the crown closure is complete and height growth is 4-5 m. This stage, which depends on the site condition, is usually reached around 10 years. The aim is to increase the growing space for the most desirable trees, and during this process the number of trees is reduced from 6000 to around 4000. The second cleaning is implemented 5 years later. This time, around 1500 trees are removed and the most desirable individuals pruned up to 2 m.

During the first thinning, between the age of 25 and 27 years, the classification of the remaining 2500 trees is one of the most important tasks of forest tending. The elaborate IUFRO tree classification system is a good assistance to develop local methods for each species. For *Pinus silvestris* the following three classes are used:

Class I

Phenotypically outstanding fast growing trees, with straight stem, symmetrical, healthy and narrow crown. Out of these trees the best 400 - 450 individuals, the so called final cut trees or

Table 5. *Pinus silvestris* stand treatment for high quality saw logs

Silvicultural measures	Age (years)	Height (m)	Diameter (cm)	Trees (no.)	Volume (m ³)
Planting 2.8 m x 0.6	1-2	—	—	6000*	—
Cleaning	1 10-12	4-5	6-8	4000	20
Cleaning					
—Pruning —2 m	2 15-17	7-8	10-12	2500	30
Thinning					
—Tree selection	1 25-27	12-14	16-18	1500	50
Thinning					
—Pruning —6 m	2 36-38	16-18	20-22	800	60
Thinning	3 50	23	26	500	40
Final cut	70-90	25-27	28-30	400-450	400-450

“V” trees, are to be reserved up to the time of the final felling.

Class II

Supporting trees, which help the growth of Class I trees, and improve the stand development as a whole.

Class III

Trees with prevalent insect, disease or other physical damages or undesirable stem or crown characteristics.

The Class III trees will provide the largest share of the 1000 trees to be removed during the first thinning.

The aim of the second thinning is to enhance the volume production and improve the quality of the remaining trees. A total of 700 trees / 60 m³ will be removed from all three classes. This thinning operation favors the 400 – 450 “V” trees which are this time pruned up to 4–6 metres.

The third thinning around age 50 is the lightest stand-tending operation. The aim is to concentrate the declining volume production on the 400 – 450 final cut trees, increase the dimensional lumber production, and consequently the value of the final harvest.

When the fiber production is the aim (Table 6) 3500 seedlings are planted in 2.8 m x 1.0 m spacing and after one cleaning and two thinnings, 150 m³ is removed. No pruning and no tree classifications are implemented. The final cut at age 50 years could yield 250 – 300 m³.

Conclusions

This information is only a guideline for tending *Pinus silvestris* in the Hungarian milieu, where forests and timber are

Table 6. *Pinus silvestris* stand treatment for fiber production

Silvicultural measures	Age (years)	Height (m)	Diameter (cm)	Trees (no.)	Volume (m ³)
Planting 2.8 m x 1.0	1-2	—	—	3500	—
Cleaning	1 20	8	10-12	2000	40
Thinning	1 30	12	14-16	1400	50
Thinning	2 40	15	15-17	800	60
Final cut	50	18	18-20	700-750	250-300

not plentiful, and where there is a strong incentive to tend the forest. More than one-third of the total harvest is obtained from tending operations. An effective road and transportation system are *prerequisite* to efficient forestry operation.

The population, well spread in villages or settlements around and in the forests, provides the permanent or mainly temporary labour force for the cyclical operations. Furthermore they are the primary users of fuel wood and building materials, which are the first products of the tending measures.

Forestry operations require an effective balancing of economic, environmental and social interests. Consequently forest tending operations should never be *codified* or reduced to a *mechanical* application. They must be re-examined and reassessed in each individual case before implementation.

As Professor Liebundgut (1966) said “each individual tree lives, each stand lives, the forest as a whole lives”, by removing desirable trees instead of undesirable ones, the forest will live, but the result could be far below the optimum productivity.

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