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FORESTRY AND FOREST INDUSTRY PRODUCTION ALTERNATIVES IN FINLAND, 1970—2015

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INTRODUCTION

After discussions with the Government Economic Council, the present research group proposed in a letter dated May 7, 1968 that the calculations concerning the development of Finnish forests, with alternative inputs and returns, in 1964–2000[1] (Appendix B 93 of the Economic Council Report of 1964) be amended. At its meeting of May 8, 1968 the Economic Council accepted the proposed working plan with a few modifications.

The future development of the allowable cut was reviewed on the basis of four input programmes (silvicultural and forest improvement programmes). The lowest alternative assumed that the input into silviculture and forest improvement will remain at its present level (the primary programme). The highest alternative had a very high but not unattainable input target (the maximum programme). Two other alternatives were chosen between these two: the minimum programme and the so-called MERA programme.[2]

Forest industry production potentials have been studied by calculating alternative short-term forecasts of the total drain in 1967–1971 on the basis of the various utilization degrees of the 1967 capacity and the realization of the currently known expansion projects (alternatives I–III) and by proposing four alternative long-term forecasts of forest industry production in 1971–2000 (alternatives 1–4) based on the assumption that at least the corresponding input programme is fulfilled.

Finally, the benefit/cost ratios of the alternative forest improvement programmes and the corresponding allowable cuts are reviewed at the stumpage price, delivery price and final product price levels.

As far as possible, the division into wood supply regions applied in the present study was: West Finland, Päijänne, Saimaa and North Finland (see Appendix 1). The drain, allowable cut and forest balance calculations of the past and the short-term forecasts have been made on the basis of this regional division. But of the long-term forecasts, only the MERA input programme and the corresponding total drain alternative were divided according to these regions. The other input programmes and drain alternatives were calculated for the whole country only.

The timber quantities are expressed in cubic metres solid measure, unseasoned wood excluding bark.

The alternative programmes compiled in the present paper are mainly biological and technological. Hence, the roundwood *price level* at which the supply of roundwood is likely to reach the expected allowable cuts has not been predicted. Since practically all predicted allowable cuts show an increase and, furthermore, all exceed the increment in the first few decades and thus reduce the growing stock, it may be expected that they will tend to raise the roundwood price level, The same trend may also follow from the increased shifting of privately owned forests from farmers to workers engaged in urban trades; but, on the other hand, this shift may have opposite effects. Further, it may be expected that the fairly rapid decrease in the number of farmers (the age distribution reveals an elderly and middle-aged farm population) as farms grow larger and the farming population generally makes a better living will reduce the propensity to sell timber and lead to an increase in the growing stock. This trend also has its inherent opposite forces; the payments to the relinquishing co-heirs are often financed by a sale of timber.

1. ERVASTI, HEIKINHEIMO, HOLOPAINEN, KUUSELA & SIREN. The development of Finland's forests in 1964–2000. Silva Fennica, 117:2. Helsinki, 1966.
2. The MERA III Programme with its continuation, the MERA programme as it will be called in this paper, is not the forestry financing programme of the MERA Committee but the forest improvement programme drafted by the MERA Committee to constitute the basis of the financing plans, and its continuation as outlined in this paper. The problems of financing the forest improvement will be disregarded here.

It is quite possible, therefore, that increasing demand for roundwood will be accompanied by a *continuous rise in the roundwood price level.* It is very difficult, at the moment at least, to predict the quantitative price increase because of a lack of information; also, these trends can be decisively affected by agricultural and forestry policies. Hence, it was impossible to predict whether firms will have sufficient *economic* resources to fully use the roundwood quantities which according to the programmes will be produced, even if the technological and biological conditions for obtaining these timber quantities are fulfilled.

1. SUMMARY

This study was completed for the Government Economic Council in 1969. It will assist in the long-term planning of the way in which Finland's production potential can best be realized, on which the Economic Council is at present working. The first task was a review of the forest resource situation, emphasizing the allowable cut.

Despite extensive fellings in recent years the growing stock in southern Finland has changed very little. The percentage of valuable coniferous trees and sawlog stands has increased and consequently the value of the growing stock has risen. On the other hand, in North Finland and especially in Lapland a decreasing growing-stock volume, delay in implementing measures by which growth can be increased and the partial failure of these measures have reduced the estimates of allowable cut.

The annual increment in the existing forests is estimated at approximately 47 million solid m^3 and the short-term sustainable allowable cut without extensive fertilization equals roughly 50 million solid m^3. Extensive forest fertilization and the implementation of the other improvement measures suggested under the MERA (Forestry Financing Committee) programme would expand the allowable cut directly to about 53 million solid m^3. The shortcomings in the programme to date are that the management targets and investment objectives have not been reached and the work done does not meet the qualitative requirements of the programme. In addition, fellings have been unevenly distributed geograpically.

The influence of the intensity of silviculture and forest improvements on allowable cut in 1970–2015 has been examined for four alternative programmes. The results are shown in the following comparison:

Forest-improvement programme	*Allowable cut million m^3 excluding bark*				
	1970	1980	1990	2000	2015
Primary	52.6	53.2	53.6	57.3	61.9
Minimum	52.8	55.3	56.7	61.2	66.2
MERA	53.6	58.7	64.3	69.3	80.2
Maximum	54.1	62.1	67.8	71.8	87.7

The primary programme implies keeping the management and investment intensity at the 1968 level. The minimum programme is equivalent to the level which has been considered the minimum target in an effort to meet the raw material requirements of the forest industries. The MERA programme corresponds to the intensity proposed in the latest report of the Forestry Financing Committee. The maximum programme, in turn, is based on the most intensive possible use in accordance with the programme submitted to the Economic Council in 1964.

The development potentials of the forest industry were analyzed separately in the study taking a short-term (up to 1971) and a long-term (up to 2000) view. The short-term analysis disclosed that, if the mid-1969 forest-industry expansion and modification plans are realized by 1971 and the resulting total capacity put to effective use, the annual total drain for the country as a whole will rise to approximately 53 million solid m^3 at the beginning of the 1970s.

In West Finland, the implementation of the industrial expansion plans will necessitate fellings that only slightly exceed the current allowable cut. In Päijänne, where the forest-balance situation at present is relatively unfavourable, expansion plans are few and the forest balance will be restored within a few years. The increasing production in Saimaa

seems to indicate that fellings will be excessive unless some of projects are put off to a later date. In this area industry should replace birch and pine consumption with spruce. In North Finland some of the projected expansion should be postponed owing to the precarious forest-balance situation. *A comprehensive analysis of the whole country suggests that the industrial expansion and modification projects for the near future should first of all aim at a higher degree of final processing and, associated with this, improved utilization of raw material. Only to the extent permitted by the forest balance in a given area should primary forest industry be expanded.* The implementation of the forest-improvement programme of the MERA III Report would, within a short period, improve the possibilities for expanding the forest industry.

In the alternative long-term forecasts the possibility of industrial expansion was viewed separately within the potential frameworks of the minimum, MERA and maximum programmes. At the same time the potential sales of the products were viewed in the light of the FAO forecasts concerning world-wide consumption of forest-industry products. Provided that the various forest-improvement programmes are fulfilled; the following percentages for annual production increase may be recommended for forest-industry expansion in the 1970s:

Forest-improvement programme	*Annual production increases in forest industry in the 1970s, per cent*				
	Plywood & slat board	Particle board	Fibre board	Pulp	Paper & cardboard
Minimum	2 1/2	4	2 1/2	2 1/2	5
MERA	3	5 1/2	3 1/2	3 1/2	6 1/2
Maximum	3	6	4	4 1/2	8

The calculations are based on the assumption that sawmill capacity remains roughly at its present level and that the industry will operate at 70–80 per cent of this capacity. The growth percentages for the paper and cardboard industry assume that pulp exports will begin to decline in the early 1970s. Naturally, there are alternatives other than those suggested for the distribution of growth percentages between the industries.

