

Finnish Forest Research Institute  
The Department of Peatland Forestry  
Vilppula  
1978

The Finnish Forest Research Institute was founded by law on the 24th of October, 1917. At present it consists of 9 research departments:

- Department of Soil Science
  - Peatland Forestry
  - Forest Inventory and Yield
  - Forest Economics
  - Silviculture
  - Forest Protection
  - Forest Tree Breeding
  - Forest Technology
  - Mathematics

In addition to these there are an Administrative Office, and an Experimental Forest Office. There are also 4 independent research stations for special regional investigations and 4 experimental stations for special projects.

The Department of Peatland Forestry was established in 1928 in order to clarify the principles of the utilization of peatlands for forestry purposes and to investigate basic forest-improvement work covering the nutrient balance and need for fertilization, scarification, hydrology and biology of peatlands. Furthermore, the activities of the department include investigations of silviculture on peatlands, the yield of wood after drainage, afforestation methods, development of machines used in forest improvement and the structure of forest roads, among other topics.

For field experiments, the Forest Research Institute has experimental areas (79 860 ha in total) in different parts of Finland (Appendix 1) and a further 62 196 ha in national parks, nature parks and conservation areas.

After the Finnish National Board of Forestry had started systematic ditching activity for the utilization of peatlands for forestry purposes, it established in 1909 the Jaakkoinsuo experimental area in order to clarify the principles of forest drainage. The primary aim was to find out by means of experiments, how large a yield of wood can be achieved on sites with different nutrient contents and further, how various drainage efficiencies and stand treatments affect the yield. The first ditchings were carried out in 1909 and since then, they have been extended for various projects. In 1923, the experimental area was placed under the Finnish Forest Research Institute the activities of which commenced in 1918.

Mean values of some climatic factors:

Mean annual temperature	+ 3.4° C
Mean temperature in July	+16.8° C
Mean temperature in February	- 8.4° C
Sum of daily mean temperatures (>+5° C)	1 220° C
Average duration of growing season (>+5° C)	164 days
Annual precipitation	600 mm
Altitude	120 m
Latitude	62° 04'

The first experiments for determining tree growth after drainage were established as early as 1909 and further experiments have been established: in 1926, experiments in which mineral soil was applied, in 1929 liming experiments and in 1937 ash fertilization experiments. Fertilization experiments using common fertilizers were started in 1949. Strip with experiments as well as ecological experimental fields are also to be found in this area.

Point 1. Sinking of the peat surface after drainage

There are several series of poles at Jaakkoinsuo which reach down to the mineral soil. The height of the poles is adjusted by levelling. It is possible to find out by means of the pole series, how much the peat layers of different thickness have sunk as a result of drainage.

Point 2. Ecological experiments in peatland forests

Here at Jaakkoinsuo as well as in the experimental area of Kivalo in Northern Finland close to the arctic circle, there are ecological experiments on a pine swamp and a spruce-birch swamp. The effect of the growth factors of trees and the differences in the degree of efficiency induced artificially in these factors, on the total growth and the annual rhythm of growth has been studied in these experimental fields since 1960. The following growth factors have formed the primary objects of the research: ground water conditions, soil temperature, state of the ground, air temperature and air humidity. All these factors have been regulated artificially.

The ground water relations have been changed by regulating the ditch water level at 0, 10, 30, 50 and 70 cm from the ground surface (called in the following drainage depth) on various plots. The ground temperature has been lowered by removing the snow from the plots throughout the winter, causing the ground to become deeply frozen. In spring the snow has been spread back over the frozen ground and covered with straw in order to prevent the snow and frozen ground from thawing. It has been possible to keep the ground temperature at a higher than normal level by covering the soil with straw before the winter, thus retarding freezing of the soil. The nutrient state of the ground has been regulated by means of various fertilizers. The air temperature has been raised by building plastic shelters around the sample trees and, further, by heating the shelters.

The diameter growth has been measured on the sample plots at intervals of 2-3 days by a banding method. The height growth has also been measured. Further investigations have been made into the biological activity in the ground and the amount and depth distribution of tree roots.

Artificial rising of the temperature surrounding some sample trees has proved that the air temperature does not have any direct influence on the total increment of the tree in Vilppula experimental area. In plastic shelter where the temperature is higher and the trees are sheltered from the wind, the height growth of pine, spruce and birch sample trees has been higher but the circumference growth smaller than that of control trees outside the shelter.

The results of the experiments on soil temperature show, that the time when growth commences is independent of the prevailing soil temperature and is determined solely by the temperature of the surrounding air in spring. Thus, on the plots where the soil has been covered by snow and the ground around the root systems has been entirely frozen the growth starts at the same time as on the normal control plots.

It is worth noting that the straw layer used in soil temperature experiments has in later years improved the tree growth by eliminating the uptake of nutrients by the ground vegetation and by keeping the surface layer humid enough for the decomposition and mobilisation activities of the soil microbes.

The results presented in Appendices 2 and 3 show that there is a clear positive correlation between the drainage depth and the growth of the basal area of tree stand on the unfertilized plots. In the peat soil the biological activity and the mobilisation of scarce nutrient resources are the more effective the deeper the ground water table has been regulated.

The results of the fertilized plots (Appendices 4 and 5) show that the greatest difference in tree growth is found between the plots of 0 and 10 cm compared with the other drainage depths. Concerning the depths of 30, 50 and 70 cm there are no clear differences in the growth. The suitable drainage depth seems to be 30-50 cm. In practice the best result is achieved using narrow strips (Appendix 6) where the soil-water mobility is highest. The lasting period of N-fertilization shows to be about 4-5 years on the N-poor site like this.

