

# Production and Quality Requirements of Forest Tree Seedlings in Finland

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About 45% of the total area regenerated each year in Finland is currently planted with nursery stock. Scotch pine (*Pinus sylvestris* L.), Norway spruce (*Picea abies* (L.) Karst.), and birches (*Betula* spp. L.) are the primary species. Container production comprises 86% of the total. Over half the seed for production of these species comes from seed orchards. Seedling quality standards are high, and compliance is monitored by inspectors supervised by the Finnish Ministry of Agriculture and Forestry. Health and vigor standards and height and diameter specifications for various stock size classes are provided for container-grown and bareroot seedlings, along with average selling prices. *Tree Planters' Notes* 49(3): 56-60; 2000.

## Seedling Production

Natural regeneration was the prevailing forest renewal method in Finland before 1960. Artificially regenerated areas increased rapidly during the 1960's (figure 1) (FFRI 1998). By 1997, 19% of the overall regeneration area was seeded, 45% was planted, and 36% was regenerated naturally by seed-tree and shelter-tree methods.

About 210 to 250 million seedlings were produced annually in the 1980's (figure 2). In the last few years, this figure has decreased to 150 million. The total number of central nurseries, excluding smaller family-owned

nurseries, is 25 (table 1). The total production area of the nurseries is 456.2 ha (1127 a), of which 33.6 ha (83 a) are dedicated to production under plastic. In the early 1990's, nurseries owned by the Central and District Forestry Boards, producing more than half of the planting stock, were converted into commercial enterprises.

Nursery practices have been subject to changes during the past 30 years. The use of regular farmland and nutrients in the form of livestock manure, compost, and green manuring were replaced in the 1970's by use of light sandy soils and peat as substrates and inorganic soluble fertilizers. In addition, plastic greenhouses with automated irrigation, fertilization, and temperature-regulating devices were introduced.

About 42% of the nursery stock produced is Scotch pine (*Pinus sylvestris* L.); 45%, Norway spruce (*Picea abies* (L.) Karst.); 9%, silver birch (*Betula pendula* Roth); and 2%, downy birch (*Betula pubescens* Ehrh.). The remaining 3% is lodgepole pine (*Pinus contorta* Doug. ex Loud.), Siberian larch (*Larix sibirica* Ledeb.), and others (figure 2). Container seedling production increased in the 1980's for all the main tree species to such an extent that in 1998 container planting stock amounted to 86% of all planting stock (figure 3). However, bareroot seedlings continue to be planted, mainly in southern Finland.

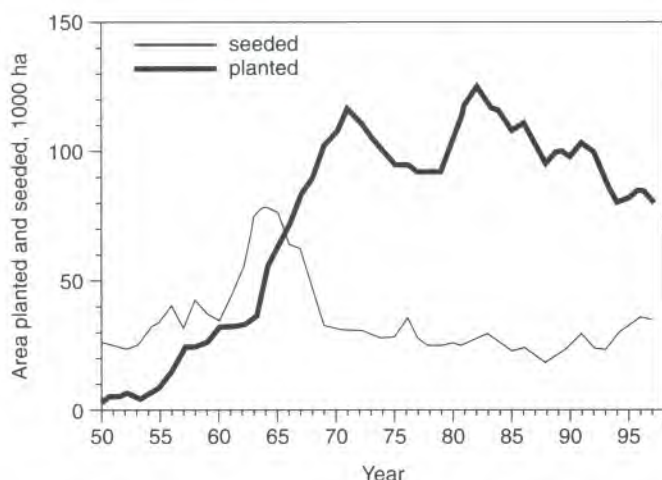


Figure 1—Areas planted and direct seeded in Finland in the years 1950–1997.