Considering individual districts, the expansion potential for the forest industry in the 1970s is definitely best in West Finland. In Päijänne the forest balance will be restored by the beginning of the next decade and the possibility of industrial expansion will then be moderately good. Nevertheless, the area will remain largely dependent on imports of roundwood from other districts for some time. In Saimaa the projected industrial expansion will be so great that timber requirements will cause the allowable cut of the early 1970s to be substantially exceeded. For this reason the expansion projects timed for the first half of the 1970s must be reduced. The best solution would be to give priority to increasing the amount of final processing rather than concentrating on developing primary production. In North Finland the situation will be much the same as in Saimaa.

The study also analyzed the advantages of the forest-improvement programmes by comparing the cost of input with the returns from production. The returns were determined at three levels using stumpage prices, delivery prices and, for the final products, export prices. In the first two cases, the evaluation method employed was to calculate the internal rate of return using the present value of returns and costs, discounting to 1970.

When net returns at the stumpage-price level were calculated and allowance was made for the expected increase in growing stock over that of the primary programme by 2015, the following internal rates of return were obtained for investment expansion:

From primary programme to:	Rate of return per cent
minimum programme	23
MERA programme	8
maximum programme	6

These mutually comparable figures which assume constantly increasing fellings indicate the advisability of initial investment expansion;

as improvement is intensified, however, profitability is quickly reduced. Despite the fact that the internal rate of return calculated for such a long period is not strictly comparable with other interest rates, forest investment may, on the basis of the above, be considered justified up to an intensity equivalent to that of the MERA programme.

When the profitability calculations were carried out at the delivery-price level, the internal rate of return on transition from the primary to the MERA programme, conservatively calculated, proved to be about 10 per cent, assuming the additional labour input required would have an opportunity cost 10 per cent less than wages paid in forestry.

Transition from the primary to the MERA programme would increase the gross national product from 1965 as follows:

with the returns forecast for	million mk
1980	437
1990	904
2000	1 023

These figures are, respectively, 1.7, 3.5 and 4.0 per cent of the 1965 GNP.

The results of the study show that the supply of roundwood for the woodworking industry now in operation and under construction, without capital cutting which would reduce the production of timber in the future, can be assured only by intensifying silvicultural and forest improvement work, and by including all forests in the sphere of intensified production. *Before expansion to increase primary timber consumption is undertaken, the input programme to be implemented should be decided on at the national level and its implementation should be ensured for a sufficiently long time. Without this decision, rational long-term planning cannot be effected in this country for either forestry or the forest industry.*

Ensuring the supply of roundwood and the continued development of the woodworking industry in the 1970s seems to presuppose a large number of actions. The most important among them are:

- An investigation should be initiated to discover why some forests are not managed for the intense felling, regeneration and forest improvement activities indispensable to increased roundwood production; the forest policy measures required to bring about a change on this point should be outlined.
- Silvicultural and forest improvement measures should be evaluated and given priorities according to their expected effectiveness and value.
- The effects of preservation, protection and multiple use of forest areas on wood production should be studied; the areas necessary for these purposes should be set apart and a decision made as to the percentage of the land area to be kept in full timber production.
- A national forest policy programme aiming at increased timber production should be drafted and implemented.
- Projects for expanding and modifying woodworking industries should be better aligned with the location and production range of the mills.
- The implementation of planned local capital cutting should be investigated in areas where the utilization of the existing industrial production capacity seems to require it.
- By increasing the price of birch cordwood, the use of birch for fuel could be reduced, thus saving wood for industrial consumption.
- In southern Finland preparations should be made for replacing birch with spruce in industrial use.
- Roundwood imports from abroad should be kept at the highest possible level and attention should be devoted to increasing the imports of deciduous species.
- The potential industrial uses of bark, stumps, small wood and trimmings as well as the methods of harvesting them should be studied more than they have been to date.
- A national committee should be appointed to develop and coordinate the overall planning of forestry and the forest industry and have research facilities at its disposal. This committee should employ a permanent staff and cooperate closely with the general economic planning authorities.

2. FACTORS AFFECTING POTENTIAL FELLINGS

21. Forest resources and their regional distribution

The allowable cut, particularly in the near future, depends on the volume and quality of the present growing stock. Also, the volume and type of the fellings, the silviculture, and the forest improvements directly affect the estimated allowable cut, so that future potential cut depends on the present growing stock less in the more distant future.

In the last 15 years, during which the Finnish forest industry has greatly expanded and the need for timber has grown to its current high level, the growing-stock volume has remained roughly unchanged in southern Finland. But in North Finland the growing-stock has decreased, thus affecting potential fellings. An exact figure on the decrease in the growing stock can be obtained once the Fifth National Forest Inventory is completed in 1970. However, despite this trend, the proportion of valuable conifers and saw-log size trees has increased so much that the value of the growing stock has risen throughout the country.

The forest resources in North Finland are characterized by an abundance of old, over-aged stands, large open regeneration areas, and young seedling stands. Since the regeneration has not been as rapid as was expected and since the older stands have not recovered after thinnings as well as in southern Finland, the reduction in the growing stock seems to portend a short supply of wood, especially in the county of Lapland; a problem which is not easy to solve.

In southern Finland the volume of thinned stands has increased, the previously plentiful middle-aged stands are approaching maturity and new seedling stands are developing rapidly. The areal proportion of stands less than 20 years old has roughly trebled in the last 15 years. As far as the total growing-stock volume is concerned, southern Finland can go on cutting at least the same volume as hitherto without jeopardizing sustained yield. If the forest improvement work develops as recommended by the silvicultural programmes, felling quantities may be gradually increased.

From the Fifth National Forestry Inventory (those results completed in 1968) it can be seen that the estimated total volume in southern Finland is slightly higher than 15 years ago. The volume of spruce has increased by 9 per cent while the volume of pine has decreased by 2 per cent and that of deciduous trees by 9 per cent. *Wide regional differences* can be seen, however, in the development of the southern forest resources (Fig. 1). Felling exceeding the sustained yield has occurred primarily in the northern part of the forestry board districts of Keski-Suomi, Pohjois-Savo and Pohjois-Karjala, especially in the state and company-owned forests. At the same time there are, in the southern, southwestern and western parts of Finland, extensive undercut regions where full utilization of the potential for felling has not been realized. Thus there has been an ageing of forest resulting in reduced increment.

The dissimilarity in development is clearly visible in stand characteristics. When the potential fellings in a forest are fully utilized, the proportion of regeneration sites, seedling stands and young pole stands is 28–30 per cent of the forest area. In the above overcut areas this proportion is 35–45 per cent and in the undercut areas 12–25 per cent. The mean volume in the most heavily logged areas is 60–80 solid m^3/ha and in undercut areas 100–130 solid m^3/ha.