Point 3. The distribution and cycling of nutrients in a pine swamp ecosystem

The aim of the study is to clarify the effect of the fertilization on the nutrient cycling in a drained dwarf-shrub pine swamp. Sample plots has been established as follows:

No.	Fertilization	Refertilization
1	-	-
2	NPK in 1974	-
3	NPK in 1965	-
4	NPK in 1965	NPK in 1974
5	PK in 1965	-
6	PK in 1965	NPK in 1974

N = calcium-ammoniumnitrate (25 % N) 400 kg/ha.

PK = PK fertilizer for peat soils (0-24-15) 500 kg/ha.

The following measurements have been done since June 1974:

- The amount and nutrient content in the litterfall of the trees and ground vegetation
- The nutrient content in the canopy throughfall of the trees and ground vegetation
- Tree growth measured with the banding method
- Ground temperature and other site factors

The biomass and nutrient content of the median trees and the ground vegetation has been determined when beginning the experiment. The microbiology and biological activity in the peat will also be studied in these sample plots. In the Appendix 7 is presented the nutrient content of the soil and the needles and an example of the needles and an example of the nutrient content of the tree litter.

Point 4. Production experiment (with different stand treatments)

The object of the experiment is to find out how the various stand treatments affect the total yield and the growth of the tree stand. The experiment consists of three experimental plots. Plot 5a has been kept in an unthinned natural state. On plot 5c the stand has had light thinning treatments and on plot 5b heavy treatments. This explains why there is at present a naturally regenerated spruce stand on the plot 5b. This stand forms the second tree generation after drainage. The information given in Appendix 8 indicates that the largest total yield has been achieved on the plot which had no thinning treatments (5a). Technically however, the stand is of very poor quality and so far the cuttings have not produced any income. On the plots which had thinning treatments the stands are of good quality and several cuttings have produced income.

Point 5. Production experiment (with different stand treatments)

The experiment consists of four experimental plots. Plots 7b and 8b have been kept in an unthinned natural state. On plots 7a and 8a the stands have had regular light thinnings. In this case, too, the information given in Appendix 8 indicates that the total yield of the unthinned plots (7b and 8b) has been larger than that of the plots which had thinning treatments.

Point 6. H-culture

A method called H-culture (= high-productive culture) has been developed for forest cultivation on peat. The method is suggested for the regeneration in connection with clear-cutting. The purpose of the method is to make the site as productive as possible by using an intensive treatment consisting of regulation of the water conditions, soil preparation, fertilization, reforestation and forest road building. The treatments required are as follows:

1. Clear-cutting is carried out in the regeneration area.

2. Stumps and snags are harvested.
3. Ditches surrounding the blocks as well as ditch bank roads are made.
4. In the area planting is performed in rows by using the tree species that is most suitable for the area. Simultaneously, a sufficient soil preparation and fertilization are carried out alongside the furrows.

On the turf ridges the water and nutritional conditions as well as the physical structure of the soil are in an optimum state for the tree growth. The area between the tree rows is suitable for growing of mushrooms, berries and fodder-plants for wild-life.

#### Point 7. Production experiment

The object of the experiment is to study the natural reforestation and the total yield of tree stands. At the time of ditching (in 1909) there were some small birches and willows growing in the area. After drainage a natural birch stand appeared in the area. Because the birch stand has had regular thinning treatments a natural spruce stand has appeared in the understory. The last of the birches were cut in 1958. Technically, the spruce stand growing at present in the area is of very good quality. The stand increment as well as the total yield of the area are very large as can be seen in Appendix 8.

#### Point 8. The effect of PK-fertilization on the growth in mature stand

The Forest Research Institute has established a large series of sample plots in mature stands in different parts of Finland to study the effect of PK- and NPK-fertilization on the tree growth. Results from two pairs of sample plots of this study located at Jakkoinsoo are shown in Appendix 9. On this nitrogen-rich site the increase of the annual increment caused by PK-fertilization has been approx. 3-4 solid m<sup>3</sup>/ha.