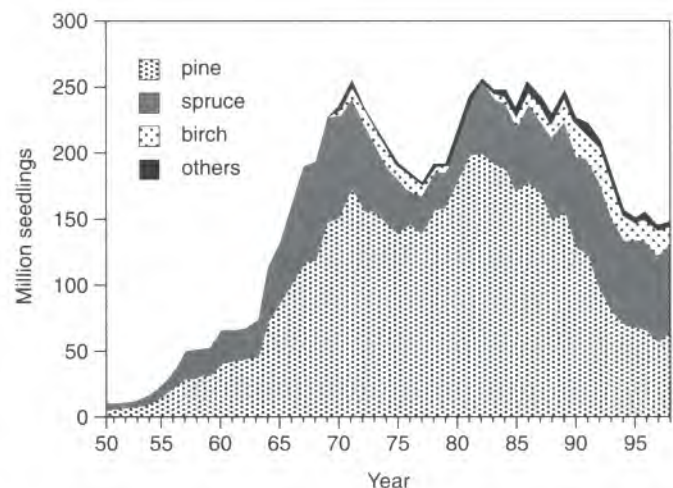


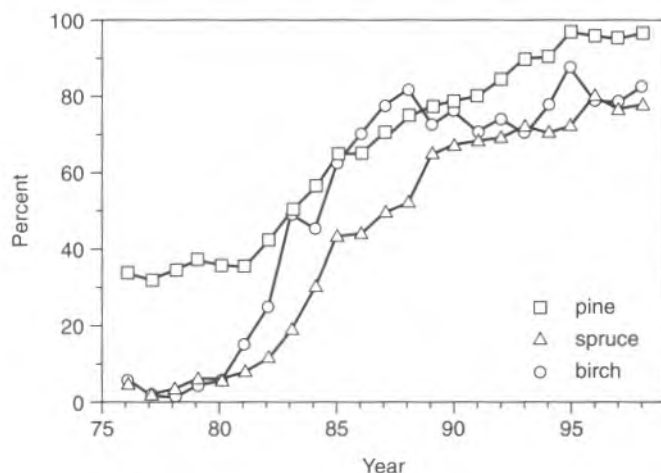
Figure 2—Seedling material delivered for planting by tree species in the years 1950–1998. The tree species compositions presented for the years 1950–1964 are estimates.

**Table 1**—Nursery area and seedling production by main ownership categories in 1998<sup>a</sup>

Nursery ownership category	No. of nurseries	Land area (ha) <sup>b</sup>			Millions of seedlings delivered
		Bareroot	Open land Container	Plastic-covered	
Finnish Forest & Park Service	3	7.2	9.6	6.5	32.7
Finnish Forest Research Institute	1	3.0	1.5	0.7	1.6
Commercial nursery companies (8)	20	293.3	79.4	21.7	89.9
Forest industry	1	0.0	5.8	1.3	7.1
Others (family-owned)	~70	11.3	11.5	3.4	17.6
Total	—	314.8	107.8	33.6	148.9

<sup>a</sup>Adapted from Finnish Ministry of Agriculture and Forestry.

<sup>b</sup>1 hectare = 2.47 acres.

**Figure 3**—Percentage of container seedlings in the years 1976–1998.

The most common types of bareroot stock are transplants (pine, 2 + 1; spruce, 2 + 2; birch, 1 + 1), "plug + 1" seedlings, and root-pruned 2-year-old seedlings. The use of plug + 1 seedlings is currently increasing. The most common container types have been Paperpots and Ecopots (Lannen Tehtaat, Finland); in 1997 they accounted for 70% of all container stock. However, a rapid shift is taking place towards hard-plastic containers (for example, Plantek, Lannen Tehtaat, Finland; BCC, Sweden) with ribbing and air slits to facilitate air-pruning and inhibit spiraling and deformation of roots. The Vapo method, which includes root pruning as part of the cultural practice, was developed to prevent root spiraling and other forms of deformation (Parviainen and Tervo 1989) but has not become common. Most container pine and birch seedlings are planted when 1 year old, and container spruce seedlings are planted when 1 or 2 years old.

### Classification and Quality Requirements of Nursery Stock

The genetic quality of seedlings is assured by sowing seed of good quality in the nursery. Seeds from seed orchards and selected seed stands used for seedling production must be approved by the Finnish Forest Research Institute. About 54% of pine seedlings, 60% of spruce seedlings, and 84% of birch seedlings are grown from seed orchard seeds (table 2). Seeds collected from known stands or regions are used mainly in northern Finland where orchard seeds are less available.