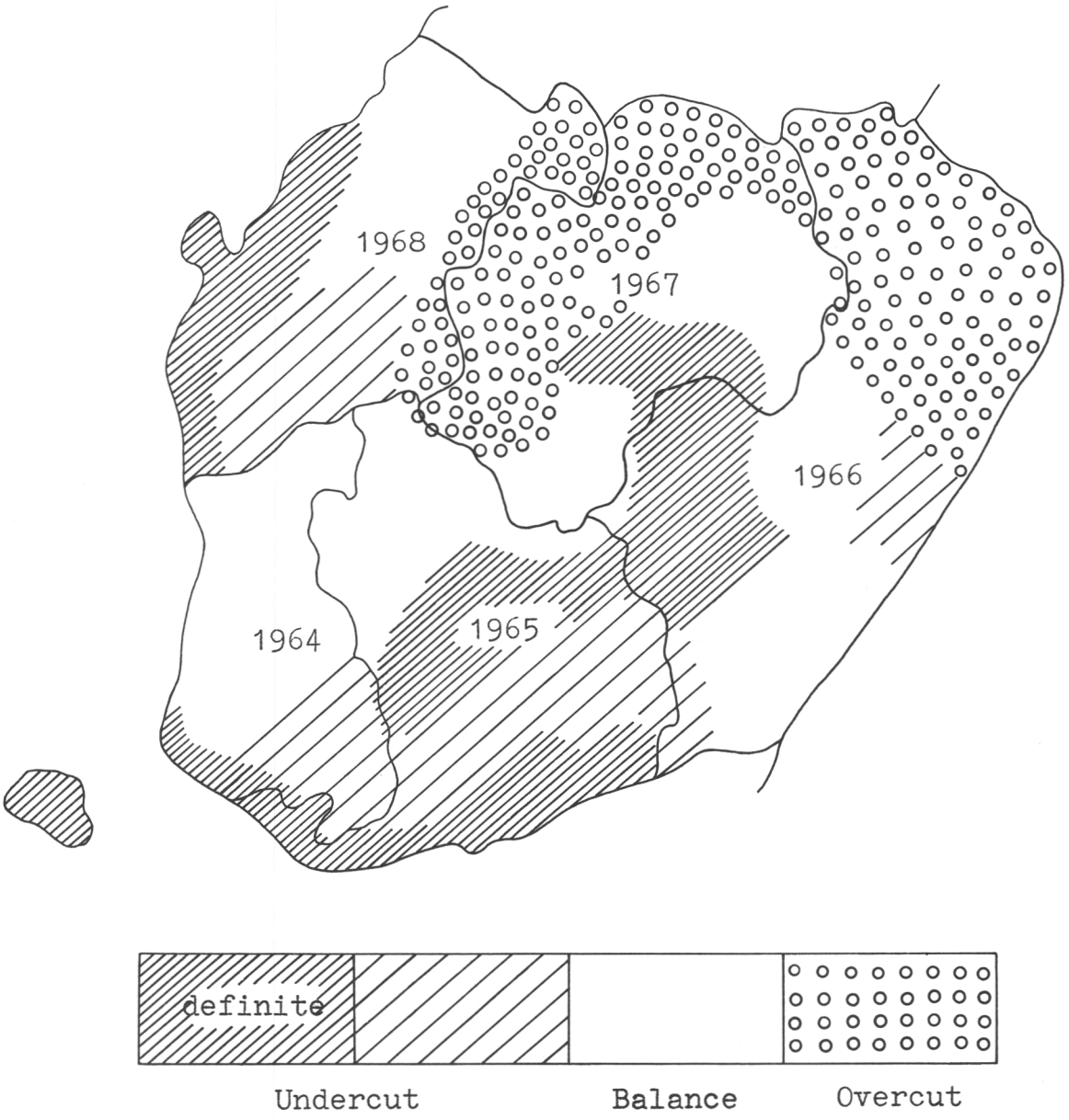
In forest policy, particular attention should be paid to the sharp decline in the volume of deciduous stands, especially in the regions where the industrial use of birch has been most profuse.

22. Effect of forest improvement on increment and allowable cut

The five different estimates of allowable cut (total sustained drain acceptable in the future) presented here all depend on the volume and increment of the current growing stock and on the extent and type of forest improvement work undertaken at present and in the future.

The current allowable cut (see Section 221) is based on the assumption that the 1966 level of

Fig.1. Forest balance in southern Finland



silvicultural and other forest improvements will be maintained in the future but not exceeded. This estimate is constant in time and accordingly does not take into account the possibility of increasing the drain in the future.

The effect of constant and progessive forest improvement work and intensity of silvicultural activity on increment and potential progressive fellings was analyzed in the present study by means of four different silvicultural and forest improvement input programmes:

the *primary programme* means maintaining in the future the input intensity level achieved in 1968;

the *minimum programme*, which is progressive both regarding input and cut, corresponds to a level of allowable cut which has been considered the minimum objective in any effort to meet the roundwood requirements of the woodworking industry;

the *MERA programme* represents the progressive intensity of inputs suggested in the latest report of the Forestry Financing Committee;

the *maximum programme* presupposes the highest realizable degree of intensity of inputs and progressiveness of allowable cut as outlined in the programme submitted to the Economic Council in 1964.

The development series of the growing stock, increment and allowable cut which correspond to the various programmes seek in the first place to throw light on the relative effect of forest improvement and intensity of silviculture on allowable cut and on the relative profitability of the implementation of the programmes. As can be seen in some detail at the end of this chapter, the allowable cuts corresponding to the input programmes do not permit a precise estimate of the volume of timber production which can be reached in the future, for this depends on the type of work done and on the area included in the sphere of efficient roundwood production.

221. The current allowable cut

An estimate of the allowable cut is one of the objects of the national forest inventory which is a continuing process proceeding by provinces. The current updated estimates of allowable cut indicate the sustainable (but constant in time) potential fellings which depend on the present growing-stock volume, increment and intensity of silviculture. The intensity of silviculture and the associated forest improvement work have been estimated on the basis of the present achievements as far as now known.

Since the current Fifth National Forest Inventory proceeds by provinces (it began in 1964; the field work for southern Finland was completed in 1968) the current allowable cut for the whole country changes annually when the results of the area covered by the inventory in the preceding summer are calculated and included in the estimate. The estimate of current allowable cut used in the present study (Table 12) was completed in the late winter of 1968 and amounts, for all forests in the whole country, to 50.4 million solid m^3 excluding bark. Of this total, 16.3 million m^3 is pine, 20.3 million m^3 is spruce, and 13.8 million m^3 is deciduous trees.

As far as silviculture and forest improvement are concerned, wood consumption equalling the allowable cut can be sustained in the future provided that new seedling stands established annually amount to some 280 000 ha, including some 220 000 ha established artificially, and some 300 000 ha of swamp is drained annually. In estimating the allowable cut, the effect of stand fertilization on mineral soils has not been taken into account, since the implementation of fertilization programmes so far has been uncertain. Nor have the modest arable areas annually afforested by planting been taken into account. Although the extent of annual artifical regeneration has remained at about 140 000 ha, the high natural regeneration and the extent of drainage make it possible to consider 50.4 million solid m^3 a sustainable allowable cut, although it exceeds the estimated increment of the current growing stock, which is 47.1 million solid m^3. New seedling stands established recently either by artificial or natural regeneration cover about 300 000 ha and drainage of swamps has been 280 000–300 000 ha per year.

The current allowable cut has been divided according to the natural wood-supply regions used in this study. When it is compared with the estimated actual drain, based on the results of wood utilization studies, the forest balances as presented below can be obtained.

222. The primary programme

Under the primary programme (Tables 1 and

2), the extent of forest regeneration, drainage and fertilization will be kept largely the same as in 1968. The annual area of forest regeneration is 140 000 ha, of drainage 250 000 ha and of fertilization 120 000 ha (80 000 ha on mineral soils and 40 000 ha on swamps). The area on which naturally regenerated stands are established has been estimated at 75 000 ha per year.

The growing-stock development series begin from 1963 so that the calculations for all the programmes will be as fully comparable as possible with the maximum programme, which was drafted earlier and will be described in detail below. The growing stock from which the chronological series start is called the "current forest". "Planted forests" refer to new stands established since 1963 by planting and seeding; "natural forests" are new stands established by natural regeneration from 1963 onwards. Adding these groups together, the volume of the total growing stock in 1970 will be 1 201 million solid m^3 excluding bark. Since the drain at first will exceed the increment the growing-stock volume will decline, but after the year 2000 when the new stands will have matured the volume will begin to increase. At the end of the calculation period in 2015, the volume will be 1 567 million solid m^3; of this, "current forest" will be 567 million m^3, "planted forest" will be 759 million m^3 and "natural forest" will be 241 million m^3. In other words, the volume of all new stands in 2015 will amount to almost two-thirds of the total growing-stock volume.

During the period from 1970 to 2015 the total increment will increase from 47.7 million to 85.6 million solid m^3 per year and the allowable cut will rise from 52.6 million to 61.9 million solid m^3 per year. Those parts of the increment and the allowable cut which result from the different forest improvement categories are shown in Table 2. The increase in the allowable cut due to fertilization will be 0.9 million solid m^3 in 1970 and 1.9 million solid m^3 in 2015. The figures for additions created by drainage at these dates are 1.1 million and 9.0 million solid m^3, respectively. The "planted forests" will not increase allowable cut until 1990 at which time they will yield a 0.6 million solid m^3 increase, but by 2015 this increase will amount to 20.0 million solid m^3. The "natural forests" will increase the allowable cut by 0.5 million solid m^3 in 2000 and 6.4 million solid m^3 in 2015. These figures reflect the characteristics of all development series: the heavy drain of the next few years can be covered by reducing the current growing stock; fertilization is the most rapid means of increasing the potential cuttings; and other forest improvement work secures future wood supplies. The causes of the production-increasing effects of the forest improvement work will be discussed in connection with the maximum programme.