Point 9. Reforestation experiment using controlled burning

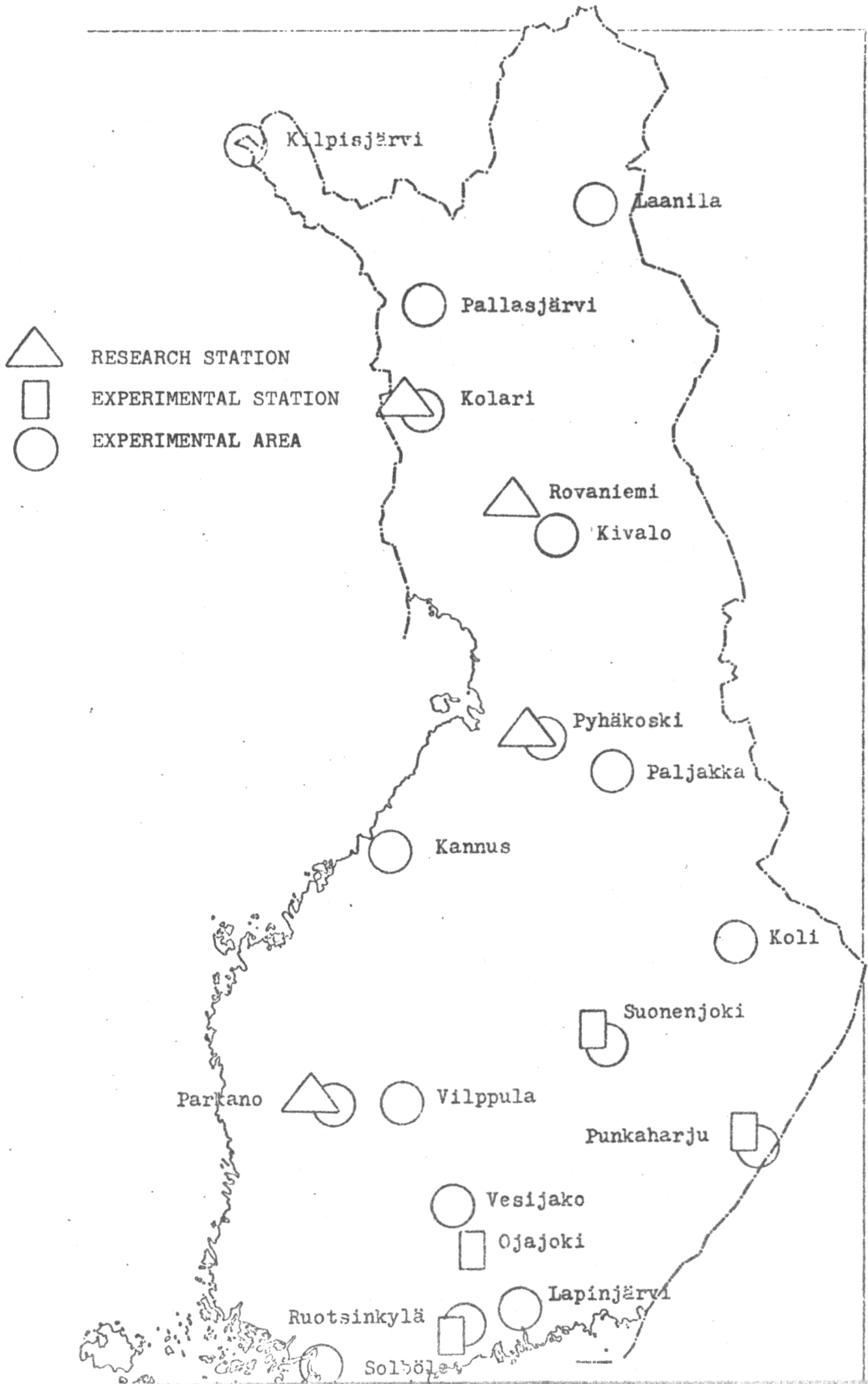
The object of the experiment is to study how controlled burning may be applied in the reforestation of peatlands. The pine stand originally on the site was cut in 1956 and controlled burning was carried out in 1958. The stand has been naturally regenerated with seed from the surrounding forests. Because the dense birch stand almost suppressed the pine seedlings the stand of birch seedlings has been controlled with a herbicide application.

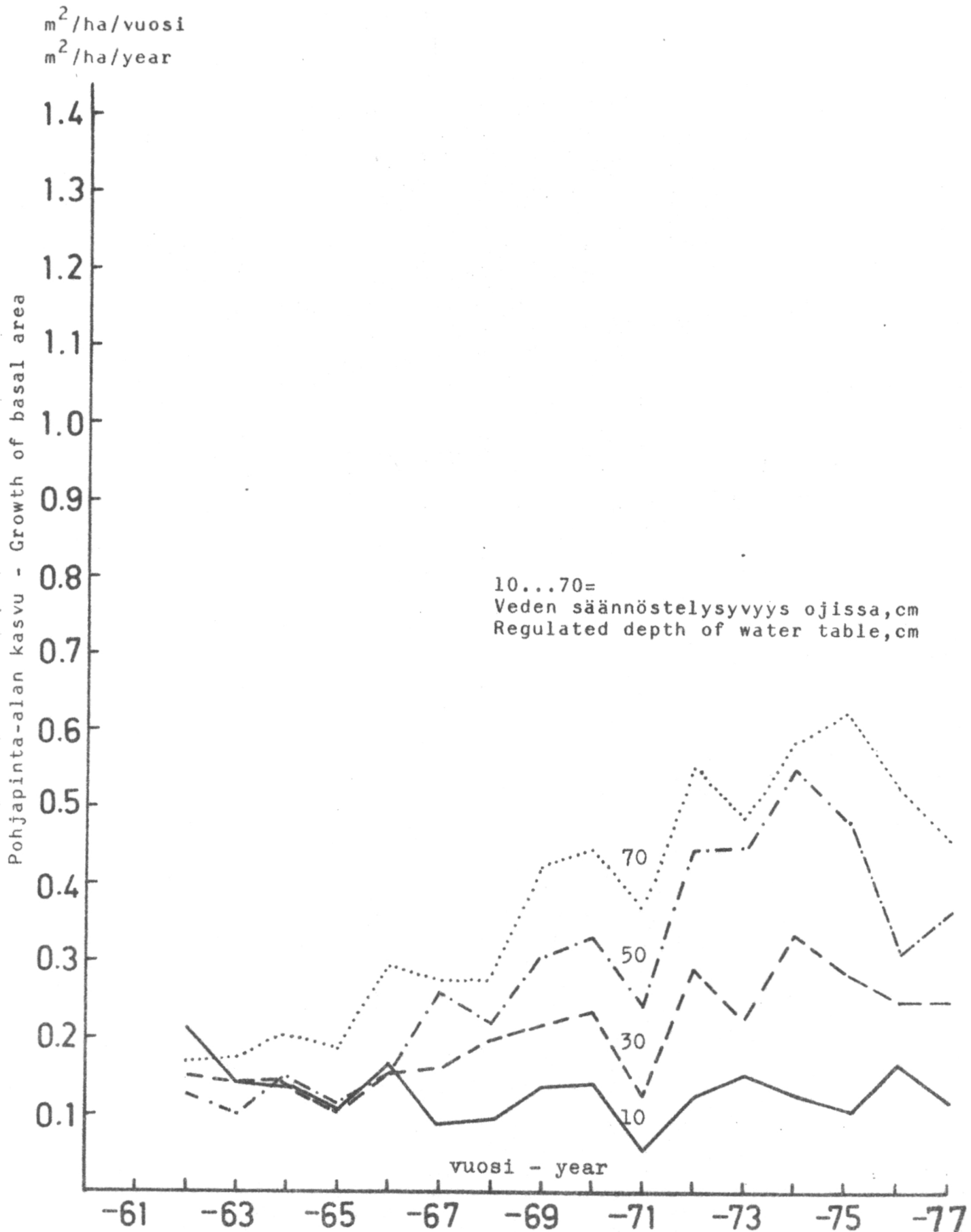
Point 10. Production experiment

The peatland site type on plot 23a is the most fertile site at Jaakkoinsoo. At the time of ditching (in 1909) there were some small-sized pines of poor growth growing in the area. It can be seen in Appendix 6 that the total yield after drainage has been very good and the annual mean growth after drainage has been calculated to be 7.6 solid m<sup>3</sup> per hectare. The experiment shows that even a swamp with a fairly thick peat layer can be made to produce very high productive stands of large timber trees. The plot 23b has been fertilized (cf. Appendix 7).

