Analysis of Maturity Ages of Estonian Forests

ALLAR PADARI, PEETER MUISTE

Estonian Agricultural University, Kreutzwaldi 5, 51014 Tartu, Estonia

Padari A., Muiste P. 2003. Analysis of Maturity Ages of Estonian Forests. *Baltic Forestry*, 9 (2): 16-19.

At the moment in Estonia a new Forest Act is worked out, which may change the maturity norms of the forests. The aim of the present study was to analyse the impact of changing the maturity ages and compare the results with the situation, when the maturity age is determined by the profit. The results of the modelling indicate, that the increase of the maturity age will decrease the annual yield and profit from Estonian forests.

Key words: maturity ages, Forest Act, yield of different assortments

Introduction

When a forest has reached the maturity? There can be different answers, depending on the final product, which we want to get from the forest. The maturity can be determined by different criteria, for example:

1) the maturity by the volume, when the goal is to get the biggest possible harvested volume per year (maximum mean annual increment of the yield of assortments);

2) the technical maturity, when the goal is to get the biggest possible volume of merchantable wood per year (maximum mean annual increment of merchantable wood);

3) the maturity by price, when the goal is to get the best possible price per year (maximum mean annual increment of timber price);

4) the maturity by profit, when the goal is to get the best profit per year (maximum mean annual increment of timber price);

5) the biological maturity, when the forest stand is cut in the end of its life cycle.

According to the Forest Act the production forest is classified as mature, if one of the maturity indicators (age or diameter) has been achieved. The maturity by the volume is achieved first, the next will be the technical maturity, then maturity by the price and finally the maturity by the profit. Much later the biological maturity will arrive. Usually the maturity age or the maturity diameter is fixed by the Forest Act. At the moment in Estonia a new Forest Act is worked out, which may change the maturity norms of the forests. The aim of the present study was to analyze the impact of changing the maturity ages and compare the results with the situation, when the maturity age is determined by the profit. The following maturity norms were analysed:

1) the valid official maturity norms stated by the Forest Act from the year 1998 (Table 1);

2) the maturity norms, proposed by the project of the Forest Act (Table 2);

3) the maturity calculated by the profit.

Table 1. The valid maturity norms enforced by the Forestry Act from the year 1998 (maturity age, years / maturity diameter, cm) (Forest Act 1988, Regulation of the maturity age 1999)

Dominant tree species	Site index of stands					
	Ia	I	II	III	IV	V
Pine	100 / 28	100 / 28	100 / 28	100 / 26	100 / 24	100 / 22
Spruce	80 / 27	80 / 26	80 / 24	80 / 24	80 / 22	80 / 18
Birch	70 / 24	70 / 23	70 / 22	70 / 20	70 / 18	70 / 16
Non coniferous hardwood	100 / 32	100 / 31	100 / 30	100 / 29	100 / 28	100 / 27

Table 2. The maturity ages, proposed by the project of the Forest Act /11/ (maturity age, years / maturity diameter, cm) (http://www.envir.ee/oigusaktid/eelnoud/)

Dominant tree species	Site index of stands					
	Ia	I	II	III	IV	V
Pine	90 / 32	90 / 30	100 / 30	120 / 30	100 / 28	140 / 26
Spruce	70 / 29	80 / 28	90 / 27	100 / 26	100 / 23	100 / 20
Birch, black alder	60 / 26	70 / 26	70 / 24	80 / 23	70 / 19	70 / 16
Aspen	50	50	50	50	50	50
Non coniferous hardwood	90 / 32	90 / 30	100 / 30	120 / 30	100 / 28	140 / 26

Methods

Estonian forest inventory data generalised by A. Kiviste (1995) served as start point for stand-wise simulation of the growth, thinning and final cutting to evaluate the impact of different maturity norms on annual yield and profitability of Estonian forests. The method of calculation has been earlier used in modelling the demand-supply balance of wood fuel (Muiste&Padari 2002). As the best characteristics to determine the forests growth and productions are site type (giving information about species compositions of forest stand and moisture regime of the soil) and site index (describing the rate of trees growth), the average annual yield of assortments was calculated for every site type in every site index. Mean annual increment (MAI) of the yield of assortments, MAI of assortments' price and MAI of profit were the output variables of the simulation. The stages of calculation were the following:

1. Growth of forest was simulated with models, created by A. Kiviste (Kiviste 1995, 1997). In these models the thickness of organogenic layer of soil (OHOR) was used to characterize the site type. Initial data (age, height, diameter, number of trees and volume per hectare) were found by using the model described above. These parameters were calculated for all tree species for every OHOR and for every site index, when the average diameter (mean DBH) was at least 7,5 cm.