223. The minimum programme

The miminum programme (Tables 1 and 2) is a production alternative based on the estimated economic minimum with work inputs, apart from drainage, being higher than the primary programme but lower than in the MERA and the maximum programmes. The area of artificial forest regeneration will be 150 000 ha per year. Estimated afforestation of arable land which was not taken into account in the previous programmes will amount to a total of 205 000 ha; this will cover 3 300 ha in 1970, 5 000 ha in 1971, 6 500 ha in 1972, 8 500 ha in 1973, and 10 000 ha in 1974 at which level it will be maintained until the early 1990s when the objective will have been achieved. The objectives in drainage are those of the maximum programme. Of the annual area to be fertilized, two-thirds will be mineral soils and one-third peatland. In 1970 the annual fertilization area will be 140 000 ha and by 1980 it will have increased to 300 000 ha. From 1986 onward 1.4 million ha of mineral lands and from 2000, 2.0 million ha of peatlands will be under the fertilization programme.

Natural regeneration will be achieved on an average of 67 500 ha per year. The area of stands established artificially by 2015 will be 7.8 million ha and their volume will be 800 million solid m^3 which is 555 million solid m^3 less than under the maximum programme. Cuttings in these forests will begin in 1990, with the drain in 2015 amounting to 21 million solid m^3/year. The effect of afforestation of arable land during the calculation period will remain relatively modest; the drain obtainable from these forests by 2015 will be 0.6 million solid m^3/year. The increase in drain obtainable due to fertilization will be 0.9 million solid m^3 in 1970 and 5.0 million solid m^3 in 2015.

At the beginning and end of the period 1970–2015 the total growing stock will be 1 200 million and 1 592 million solid m^3, the increments 47.7 million and 92.6 million solid m^3, and the allowable cuts 52.8 million and 66.2 million solid m^3, respectively.

224. The MERA programme

The MERA programme (Tables 1 and 2) for 1970–75 is the same as that presented in the report by the Forestry Financing Committee to the Government on June 16, 1969. From 1975 onwards the projections under the programme are according to the long-term forecast outlined in this report.

Artificial forest regeneration will increase from the 1968 level of 140 000 ha to 250 000 ha by 1978, then declining to 200 000 ha after most forests with low yield have been cut and replanted. By 2015 the forest area established by planting and seeding will cover 11 million ha. Naturally regenerated stands will be established at the rate of 53 000 ha per year.

Afforestation of arable land with spruce plantings started in 1969 and covered an area of 5 000 ha. According to the plan, the areas in 1970–73 will be 10 000, 15 000, 20 000 and 25 000 ha, respectively; from 1974 onwards the area will be 30 000 ha annually up to 1991, at which time all the arable land planned to be shifted from agriculture, about 600 000 ha, will have been afforested.

The development of these planted spruce stands is based on the *Oxalis-Myrtillus* site-type series in the study by MÄKINEN.[1] The increment level of the series was reduced by 10 per cent because some of the arable land to be afforested represents a poorer soil than the *Oxalis-Myrtillus* site type.

According to available development series the rotation of planted stands is 60 years. The increment of afforested spruce stands will reach an important level in the 1980s but the drain from these stands will become significant only after 2000; the annual drain will reach its maximum, 6.6 million solid m^3, 65 years after the plantings are started. Due to the accumulation of mature stands ready for final cutting, the drain is much higher than the average drain (3.7 million solid m^3 per year) of a normal forest with a smooth age structure growing on the same area.

Afforestation of arable land increases allowable cut mainly in the distant future. At the end of the calculation period, 2015, it will have produced an accumulated total drain of some 30 million solid m^3 and added to the growing stock some 66 million solid m^3.

Drainage will increase from the 1968 level to 350 000 ha by 1970 then decline to 170 000 ha annually in 1978–86. The new drainage programme will be completed by 1986 for southern Finland. In North Finland the objective will be fulfilled by about 1978. The total area drained will amount to some 7.4 million ha. After the completion of the drainage programme the forest area will total about 22 million ha, to which the area of afforested arable land, 600 000 ha, must be added.

Of the total fertilization area, some two-thirds will be on mineral soils and one-third on peatlands. The 1970 target is 240 000 ha and from 1985 onwards it will be 700 000 ha per year. After the year 2000 a total of 7.9 million ha of forest land will have been fertilized; 3.3 million ha will be mineral soils and 4.6 million ha peatland. The increase in increment and allowable cut achievable by fertilization, on the basis of the 1968 performance, will be 0.4 million solid m^3 per year. According to the MERA programme, the increase in 1970 will be 1.1 million solid m^3, in 1980 7.2 million solid m^3 and at its maximum at the end of the century and onwards, about 11.4 million solid m^3.

A combination of the development series for the current forests, new stands established by artificial and natural regeneration, and the stands established on arable land will give a volume increase from the 1 192 million solid m^3 in 1970 to 1902 million solid m^3 in 2015. The estimated increments in these years are 47.7 million and 122.6 million solid m^3, respectively, and the allowable cuts are 53.6 million and 80.2 million solid m^3, respectively. The high estimate of increment in 2015 is based on the existence of a large number of young stands in their best growth phase but not ready for heavy cuttings. Their increment, however, will replace the earlier decrease in volume.

As early as 1970 the allowable cut for the whole country will exceed the current allowable

1. MÄKINEN, VEIKKO O. Viljelyskuusikoiden kasvu- ja rakennetunnuksia. Summary: Growth and structure characteristics of cultivated spruce stands. **Folia Forestalia**, 34. Helsinki, 1967.

cut and also that of the minimum programme primarily because the extensive fertilization very rapidly increases the increment and the potential fellings.

The allowable cut according to MERA is divided on the basis of the present condition of the forests, i.e. without development calculations, by wood-supply regions (Table 3). The direct improvement of potential fellings presupposed by the allowable cut under MERA as compared with the current allowable cut is relatively highest in West Finland, where the large number of mature stands and the existing undercutting are most obvious. The allowable cut presupposed by MERA for North Finland is lower than the current allowable cut because the current allowable cut is based on the data of the last forest inventory, carried out in this region in 1962–63, and because subsequent experience in state-owned forests plus the principle that a number of the overmature forests in Lapland will remain outside intense timber production tend to indicate a reduction in the potential for fellings.

225. The maximum programme

The maximum programme, as indicated above, corresponds to the highest possible realistic intensity in timber production on the basis of currently available data. Since this programme was first constructed by estimating the effect of the various kinds of forest improvement work on which a number of the calculations were based, these will be described here in more detail. This basis is common to all the input programmes drafted.

In 1963–67 the annual area of artificial regeneration (Table 1) grew from 110 000 to 142 000 ha. By 1972, this will have increased to 300 000 ha and will remain at that level for 15 years. Subsequently, after most stands of low yield have then been cut and replanted, the regeneration area will be 250 000 ha/year.

The assumptions on which the estimates for the development of planted stands were based are those used in the report submitted in 1964 to the Economic Council.[1] The growing stock development is based on the study results reported by CAJANDER,[2] KALLIO,[3] VUOKILA,[4] and SIREN.[5] On the basis of the regeneration areas recorded to date, seeding was estimated to have been used on 40 per cent and planting on 60 per cent of the area.