Point 11. Production experiment

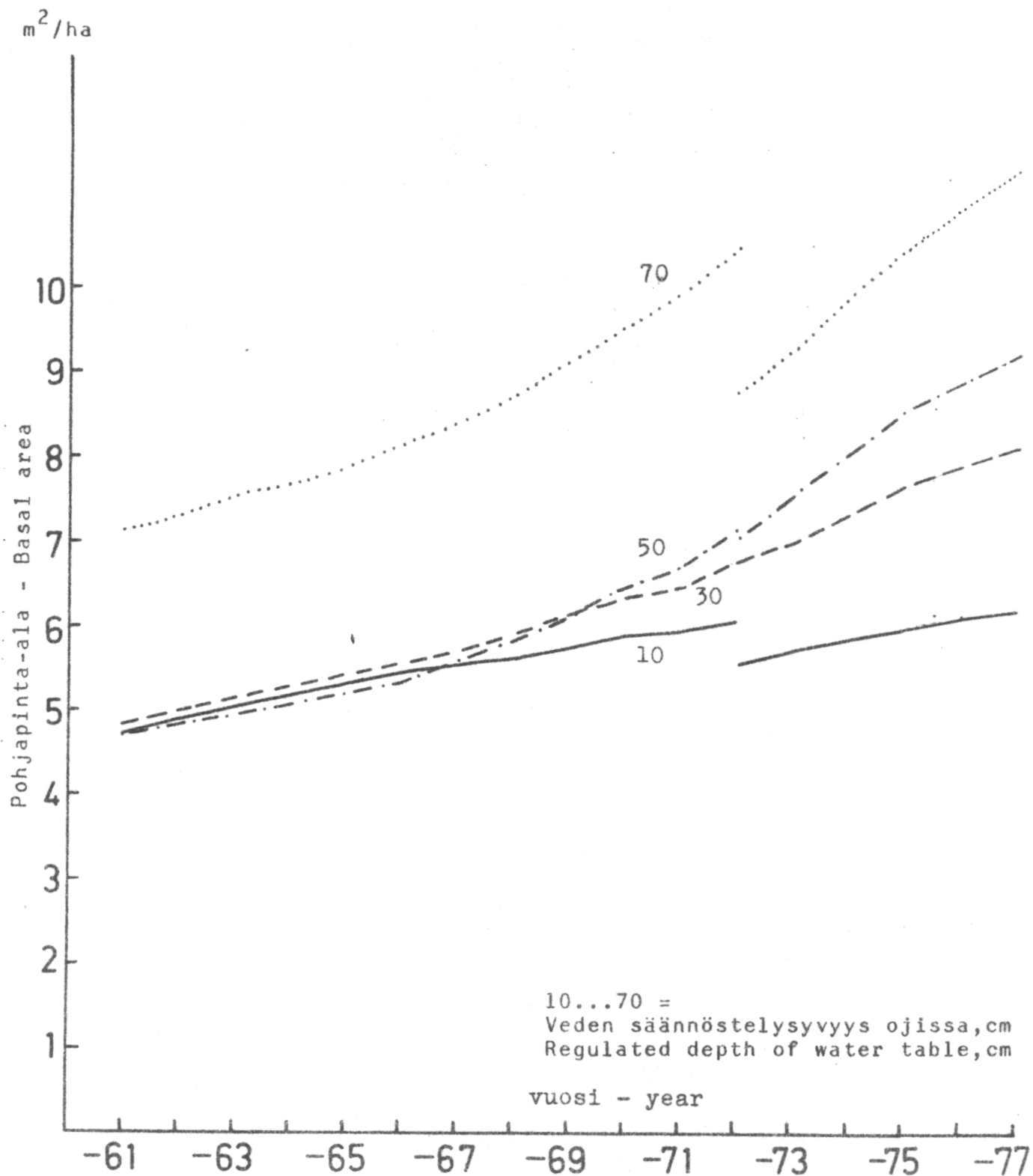
At the time of ditching plot 15a was an entirely treeless swamp. However, up to now, it has produced 248 m<sup>3</sup> of wood and the present stand consists of large timber trees of fairly good quality. The importance of the nutrient content of the site for wood production after drainage can clearly be seen in Appendix 6. The total yield and the growth of the stand on plot 23a are nearly twice those of plot 15a.





Mäntypuuston pohjapinta-alan vuotuinen kasvu rämeen koekentällä Jaakkoinsuolla.Vilppula.