Nursery production in Finland is supervised by the Ministry of Agriculture and Forestry by virtue of the Forest Reproduction Material Trade Act of 1979 and the related decision issued in 1992. Three regional seedling inspectors appointed by the Ministry control seedling quality in nurseries by conducting surveys in the spring. They do this by checking the seedling packages readied for dispatching.

The Decision of the Ministry of Agriculture and Forestry (1533/92) requires that seedlings sold shall be healthy, vigorous, and, in other respects as well, appropriate for the purpose. Seedling lots sold may include seedlings that do not meet the requirements, but such

**Table 2**—Amount of seed in kilograms<sup>b</sup> used in nurseries in 1998, by seed origin and tree species<sup>a</sup>

Species	Seed orchards	Selected seed collection stands	Known stands	Known regions	Total
Pine	374	1	158	163	696
Spruce	672	46	406	6	1130
Silver birch	38	3	4	1	45
Downy birch	2	2	1	0	5
Others	144	2	85	1	232

<sup>a</sup>Adapted from Finnish Ministry of Agriculture and Forestry.

<sup>b</sup>1 kilogram = 2.2 pounds.

Table 3-*Minimum size requirements by size class for transplanted hareroot seedlings, based on median seedling height by species and lot*

Species	Size Class I			Size Class II				Size Class III				Size Class IV			
<b>Scotch pine (<i>Pious sylvestris</i>)</b>															
Median seedling height (cm) of lot	12	13	14	15	16	17	18	19	20-21	22-23	24-25	≥ 26			
Minimum seedling height (cm)	6	7	8	9	10	11	12	13	14	16	17	19			
Minimum stem diameter (mm)	2.5a	3.0	3.0	3.0	3.0	3.0	3.0	3.5	3.5	3.5	3.5	4.0			
<b>Norway spruce (<i>Picea abies</i>)</b>															
Median seedling height (cm) of lot	27	28-30		31-33			34-36		37-39	40-42		≥ 43			
Minimum seedling height (cm)	18b	19		21			23		25	27		30			
Minimum stem diameter (mm)	4.0b	4.5		4.5			5.0		5.0	5.0		5.5			
<b>Birch (<i>Behan</i> spp.)</b>															
Median seedling height (cm) of lot	5_40	41-45		46-50		51-55		56-60		61-65	66-70	71-80	81-90	91-100?101	
Minimum seedling height (cm)	25	25		27		30		33		37	42	46	51	56	60
Minimum stem diameter (mm)	3.0	4.0		4.0		4.0		5.0		5.0	5.0	5.5	5.5	5.5	5.5

<sup>a</sup>For seedlings in the provinces of Oulu and Lapland, the value is 2.0 mm.

<sup>b</sup>For seedlings in the provinces of Oulu and Lapland, the minimum height is 15 cm and the minimum diameter is 3.5 mm.

seedlings may make up no more than 5% of the total number. A seedling does not meet the above requirements if any of the following conditions are true:

1. The seedling is afflicted by plant diseases or pests (or damage caused by them), thereby impairing its vigor.
2. The seedling (in the case of pine, spruce, and birch) does not meet the size requirements (tables 3 and 4), or additionally for a container seedling, the growing density and container volume are such that the vitality or structure of the seedling is not suitable for planting.
3. The shoot or root system of the seedling is markedly curved, there are insufficient lateral roots, or the root system is otherwise insufficient or faulty.
4. The leading shoot of a conifer seedling is abnormal or there is more than 1 leading shoot (with the exception of spruce seedlings, which may have 2 leading shoots).
5. The seedling has serious bark injuries or the bark is torn.

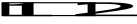
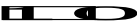
If seedling lots show any of these above conditions, they must be sorted to discard the unacceptable ones or, in the case of serious diseases (Lilja and others 1997) and frost damage, the entire seedling lot may be discarded. Insects may also cause extensive damage. In the 1980's, lygus bugs (*Lygus rugulipennis* Popp.) caused growth disturbances (multiple leaders and bud disorders) (Holopainen 1986; Holopainen and Rikala 1990) in Finnish nurseries, and the affected seedlings were culled in accordance with the regulations. Subsequently, however, studies (Raitio and others 1992) showed that only the most serious of these disturbances lead to increased mortality or markedly retarded shoot growth.