Afforestation of arable land is the same as in the MERA programme. The annual area to be drained under the maximum programme is 250 000 ha until 1986, when the total target will have been reached. The basis on which the increase in production has been calculated was presented by HEIKURAINEN.[6] The increase in the annual felling due to drainage by 2015 will be 9 million solid m^3/year and the accumulated total by 2015 will be 219 million solid m^3. These figures concerning the drainage area include about 1.9 million ha of the poorest swamp. No increase in increment or cutting due to their drainage has been included in the calculations. According to HEIKURAINEN, the effect of draining these swamps could raise the total increases in increment and drain used here as follows (the increases would be identical under all the input programmes):

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1. ERVASTI, HEIKINHEIMO, HOLOPAINEN, KUUSELA & SIREN. The development of Finland's forests in 1964–2000. Silva Fennica 117:2. Helsinki, 1965.
2. CAJANDER, ERKKI K. Tutkimuksia Etelä-Suomen viljelykuusikoiden kehityksestä. Referat: Untersuchungen über die Entwicklung der Kulturfichtenbestände in Süd-Finnland. (Studies on the development of planted spruce stands in southern Finland). Communicationes Instituti Forestalis Fenniae, 9:3. Helsinki, 1933.
3. KALLIO, KUSTAA. Etelä-Suomen kylvömänniköiden rakenteesta ja kehityksestä. Summary: On the structure and development of pine stands established by sowing in the south of Finland. Acta Forestalia Fennica, 71:3. Helsinki, 1960.
4. VUOKILA, YRJÖ, Etelä-Suomen hoidettujen kuusikoiden kehityksestä. Summary: On the development of managed spruce stands in southern Finland. Communicationes Instituti Forestalis Fenniae, 48:1. Helsinki, 1956.
5. SIREN, G. Pohjois-Suomen kylvömänniköiden kehitys ja käsittely. (Development and treatment of seeded pine stands in North Finland). Manuscript. Helsinki, 1964.
6. HEIKURAINEN, LEO. Metsäojituksen vaikutuksesta puuston kasvuun ja poistumaan. Summary: The influence of forest drainage on growth and removal in Finland. Acta Forestalia Fennica, 71:8. Helsinki, 1961.

Year	Increment increases million solid m^3		Drain increase excluding bark	
	Figures used	Corrected figures	Figures used	Corrected figures
1975	2.5	2.5	1.4	1.4
1985	5.3	5.5	2.8	2.8
1995	7.1	8.5	4.6	4.7
2005	8.0	9.0	6.8	7.0
2015	7.0	9.5	9.0	12.0

According to the fertilization programme, 200 000 ha mineral soils and 100 000 ha peatland (300 000 ha in total) will be annually fertilized in 1970. The final level of fertilization, which will be reached in 1980, is 800 000 ha of mineral soils and 200 000 ha of swamp, a total of 1 million ha per year. From 1983, onwards, 5.6 million ha of mineral soil will be under fertilization and from 1996 onwards, 4.0 million ha of peatland.

The average increment increase produced by fertilization on mineral soils has been estimated during the first five years at 2 solid m^3/ha/year and during the next two years at 1 solid m^3/ha/year. On peatlands, the estimated average increment increase produced by fertilization is 1.25 solid m^3/ha/year and the duration of effect is twenty years. The drain increase obtainable from the fertilization programme is estimated in 1970 at about 1.3 million solid m^3 and from 2000 onwards at 14.5 million solid m^3/year.

The new stands established by means of natural regeneration, like those of the growing stock which the HKLN programme[1] aims at, develop on sites with fertility approximately halfway between that of the *Myrtillus* and *Vaccinium* site types. Although natural stands on mineral soils grow on the most barren sites, there are natural stands on relatively fertile peatlands, too. Natural stands are expected to be established annually on an area of approximately 45 000 ha.

The volume of "natural forests" in 2015 will be 150 million, increment 6.1 million, and drain 4.0 million solid m^3. The annual drain does not reach a significant level before the year 2000, at which time it will be 0.5 million solid m^3.

The volume of the total growing stock will decrease in this programme until about 1980, after which the rapidly increasing increment of the new stands will stem this and create a rising trend. By 2015, the volume will be 2 090 million solid m^3 which is roughly 76 per cent more than in 1970. The estimated increment in 1970 will be 47.6 million solid m^3. It will begin to increase immediately, firstly as a result of fertilization and secondly due to drainage. In 2015 it will total about 140 million solid m^3. During the same period the allowable cut will increase from 54 million to about 88 million solid m^3. The disproportionately great increment, compared with the allowable cut, is explained by the fact that there will be an accumulation of rapidly growing young stands in the forests after 2000, but (Figs. 2 and 3) which cannot at that age give much usable roundwood.

226. Comparison of the silvicultural programmes

Tables 1–3 indicate the work inputs, volume and increment of growing stock, and allowable cut under the different programmes. It can be seen from the tables that increasing timber production to meet the current and future demand for wood without exceeding the sustainable drain is possible only if extensive fertilization is introduced (cf. Figs. 2 and 3). It is characteristic of the minimum programme that although its work inputs exceed those of the 1968 silvicultural level, meeting the demand for industrial roundwood presupposes that the growing-stock volume up to 2000 must be reduced from what it is today. In other words, without extensive planting and fertilization, the large drain can be cut only by drastically reducing the current growing stock.

The immediate increasing effect on allowable cut from an expanded forest improvement programme was nearly exhausted under the primary programme. This immediate increase reaches its relative maximum in conditions where the intensification of natural forestry starts and where mature stands are relatively

1. HEIKURAINEN, KUUSELA, LINNAMIES & NYYSSÖNEN. Metsätalouden suunnittelukomitean mietintö. Liite 1. Metsiemme hakkuumahdollisuudet. Pitkän ajan tarkastelua. Summary: Report of the Forestry Planning Committee. Appendix 1. Cutting possibilities of the forests of Finland. A long-term analysis. Silva Fennica, 110. Helsinki, 1961.

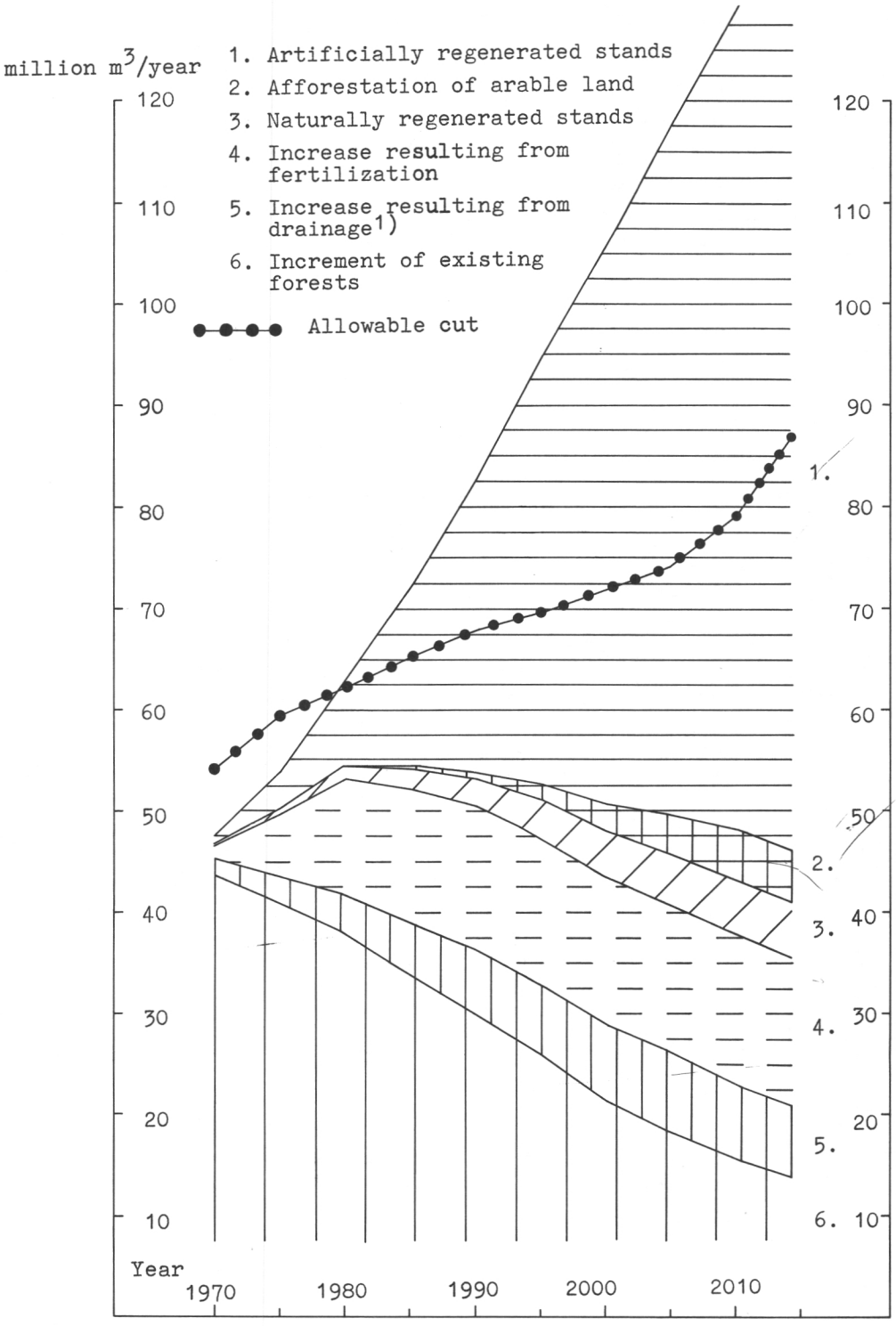

Fig.2. Development of increment. Maximum programme.