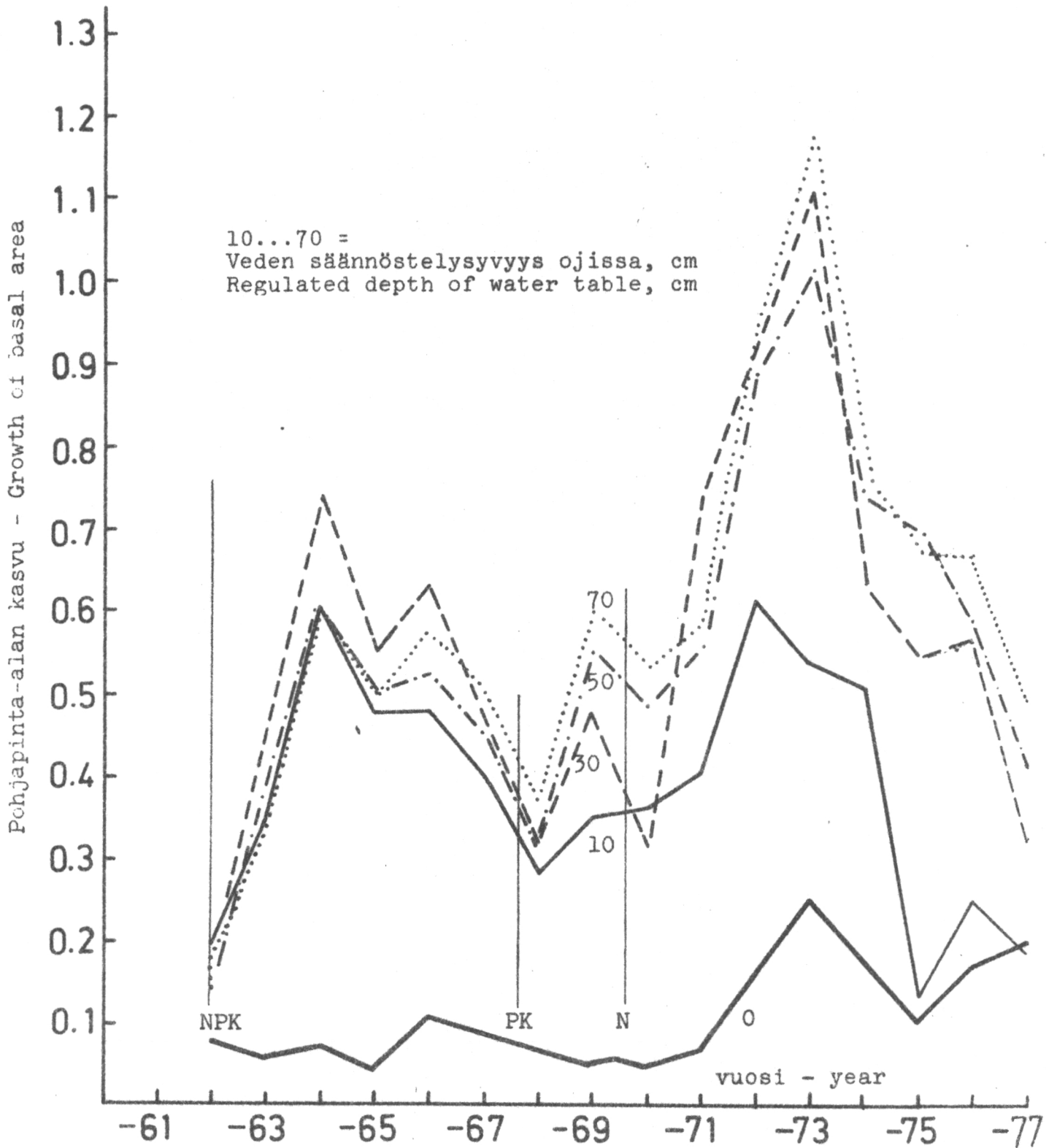
Growth of the basal area of tree stand on the Jaakkoinsuo pine swamp experimental area.Vilppula.



Mäntypuuston pohjapinta-alan vuotuinen kehitys rämeen koekentällä Jaakkoin-suolla. Vilppula.

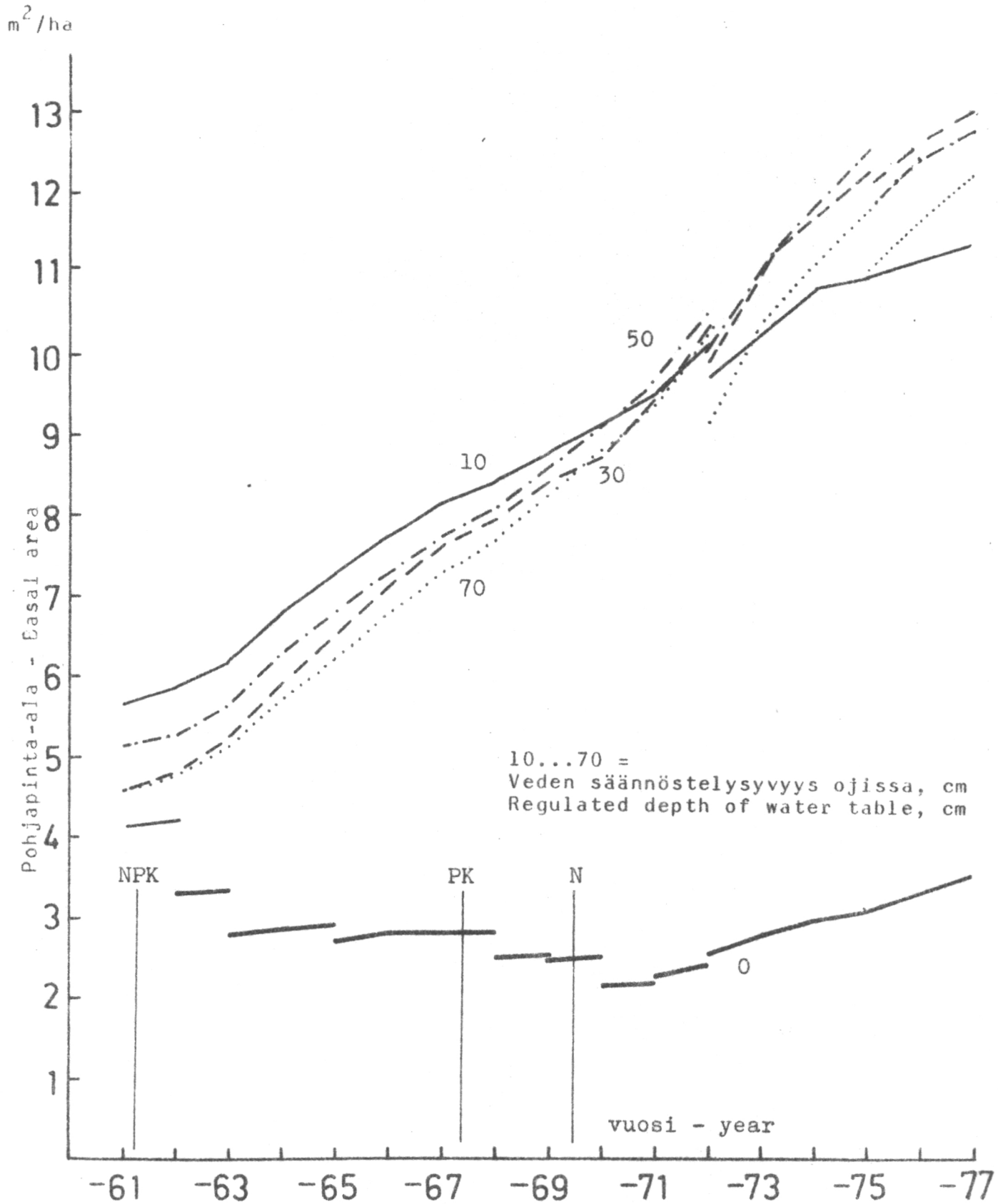
Development of the basal area of tree stand on the Jaakkoin-suo pine swamp experimental area. Vilppula.