Seedling size is normally determined in the autumn

in conjunction with nursery stock inventory. Each seedling lot is inventoried and classified individually. A seedling lot in this context means a group of seedlings, the treatment and seedling height of which are uniform, grown in a definable area from a single seedlot or propagated vegetatively. Fractions of the seedling lot whose height clearly differs from that of the rest of the seedlings can also be defined as separate seedling lots. The median height of the seedlings in a lot is determined by a sampling protocol that provides a reliable estimate on which to base lot classifications according to size. The median height of the sample seedlings assigns the size class and the minimum acceptable height and diameter of an individual seedling in the lot (tables 3 and 4). All seedlings shorter or thinner than the lower limits of a particular class must be discarded—they may not be removed to another smaller-size seedling lot. If the median height of the lot exceeds the maximum value, the entire lot must be rejected.

The culling of seedlings that are too small with respect to the median height of the lot is based on the idea that these small seedlings are genetically inferior or damaged due to environmental factors. Be that as it may, the undersized seedlings are considered too weak to withstand the planting shock. The culling of a whole container seedling lot that is too tall with respect to the allowable median height for the particular growing density is based on the idea that the seedlings are not sturdy enough and that the root system may be compressed due to an inadequate container volume. The size requirements applied are based on seedlings measured at nurseries (for example, Huuri and others 1970; Kokkonen and Räsänen 1980) and outplanting tests (for example, Pohtila 1977; Rikala 1989).

Table 4—Container seedlings: the maximum allowable median seedling height of a lot, determined by species and growing density, and the minimum allowable seedling height, determined by the median seedling height of a lot"

Growing density (containers/m <sup>2</sup> )	Max. median seedling ht. (cm)	Seedling height (cm)														
		Median seedling height of lot														
Pine ( <i>Pinus</i> spp.)																
		5	8	9-10	11	12	13	14	15	16	17	18	19	20-21	22-23	24-25
		Minimum height of a seedling in the lot														
< 300	25				4	5	6	7	8	9	10	11	12	13	14	15
300-399	23				4	5	6	7	8	9	10	11	12	13	14	
400-499	21				4	5	6	7	8	9	10	11	12	13		
500-599	19				4	5	6	7	8	9	10	11	12			
600-799	17				4	5	6	7	8	9	10					
800-999	16				4	5	6	7	8	9						
1,000-1,299	15				4	5	6	7	8							
1,300-1,600	14				4	5	6	7	—	—						
1,601-2,000 <sup>b</sup>		3	4		4	5										
2,001-2,500 <sup>b</sup>		3	4													
2,501-3,000 <sup>a</sup>	6	3														
Spruce ( <i>Picea</i> spp.)																
		5	12	13-14	15-16	17-18	19-20	21-23	24-26	27-30	31-35	36-40				
		Minimum height of a seedling in the lot														
< 300	40	4	6	8	9	10	11	12	14	16	18					
300-399	35	4	6	8	9	10	11	12	14	16						
400-499	30	4	6	8	9	10	11	12	14							
500-599	26	4	6	8	9	10	11	12	—							
600-799	23	4	6	8	9	10	11	—								
800-999	20	4	6	8	9	10										
1,000-1,299	17	4	6	8	9											
1,300-1,600	16	4	6	8	—											
Birch ( <i>Betula</i> spp.)																
		5	45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-100	101-110		
		Minimum height of a seedling in the lot														
< 100	110	25	27	29	32	36	40	44	48	52	56	60	64			
100-124	100	25	27	29	32	36	40	44	48	52	56	60	—			
125-149	90	25	27	29	32	36	40	44	48	52	56					
150-174	80	25	27	29	32	36	40	44	48	52						
175-199	70	25	27	29	32	36	40	44	48							
200-224	60	25	27	29	32	36	40	44								
225-249	50	25	27	29	32	36	40									
250-275	45	25	27	29	32	36										

<sup>a</sup>When growing pine and spruce seedlings, the minimum volume of the container is 45 cm<sup>3</sup> and the maximum growing density is 1600 containers/m<sup>2</sup>. The maximum growing density for birch is 275 containers/m<sup>2</sup>. The seedling lots are to be thinned (m<sup>2</sup>/10.76 ft<sup>2</sup> 2.54 cm 1 in).