1) See note pp. 13-14.

1. Artificially regenerated stands
2. Afforestation of arable land
3. Naturally regenerated stands
4. Increment resulting from fertilization
5. Increase resulting from drainage[1)]
6. Equivalent to increment of existing forests
7. Reduction of existing forests

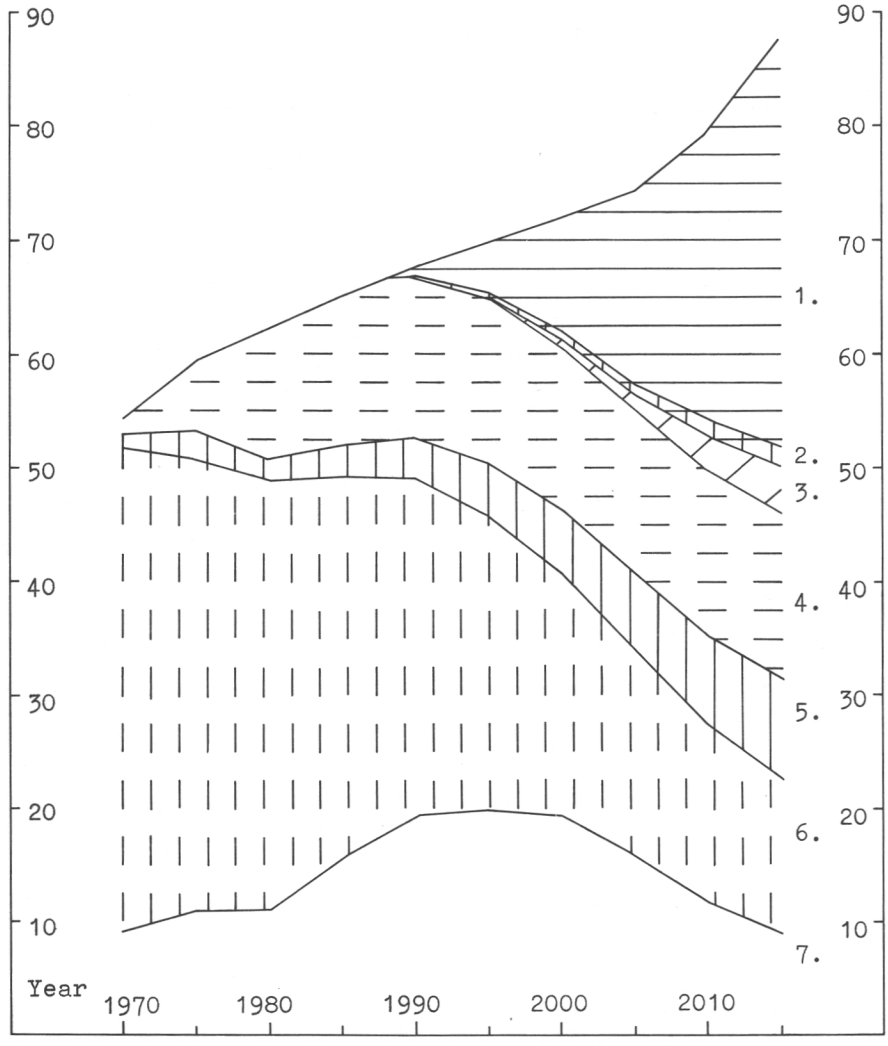

Fig.3. Development of allowable cut. Maximum programme.
1) See note pp. 13-14.

numerous. At present, expansion of forest improvement has an increasing effect on timber production to any great extent only in the fairly distant future. This manifests itself clearly when it is borne in mind that in 2015 the growing-stock volume under the minimum programme will total 1 592 million, under the primary programme 1 567 million, under the MERA programme 1 902 million, and under the maximum programme 2 090 million solid m^3.

227. Chances for implementing the programmes

All the programmes outlined used the same basis for their estimates of the potential increase in timber production. This was done in order to ensure comparability of the results. The basis consisted of the knowledge and expectations of the early 1960s. On the strength of the results of the Fifth National Forest Inventory and the experience gained from forestry in North Finland, it would seem that intensification of forestry to date has not been the same in all parts of the country; nor have work targets been achieved, qualitatively or quantitatively, in all cases.

It was indicated above, where the forest resources were described, that over extensive regions in southern Finland the forest owners are too passive to cut as much as they could have cut or do what could have been done to increase production. This reduces the amount of timber available, as compared with the allowable cut, by about 3 million solid m^3 per year.

Of the stands established artificially, about 24 per cent are too thin or are left untreated; about 35 per cent of the drained areas need further treatment. If stand-improvement work is not properly completed, its potential for increasing increment remains below the level presupposed in the basis of the calculations. Fertilization increases most rapidly the growth of trees on mineral soils, but the extent of the work expands very slowly. In North Finland, failure of the improvement work has led to the result that allowable cuts in state-owned forests will be reduced.

Developing patterns of land use reveal a growing tendency towards excluding considerable forest areas from effective timber production, especially near towns and urban areas, along the coast, and in North Finland where the high cost of timber production also is a restricting factor. A considerable proportion of privately owned forests is in the possession of persons not receiving their main subsistence from agriculture and forestry and this form of ownership is constantly increasing. More significantly, when the owner lives at a distance from his forest, as in a town, his interest in effective utilization of his forest is often reduced. In addition, forest owners who have shifted from agriculture and forestry to other occupations often have little chance of pursuing intense management on their holdings.

The above factors which reduce the efficiency of timber production are primarily a manifestation of the fact that while timber consumption has increased no advance or timely attention has been given to the prerequisites of increasing timber production. In some cases, e.g. through land-use policy, the position of forestry has been weakened. In the general economic policy and in forestry policy the belief seems to have been that timber production will increase automatically. This, however, is not the case. Not even the amount and level of knowledge has been adequate to meet the need. Work methods have been put to extensive use in forestry even before they have been studied and tested. Care has not been taken to secure the general preparedness and ability of foresters and the community as a whole in the attempt to increase roundwood production adequately to meet the demands of industrial expansion.

In the light of available information, it seems that expectations of increased roundwood production in correlation with the basis of the programmes have not been realistic in all respects. It is also unrealistic to assume that repercussions of long-term negligence can be offset within a sufficiently short period, especially as apparently no overall economic policy decisions will be made to master the situation. For this reason it appears that roundwood production will not increase in the way presupposed by the basis on which the programmes are built. Increment increase and potential cuttings in the future will lag behind expectations. Reliable estimates of the realistic level of production are only possible after sufficient information has been acquired concerning the effect of stand improvement on the development of forest resources over extensive regions.