2. Taking initial data as the base and using growth models by A. Kiviste (Kiviste 1997, 1999) models, the growth of forest (the diameter and the height) was simulated year by year. Besides equations of growth, diameter dependency on stand density was considered. This model (created by Artur Nilson and Allar Padari) is not published, but has been used in the information system of the Estonian State Forest Management Organization. Also the natural fellout was considered.

3. The simulation programs checked the fit for thinning using the models by H. Korjus (Korjus 1999). Since in real life is difficult to organize thinning in optimal time, the norm of density (recipial of square root density, somewhat similar to tree distance) for pre commercial thinning was increased by 5 %. When the appropriate density level was achieved, the thinning was simulated. Mean diameter of the trees thinned was less than initial one of the stand.

4. The quantities of different assortments were calculated for every year for all trees. The traditional forest inventory in Estonia is focused on industrial wood (sawlogs, pulpwood and traditional fuelwood) and does not include information about forest residues. In the present study these residues were also included in the calculation. For calculation of volumes of assortments several models were used:

• Trees were divided into diameter classes by normal distribution (Padari 1999);

• Height for every diameter class was calculated (Padari 1999);

• Volumes of different assortments were calculated according to the diameter and height, using the equation of taper curve formula by R. Ozolins (Standard of Forest Inventory 1988). This equation is widely used in calculation of volumes of Estonian forests. Assortments were divided into different groups by top diameter and the volume of top was added to the volume of branches;

• The volumes of branches were estimated roughly as a percentage of the volume of the stem – 7% in pines, 6% in birch and 8% in other tree species (Reference Book of Forestry 1966).

• The calculated volumes of assortments were corrected according to percentage of damages and defects, which depend on the tree species and the age. After that the effect of crook and the knotty were calculated (Padari 1999).

• The volumes of logs, small dimension logs and pulpwood were calculated without bark, the fuel wood, tops and branches with bark. The volume of leaves and needles was not included in the calculation.

5. The age of clear cutting was found separately for different maturity norms. If the age of maturity determined by the laws and other regulations was achieved earlier than the age of maturity by the profit, the last one was selected. The age of clear cutting was selected by profit maturity, which was found by comparing incomes and expenses for every year. In the calculation of the income the average prices of assortments, the cost of harvesting and the afforestation were used. The calculated profit was divided by age of forest stand, giving the average profit per year. The age of the greatest annual profit was set as the maturity age.

6. The volumes of calculated assortments from thinning and final felling were compounded. These sums were divided with length of rotation period and resulted average annual production of assortments of every site index, every OHOR and every tree species.

7. Next, the composition of trees species for every sites type and for every site index class were found as average of similar stand groups of forest inventory data in the database of state forests. Then the productions of different assortments were calculated. According to the composition of tree species of site types, the productions and profit of different site types and quality classes were calculated. The productions were not calculated for strictly protected forests and for protected forests 50 % of the potential was taken into account. These forests were located only in state forests.

8. As in reality it is impossible to harvest forest always in optimal time, the results were decreased by

15 %. Among the reasons, which may decrease the yield, the following can be pointed out:

- the delay of harvesting due to the afforestation time (stated by the Forest Act) of neighbouring felling areas;
- on some remote sites and in heavy soil conditions the harvesting may be unprofitable;
- it is complicated to give prognosis of some types of forest damages (forest fires, windstorms, wild animals etc.), which may decrease the production and profit.

After estimation of the production capacity of forests of different site types and site indexes, the data on distribution of forest areas by site types and site indexes are needed. The available information about state forests is reliable, as the inventory data are updated continuously. But only a part of private forests is described by fresh inventory data. To describe all private forests, the data about state forest enterprises, state and collective farms from the period 1982-1993 was generalized. From the summarized tables describing site types and quality classes of these forests, the data on state forest were excluded. In this way the distribution of private forests by site types and quality classes was obtained. Due to the afforestation of abandoned agricultural lands during the period 1982 – 1993, the forest area has enlargeed. For these corrections the remote sensing data on Estonian forests was used (Peterson 2001). According to this data, the forest area of Estonia is 2 157,8 thousand ha. It includes also the forest land, which was not covered by forest inventory before 1993 (former Soviet military areas).