<sup>b</sup>Seedlings grown at densities between 1601 and 3000 seedlings/m<sup>2</sup> and using containers with volumes of at least 15 cm<sup>3</sup> may be used only in the provinces of Oulu and Lapland (northern Finland).

The quality requirements of forest reproductive material in the upcoming directive of the Council of the European Union are unlikely to be as detailed as the present Finnish national regulations. Also, on a national level in Finland, seedling specifications in contracts between growers and customers are likely to be the focus of emphasis instead of the present control by authorities.

## Seedling Prices

Seedling prices are negotiated between seedling producers and customers, and they can vary from producer to producer (table 5). Seedling price depends on container size, the size class of seedling lot (only in the case of birch), and the seed class. Producers tend to enter into long-term contracts with customers.

**Table 5**—Average seedling prices for contract customers in 1998; value-added tax (VAT) of 22% and package costs not included

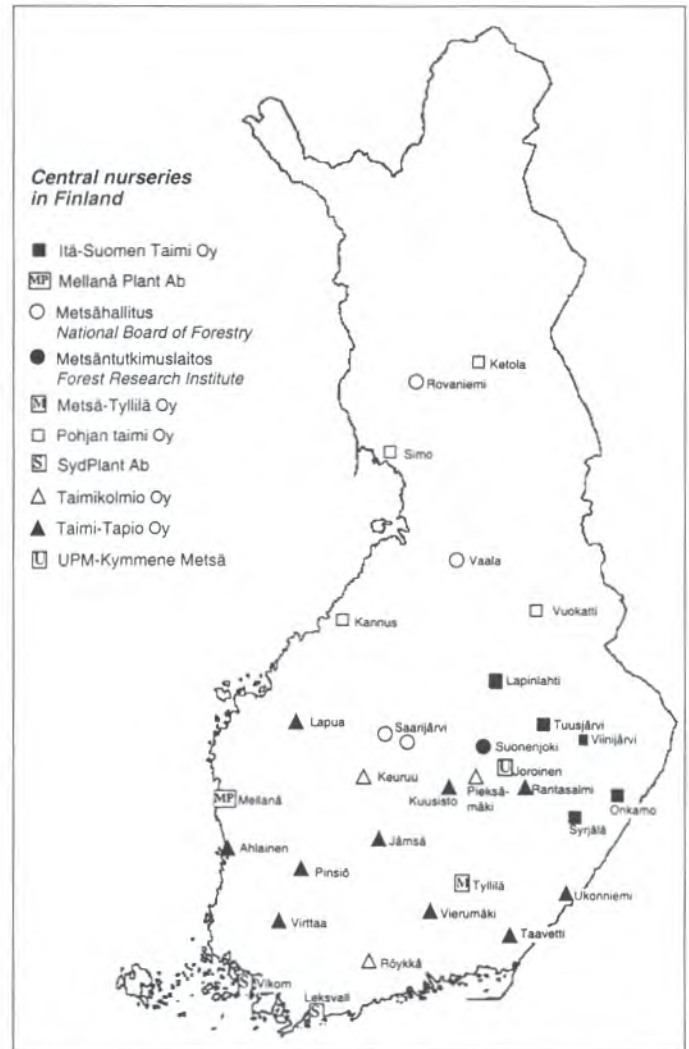
Species and stock type	Age (yr)	US\$/1,000 <sup>a</sup>
<b>Scotch pine (<i>Pinus sylvestris</i>)</b>		
Bareroot, root-pruned	2	84
Bareroot, transplanted, Plug + 1	2–3	160
Container	1–2	79–183
<b>Norway spruce (<i>Picea abies</i>)</b>		
Bareroot, transplanted, Plug + 1	3–4	200
Container	1–2	120–193
<b>Silver birch (<i>Betula pendula</i>)</b>		
Bareroot and container	1–2	165–313

<sup>a</sup>1 euro = US\$1.047

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**Figure 4**—A map showing the location of forest tree nurseries in Finland.