m<sup>2</sup>/ha/vuosi  
m<sup>2</sup>/ha/year



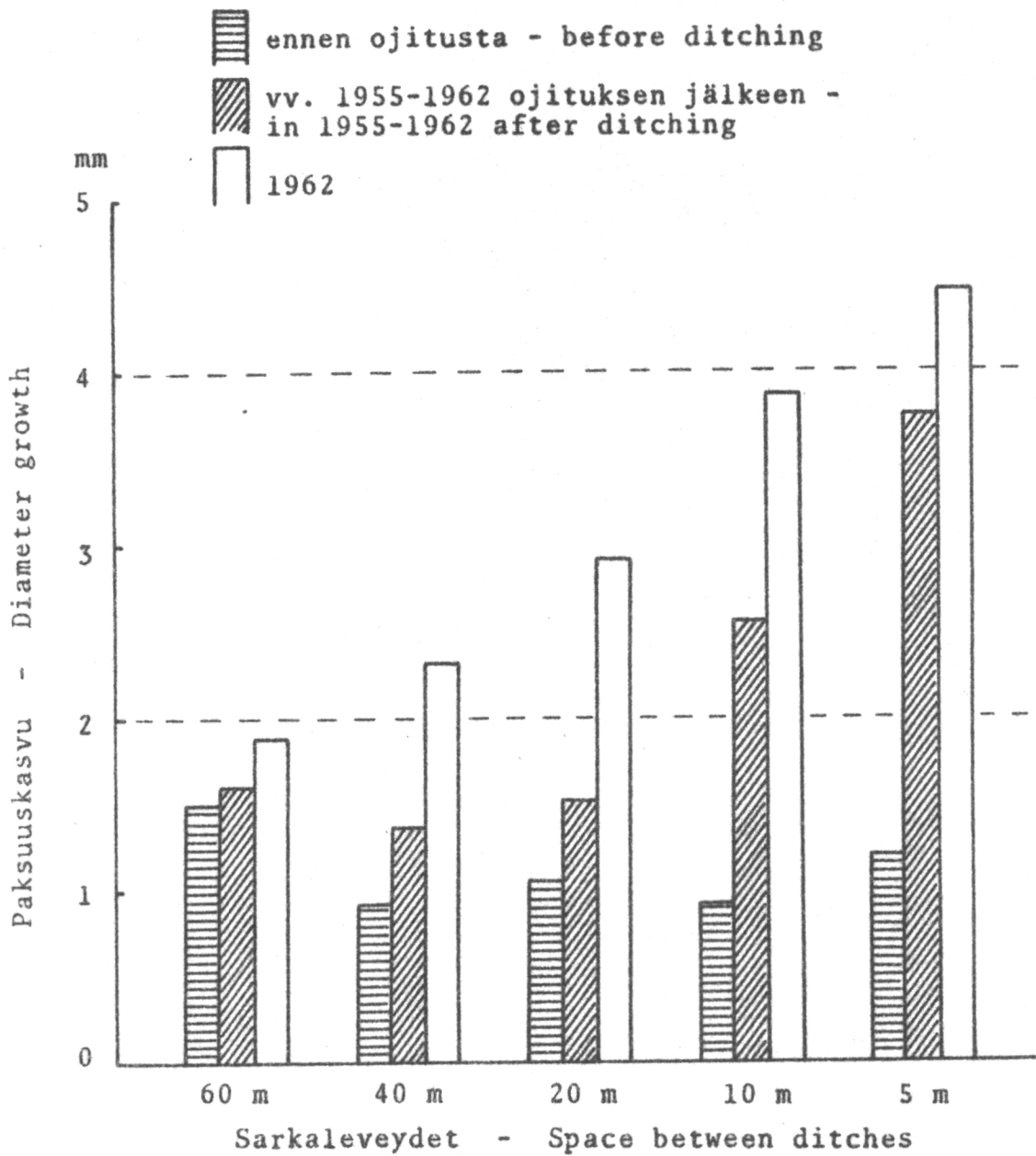
Mäntypuuston pohjapinta-alan kasvu rämeen koekentällä Jaakkoin-  
suolla. Vilppula.

Growth of the basal area of tree stand on the Jaakkoinsuo pine  
swamp experimental area. Vilppula.



Mäntytuuston pohjapinta-alan vuotuinen kehitys rämeen koekentällä Jaakkoinsuolla. Vilppula.

Development of the basal area of tree stand on the Jaakkoinsuo pine swamp experimental area. Vilppula.