Table 3. Annual yield and profit for different maturity norms

Maturity	Tree species	Volume, thousand m³/year						Annual profit, million EEK
		Logs	Small dimension logs	Pulpwood	Fuel wood	*Total*	Tops, branches	
Valid Forest Act	Aspen	89,0	27,4	193,9	139,6	*449,9*	100,2	28,78
	Birch	466,0	308,9	909,2	221,2	*1905,3*	410,0	459,26
	Spruce	971,1	388,9	536,8	114,5	*2011,3*	296,5	900,19
	Black alder	56,0	29,1		160,0	*245,1*	54,4	15,44
	Grey alder	4,6	3,3		156,1	*164,0*	40,3	0,60
	Pine	1026,3	500,2	714,1	16,4	*2257,1*	378,8	853,10
	Ash	15,5	10,9		12,3	*38,8*	8,0	21,14
	Oak	7,8	2,6		3,6	*14,0*	2,6	9,33
	Total	**2636,3**	**1271,3**	**2354,0**	**823,6**	***7085,3***	**1290,9**	**2287,84**
Project of the Forest Act	Aspen	74,3	20,2	197,7	155,0	*447,2*	93,5	25,18
	Birch	456,5	248,3	853,9	280,7	*1839,3*	371,1	432,09
	Spruce	936,8	306,3	514,3	160,1	*1917,4*	270,3	842,60
	Black alder	47,3	19,9		166,2	*233,4*	49,0	12,60
	Grey alder	4,0	3,0		151,0	*158,1*	38,3	0,55
	Pine	1014,2	420,7	615,0	34,2	*2084,0*	342,4	801,60
	Ash	17,3	9,5		11,1	*37,9*	7,6	22,41
	Oak	7,7	2,1		3,2	*13,0*	2,4	9,04
	Total	**2558,0**	**1030,1**	**2180,9**	**961,4**	***6730,4***	**1174,7**	**2146,06**
Maturity by the profit	Aspen	85,6	24,8	195,9	148,0	*454,3*	99,3	27,84
	Birch	472,6	321,8	922,0	203,9	*1920,3*	420,5	467,27
	Spruce	952,8	461,8	556,5	82,6	*2053,6*	307,7	921,30
	Black alder	55,1	28,7		160,3	*244,0*	54,4	15,19
	Grey alder	3,2	2,5		156,1	*161,8*	38,8	0,37
	Pine	940,0	625,8	836,9	6,8	*2409,5*	422,3	875,72
	Ash	15,3	10,9		12,3	*38,6*	8,0	20,93
	Oak	7,6	2,9		3,9	*14,4*	2,8	9,24
	Total	2532,2	1479,2	2511,3	773,9	*7296,5*	1353,8	2337,87

Table 4. The diameters of maturity calculated by the profit

Dominant tree species	Site index class of stands					
	Ia	I	II	III	IV	V
Pine	27	26	23	22	20	19
Spruce	26	23	20	19	18	15
Birch	28	25	22	19	16	12
Black alder	27	25	22	19	17	14
Aspen	25	23	20	20	19	19
Hardwood	32	30	28	24	21	19

Results

Based on the data on production capacity of different assortments of different types of forests, the sums of areas for different site types and quality classes were found. The calculations were carried out by communes separately for state and private forests. The final results of the calculation are presented in the tables – in Table 3 the annual yield and the profit, in Table 4 the diameters, corresponding to the maturity age by profit.

Conclusions

Based on the results of the calculation (Table 3), it is possible to draw the conclusions. If the Estonian forests are managed according to the valid Forest Act, the annual yield in the long run will be 7,085 Mm³. But if the project of the Forest Act is enforced, the annual yield eventually will be 6,730 Mm³. Among the three alternatives (the valid official maturity norms stated by the Forest Act, the maturity norms, proposed by the project of the Forest Act and the maturity norms calculated by the profit), the biggest annual harvested volume (7,296 Mm³) and the profit can be achieved, if the maturity of the forest stands is determined by the profit. From the economical point of view the worst choice is, if the harvesting is carried out according to the regulations of the project of the Forest Act. Then the total harvesting volume will be 566 thousand m³ less than in the case of determining the maturity by profit and 355 thousand m³ less compared with the valid regulations. Also the profit will be decreased, correspondingly by 192 million EEK and 142 million EEK. Only the volume of traditional fuel wood will be biggest, if forest harvesting is carried out according to the regulations of the project of the Forest Act. It is caused by the increased volume of the rotten trees.