3. FORECASTS OF TOTAL DRAIN

31. Method

The forecasts of the total forest drain were based on the estimated development of the various wood-use categories. They were divided into short-term and long-term forecasts, the former extending to 1971 and the latter to 2000. The short-term forecasts contain three alternatives (I–III) for the development of forest industry and the corresponding drains; the long-term forecasts contain four (alternatives 1-4). In the short-term calculations the forest industry expansion and modification projects were taken as given quantities. Studies were made as to whether they could be successfully implemented or whether the foreseen production would have to be curtailed. The long-term calculations, in turn, consider the forest industry expansion projects which will be possible if different primary (silviculture and forest improvement) programmes are implemented. Conclusions were based on forest balance comparisons, in other words, on comparisons of the total drain and the allowable cut. Before total drain could be determined, forecasts of the industrial consumption of industrial waste, stumps (and root spurs), branches, bark, dead trees on the stump (including logging waste from previous years), imported roundwood, and the probable (net) transfers of industrial roundwood among the natural wood-supply districts were required. Exports, wood utilization by real estates and other groups, and waste wood items were also forecast. These estimates were based on the chronological series of 1955–67, the current outlook, and opinions of experts in the different fields. The alternative totals of these items make up the forecasts of total drain.

32. Industrial use of domestic roundwood

321. Forecast up to 1971

In the short-term survey (1967–71) the following three alternatives for forest industry production were calculated:

Alternative I: The basis is the *output in 1967,* assumed to remain constant up to 1971.

Alternative II: The basis is the forest industry production in 1967 which is raised to equal by 1971 the output calculated on the basis of the *1967 capacity* in the following way:

- The sawmills included in the industrial statistics operate at 65–80 per cent of their present capacity. The small-scale sawmills (not included in the industrial statistics) operate with the same capacity as in 1965. (For details, see Appendix 2).
- Cellulose and hemicellulose industries work at 95 per cent of capacity; mechanical pulp, plywood and fibreboard industries operate at 90 per cent of capacity; and the particle board industry works at 85 per cent of capacity.

Alternative III: The basis is the forest industry production in 1967, raised to equal by 1971 the output calculated in the following way on the basis of the *1967 capacity and the additional capacity resulting from the expansion and modification projects announced to date* (by summer, 1969) *and to be completed by 1971:*

- The sawmills included in the industrial statistics operate at 65–80 per cent of their current capacity. The small scale sawmills operate with the same capacity as in 1965. (For details, see Appendix 2).
- Cellulose and hemicellulose industries work at 95 per cent, mechanical pulp, plywood and fibreboard industries at 90 per cent, and the particle board industry at 85 per cent of the 1967 capacity plus the aggregate additional capacity resulting from expansion and modification projects.

The 1967 output figures of the sawmills included in the industrial statistics were obtained from Sahojen Valvontayhteisö (The Finnish Sawmill Control Organization) and Suomen Sahat ry (Finnish Sawmills). There are two studies (1965 and 1967) by the Forest Research Institute concerning the output of the small-scale sawmills not included in the industrial statistics. However, the capacities of these sawmills are not known.

The output and capacity figures for the pulp and board industries, specified by regions and by industries, were obtained from the Central Association of Finnish Woodworking Industries.

These industries' expansion projects up to 1971 were obtained from the same source, similarly specified. The Central Association has collected the data from the industries themselves. The short-term forecast could perhaps have been extended slightly beyond 1971, but it is probable that the information on the later years would have been relatively unreliable. The expansion projects forming a part of the basis of this calculation will probably also undergo changes.

The forest industry output figures (and capacity figures for the whole country) in 1971 are presented in Table 4 by groups of industries and wood-supply regions.

Raw material consumption corresponding to the output figures of the groups of industries was calculated from consumption figures collected from various sources and adjusted by the figures calculated on the basis of the 1966 and 1967 industrial statistics. The consumption figures change with time but no allowance could be made for this in the calculations; the same figures were used throughout the period of the short-term forecast.

In order to arrive at the figures indicating the use of domestic industrial roundwood by logging areas, the following items must be subtracted from the total industrial roundwood consumption: domestic and imported industrial waste (chips, sawdust and veneer waste), dead trees on the stump (and logging waste from previous years), and imported roundwood. In addition, the internal transfers of roundwood from one wood-supply district to another (Table 5) must be taken into account.

The forecast of the use of industrial waste (chips and sawdust) was based on projected quantities of waste calculated from sawmill and plywood industry output[1] as well as on the quantities of domestic industrial waste used by the board and pulp industries in 1966 and 1967. A forecast of their future consumption was based on the above theoretical quantities and quantities of industrial waste exported from the country. Growth in the imports of industrial waste was estimated in cooperation with the Central Association of Finnish Woodworking Industries, Forests Division.

When the quantities of domestic and foreign waste wood used are subtracted from industrial roundwood consumption, the result shows the use of domestic and imported roundwood (including dead trees on the stump). The tree-species distribution in this consumption was forecast by allocating the forecast quantities of waste wood consumption among the industrial groups on the basis of the 1967 data and the expected development of waste wood consumption, prior to subtraction. The quantities of total roundwood use per industrial group thus obtained were then distributed into tree species using the ratios of the 1967 tree-species distribution.

The expected development in the use of dead trees on the stump and logging waste from previous years was taken directly from the calculations of the Forest Balance Committee.[2] The forecast of the imports of roundwood was made in cooperation with the Central Association of Finnish Woodworking Industries, Forest Division.

Transfers of industrial roundwood from one wood-supply area to another have been calculated as net imports or net exports for the area. The figures are based on a 1967 study of roundwood removals for sale.

A comparison of the various alternatives for the development of industries (see also Table 4) reveals that the Finnish forest industry in 1967 operated at a considerably reduced capacity. The degree of capacity reduction in the whole country corresponded to some 4.5 million solid m^3 of roundwood. In the Päijänne region the situation was the worst, but it was poor all over southern Finland. The projected expansions up to 1971 correspond to an approximate 3 million solid m^3 increase in raw material requirements. The expansions are most pronounced in the Saimaa area where the forest balance at the moment is good. Here they imply an increase in raw material requirements by some 1.5 million solid m^3. The projects are least important in Päijänne where the timber balance is most

1. Quantities of waste per production unit: Sawmills of the industrial statistics (according to ISOMÄKI), chippable waste 2.3 solid m^3 and sawdust 1.1 solid m^3 per std.; small-scale sawmills (according to SALO), chippable waste 1.9 solid m^3 and sawdust 1.0 solid m^3 per std.; plywood industry (according to SALO), waste 1.6 solid m^3 per cubic metre.

2. Teollisuusneuvottelukunnan Metsätasteoimikunta. Pohjois-Suomen metsätase vuoteen 2000. (Northern Finland's forest balance to 2000). Mimeographed. Helsinki, 1968.

precarious. In this district the modifications and expansions do not increase roundwood requirements. If the present and expanded industrial capacity for the whole country is put to effective use by 1971, the result will be an increase of over 7 million solid m^3 in the use of domestic roundwood as compared with 1967.

322. Forecast up to 2000

The long-term review (1971–2000) offers a choice of four alternative courses for developing the forest industry.

The *basis in 1971* is the same for *all the alternatives,* viz. forest industry production which corresponds to the *output figures calculated on the basis of expanded capacity* (the 1967 capacity plus the additional capacity resulting from the expansion and modification projects known in the summer of 1969 and extending to 1971), as was described under short-term alternative III, Section 321. This has been considered the most realistic basis in all the districts although it does not seem sensible from the forest balance point of view.

Alternative 1. After 1971, forest industry output is assumed to remain *constant* up to 2000.