Sarkaleveyden vaikutus paksuuskasvuun Liesnevan koeojitus-alueella.

The effect of ditch spacing on diameter growth on Liesneva experimental area.

Nutrient content of the soil (November 1976)					
Sample plot n:o	pH	N <sub>tot</sub> , %	P <sub>tot</sub> , mg/l	K <sub>tot</sub> , mg/l	Ca <sub>tot</sub> , mg/l
1	3,3	1,32	202	85	641
2	3,3	1,34	178	87	682
3	3,2	1,26	168	77	467
4	3,3	1,15	130	68	486
5	3,3	1,20	175	84	593
6	3,1	1,15	195	78	779

Nutrient content of the needles (March 1977)									
Sample plot n:o	N, %	P, mg/g	K, mg/g	Ca, mg/g	Mg, mg/g	Mn, mg/g	Cu, mg/kg	Zn, mg/kg	B, mg/kg
1	1,60	1,45	5,49	2,61	1,15	243	1,42	37,6	18,4
2	1,60	1,69	5,38	2,93	1,32	290	1,25	57,5	18,4
3	1,57	1,63	5,71	2,35	1,14	225	1,25	44,2	13,6
4	1,57	1,76	5,27	2,42	1,32	240	0,89	48,7	16,0
5	1,48	1,64	5,77	2,61	1,25	225	1,33	50,9	12,8
6	1,46	1,69	5,54	2,93	1,34	275	1,07	46,5	13,6

TREE LITTER

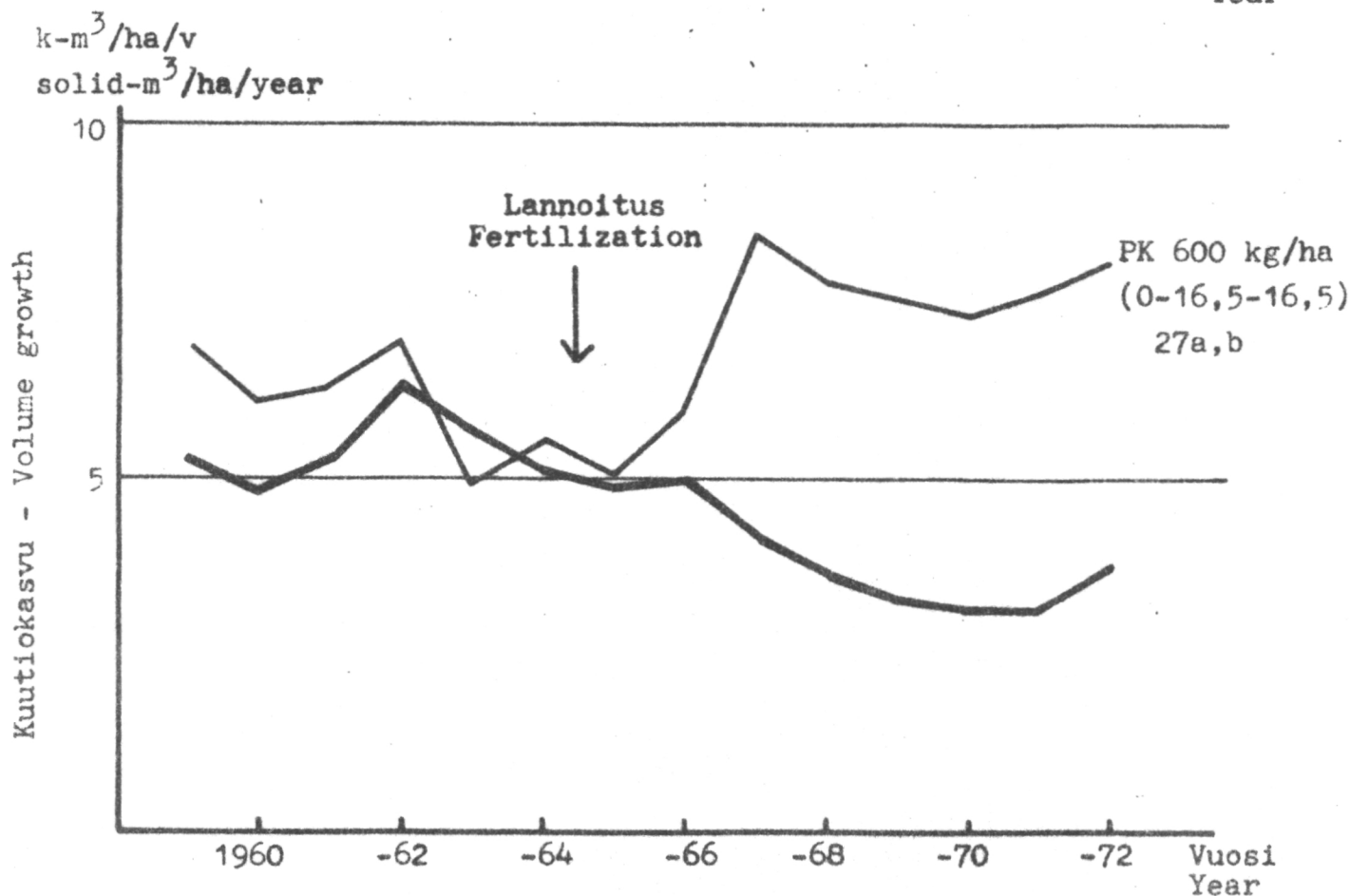
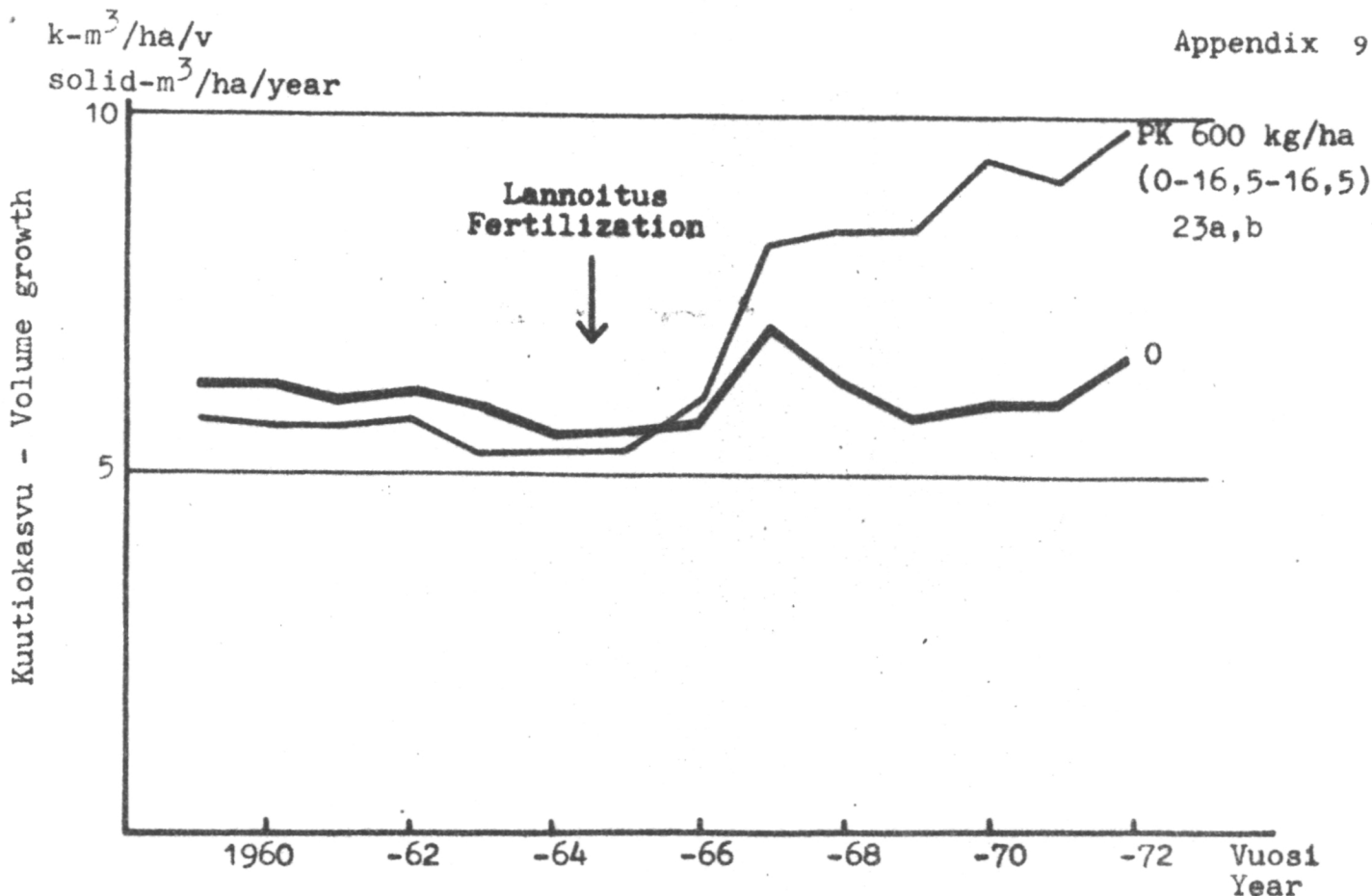
Amount of nutrients in the litter (15.10.1975-14.10.1976)