The data presented in Table 3 characterize the situation, if the age distribution of forests is normal. Today the share of older forests is relatively high and the real harvested volumes will be bigger. But the main conclusion can be generalized to the present structure of the forests also – if harvesting is carried out according to the regulations of the new Forest Act, increasing the maturity age or the diameter, it will give significant recession from the economical point of view. To increase the profitability, the maturity diameters should be decreased.

References

Kiviste, A. 1995. Eesti Riigimetsa puistute kõrguse, diameetri ja tagavara sõltuvus puistu vanusest ja kasvukohatingimustest 1984. - 1993. a. metsakorralduse takseerkirjelduste andmeil. [Function of stand height, diameter and volume depending on stand age and site factors for Estonian state forests]. EPMÜ teadustööde kogumik nr. 181, Tartu: 132-148. (in Estonian)

Kiviste, A. 1997. Eesti Riigimetsa puistute kõrguse, diameetri ja tagavara vanuseridade diferentsmudel 1984. - 1993. a. metsakorralduse takseerkirjelduste andmeil [Difference model of stand height, diameter and volume for Estonian state forests, based on the inventory data from years 1984-1993]. EPMÜ teadustööde kogumik nr. 189. Tartu: 63-75. (in Estonian)

Kiviste, A. 1999. Eesti puistute kasvumudelitest. [On growth models of Estonian stands] EPMÜ Metsandusteaduskonna toimetised nr. 32. Pidev metsakorraldus. Tartu: 28-36. (in Estonian)

Korjus, H. 1999. Hooldusraiete mudelitest. [About models of thinning] EPMÜ Metsandusteaduskonna toimetised nr. 32. Pidev metsakorraldus. Tartu : 44-49. (in Estonian)

Metsamajanduse teatmik, 1966. [Reference book of forestry] Tallinn, 375 p. (in Estonian)

Metsaseadus (Forest Act), RT I 1998, 113/114, 1872, RT I 2002, 63, 387 (in Estonian)

Muiste, P., Padari, A. 2002. Demand-supply Balance of Wood Fuel for Energy Production in Estonia - Proceedings of the 12th European Conferenceon Biomass for Energy, Industry and Climate Protection, Vol.1, Amsterdam, the Netherlands : 91-94

Nooremate kui saja-aastaste männi- ja kõvalehtpuupuistute, kaheksakümneaastaste kuusikute ning seitsmekümneaastaste kaasikute lageraiet lubava keskmise rinnasdiameetri ja täiuse kinnitamine. Keskkonna ministri 01.04.1999 määrus nr 38 , 1999 [Regulation of the maturity age by the average diameter. Ministry of Environment, Regulation No 38 from 01.04.1999] , RT lisa 1999, 68 : 892 (in Estonian)

Padari, A. 1999. Kasvava metsa hindamisest. Sortimendid ja rikked. [About the assessment of the growing forest. Assortments and defects] EPMÜ Metsandusteaduskonna toimetised nr. 32. Pidev metsakorraldus. Tartu : 37-43. (in Estonian)

Peterson, U. 2001. Eesti metsad pealtvaates.[Estonian forests from the outer side] Eesti Mets, 3, 2001: 6-7. (in Estonian)

The Standard of Forest Inventory of Latvian SSR. (in Russian). Riga, 1988

http://www.envir.ee/oigusaktid/eelnoud/

Received 26 March 2003

АНАЛИЗ ВОЗРАСТА СПЕЛОСТИ ЛЕСОВ ЭСТОНСКОЙ РЕСПУБЛИКИ

А. Падари, П. Муйсте

Резюме

В Эстонии в настоящее время разрабатывают новый Лесной Закон, который может менять нормы спелости лесов. Целью данной работы был анализ последствий изменения возраста спелости лесов и сравнение с ситуацией, когда возраст спелости определяется по прибылы. Результатами расчета доказано, что обьем рубки и прибыль уменьшаются, если увеличить возраст спелости.

Ключевые слова: нормы спелости лесов, обьем рубки, прибыль