Sample plot n:o	Amount of the litter kg/ha	N, kg/ha	P, kg/ha	K, kg/ha	Ca, kg/ha	Mg, kg/ha	Mg, kg/ha	Cu, g/ha	B, g/ha
1	2004	13,387	0,909	1,472	8,222	0,953	0,737	11,4	20,1
2	1796	13,292	0,899	1,776	8,090	0,985	0,777	10,1	15,2
3	1542	11,107	0,731	1,370	7,088	0,828	0,554	8,6	13,7
4	1879	13,341	0,861	1,503	9,292	1,074	0,717	10,1	16,0
5	1427	8,884	0,651	1,081	6,695	0,768	0,514	7,9	13,0
6	1865	13,328	0,916	1,836	9,091	1,148	0,740	10,1	17,2
Fertilization 1973									
0	1658	11,126	0,764	1,308	7,335	0,850	0,602	9,3	15,6
NPK	1847	13,320	0,892	1,705	8,824	1,069	0,745	10,1	16,1

Point No.	Sample plot No.	Original peatland site type x)	Peat layer m	Site quality class (1..6)	Tree stand in 1971				Total production	
					Pine	Spruce	Birch	Total		Annual increment
					solid m <sup>3</sup> /ha					
4	5a	C PS	0.4	3	5	99	161	265	4.3	324
	5b	"	0.5	3		29		29	2.7	287
	5c	"	0.6	3	76	19	46	141	5.6	- xx)
5	7a	"	0.4	3	80	23	82	185	6.3	291
	7b	"	0.4	3	135	24	133	292	5.8	346
	8a	"	0.4	3	190	7	32	229	7.5	310
	8b	"	0.3	3	166	42	74	282	7.2	316
7	26	H C SS	0.3	2		181		181	10.4	412
10	23a	F PS	1.0	1	200	10	55	265	7.2	471
11	15a	(open)C S	0.8	4	136		32	168	3.5	248

x) C = sedge (Carex)=rich  
 PS= Pine swamp  
 H = Herb-rich  
 SS= Spruce swamp  
 F = Fen-like

xx) Sample plot has been established in 1963



Mäntypuuston vuotuinen kasvu PK-lannoitetuilla ja lannoittamattomilla vertailukoelohilla.

Annual growth of pine stand on PK-fertilized and unfertilized sample plots.