Alternative 2. After 1971 the forest industry will be expanded within the framework of the increase in allowable cut according to the *minimum programme* and the consumption of forest industry products as forecast by FAO (the Food and Agriculture Organization of the United Nations). The output of the sawmill industry is assumed to increase very slowly up to 1980 and then remain constant (see Appendix 2). The other forest industry groups are presumed to increase their production as follows:

The mean annual increase percentages forecast under Alternative 2, taking the first year of the relevant 5-year period as the basis

	Plywood & slat board %	Particle board %	Fibre-board %	Pulp %	Paper & cardboard %
1971–75	2.75	5.0	3.0	2.7	5.8
1975–80	2.25	3.5	2.5	2.4	5.2
1980–85	1.75	2.5	2.0	1.5	3.4
1985–90	1.5	2.0	1.75	1.6	2.8
1990–95	1.25	1.75	1.5	1.8	2.8
1995–2000	1.0	1.5	1.25	1.7	2.1

Alternative 3. After 1971 the forest industry will be expanded within the framework of the increase in allowable cut according to the *MERA programme* and the consumption of forest industry products as forecast by FAO. The calculations have been made by districts. The output of the sawmill industry is expected to increase very slowly up to 1980 and then remain unchanged (see Appendix 2). The other forest industry groups are expected to increase their production as follows:

The mean annual increase percentages forecast under Alternative 3, taking the first year of the relevant 5-year period as the basis

	Plywood & slat board %	Particle board %	Fibreboard %	Pulp %	Paper & cardboard %
West Finland					
1971–75	3.5	8.5	5.0	10.2	16.0
1975–80	3.0	6.0	4.5	3.2	5.2
1980–85	2.5	4.5	4.0	3.2	4.7
1985–90	2.0	4.0	3.5	2.3	3.1
1990–95	1.75	3.75	3.0	1.3	1.9
1995–2000	1.5	3.5	2.5	1.7	2.0
Päijänne					
1971–75	3.0	5.5	3.5	5.5	8.0
1975–80	2.5	4.0	3.0	2.0	3.4
1980–85	2.0	3.0	2.5	2.3	3.5
1985–90	1.75	2.5	2.25	1.6	2.3
1990–95	1.5	2.25	2.0	1.1	1.7
1995–2000	1.25	2.0	1.75	1.4	1.7
Saimaa					
1971–75	3.0	5.5	3.5	1.0	3.8
1975–80	2.5	4.0	3.0	2.8	6.6
1980–85	2.0	3.0	2.5	2.5	5.2
1985–90	1.75	2.5	2.25	2.5	4.0
1090–95	1.5	2.25	2.0	1.9	2.9
1995–2000	1.25	2.0	1.75	1.7	2.1
North Finland					
1971–75	–	6.5	–	0.4	3.4
1975–80	–	4.5	–	3.4	8.8
1980–85	–	4.0	–	2.9	6.2
1985–90	–	3.0	–	2.5	4.2
1990–95	–	2.75	–	1.6	2.8
1995–2000	–	2.5	–	2.0	2.5
Whole country					
1971–75	3.1	6.4	3.8	4.2	8.0
1975–80	2.6	4.6	3.3	2.8	5.4
1980–85	2.1	3.5	2.8	2.7	4.7
1985–10	1.8	3.0	2.5	2.2	3.3
1190–95	1.5	2.8	2.2	1.4	2.2
1995–2000	1.3	2.5	1.9	1.7	2.0

Alternative 4. After 1971 the forest industry will be expanded within the framework of the increase in allowable cut according to the *maximum programme* and the consumption of forest industry products as forecast by FAO. The output of the sawmill industry is expected to increase very slowly up to 1980 and then remain constant (see Appendix 2). The other forest industry groups are expected to increase their production as follows:

The mean annual increase percentages forecast under Alternative 4, taking the first year of the relevant 5-year period as the basis

	Plywood and slat board %	Particle board %	Fibreboard %	Pulp %	Paper and cardboard %
1971–75	3.5	7.5	4.0	5.5	10.0
1975–80	3.0	5.0	3.5	4.1	7.0
1980–85	2.5	3.5	3.0	2.7	4.4
1985–90	2.0	3.0	2.5	1.6	2.5
1990–95	1.75	2.75	2.25	1.2	2.0
1995–2000	1.5	2.5	2.0	1.5	1.8

The capacity required to produce these quantities can be calculated if we assume that the cellulose and hemicellulose industry will operate at 95 per cent of its total capacity, the mechanical pulp, plywood and fibreboard industries at 90 per cent of capacity, and the particle board industry at 85 per cent of capacity. It was considered unnecessary to quote the capacity figures in the tables.

The alternative production growth forecasts for the forest industry are based, as noted above, on the allowable cut alternatives according to the various input programmes and the FAO forecasts of the consumption of forest industry products. When Alternatives 2–4 were adjusted to correspond to the various input programmes, conservative estimates were used in that the total drains corresponding to the alternatives for industrial expansion are slightly lower than the corresponding allowable cuts. This was considered advisable on the basis of the views presented in Section 227. The FAO forecasts of the consumption of forest industry products, mainly the most recent forecast of timber-product consumption in Europe (excluding the Soviet Union) up to 1980,[1] were employed to help in dividing the alternative roundwood quantities available for forest industry among the industrial groups and to help in assessing the potential for marketing these products. About four-fifths of the Finnish timber-products exports are destined for European markets. Since elsewhere in the world the trends will not appreciably differ from the changes expected in the European uses of the corresponding products,[2] the forecast can be based on these figures. Appendix 3, based on data released by FAO, presents the quantities of sawn goods, plywood (including slat board), particle board, fibreboard, paper, and cardboard used in 1950–65 and three alternative prospects up to 1980.

The trend in sawn goods production (see Appendix 2) has been assumed to be the same in forest industry production alternatives 2–4; exports around 1970 have been estimated to average about 950 000 stds. per year and the output has been calculated on this basis. Although the consumption of sawn goods in Europe in the 1970s, according to the FAO forecast, will definitely increase, the Finnish sawn goods production in the 1970s has been assumed to increase only slightly and in the last two decades of the century it has been assumed to remain at the level then attained. The main factor restricting sawmill industry production is a shortage of roundwood. But, even so, the sawlog-size stands in Finland's forests are relatively numerous because of the skewed age-class distribution; thus the shortage of supplies is much more severe in the pulp industry than in the sawmill industry. In the regional development of sawmill industry production, a point which has been taken into account is that the sawmill industry of North Finland, owing to the tight raw material situation, has in the last few years been compelled to cut its production permanently.

The output of the board industry has been forecast to increase under alternative 4 at almost the same rate as the increase in use of these products in Europe, according to the maximum FAO estimate. Under alternative 3, the increase in board production is approximately equal to the minimum FAO estimate, and under alternative 2, on the average, it remains slightly below the minimum FAO estimate.

1. FAO/ECE. European timber trends and prospects, 1950–1980. An interim review. Volume I. Supplement 7 to volume XXI of the Timber Bulletin for Europe. Geneva, 1969.

2. FAO. Wood: World trends and prospects. Basic Study No. 16, pp. 39–41. Rome, 1967.

After the increase in sawmill and board industry production had been forecast as described above, the quantities of pulp, paper and cardboard production were derived from the allowable cut forecast corresponding to the relevant production alternative. In other words, the expansion potentials within a projected sustainable allowable cut were tested. It has been assumed that a ton of pulp yields a ton of paper or cardboard. In reality, the pulp consumption, owing to loss and the difference in the degree of dryness, exceeds the weight of the produced paper or cardboard quantity by 3–5 per cent. On the other hand, since production also requires additives the consumption figure selected is probably very nearly correct. The use of waste paper as a raw material in paper and cardboard production has been assumed to increase by 3–5 per cent annually. Moreover, it has been assumed that mechanical pulp and cellulose exports will reach their peak by 1971, after which the exports will decline smoothly and by the year 2000 will be of little importance.

The increase in paper and cardboard output under alternative 4 (corresponding to the maximum programme) distinctly exceeds the maximum FAO estimate in the early 1970s, but by the end of the decade will be roughly equal to it. Under alternative 3 (which corresponds to the MERA programme) the increase in the early 1970s will slightly exceed the maximum FAO estimate, but subsequently remains distinctly below it. Under alternative 2 (which corresponds to the mimimum programme) the increase will remain below those forecast above and roughly equal the minimum FAO estimate. The regional increase percentages of pulp, paper and cardboard under alternative 3 vary considerably. The difference in the 1970s stem primarily from the forest balance situation of the different areas at the beginning of the period.

It appears that, considering the possibilities of selling the increased forest industry production, all the alternative production expansions are possible. It is true that alternative 4 exceeds the ceiling of consumption predicted by FAO but with vigorous marketing efforts even this quantity can probably be sold.

Sales, naturally, are not the only factor governing the expansion of production and the composition of the range of products. Additional factors, such as the supply of raw material, financial and manpower problems, and determination of the optimum returns from production within the enterprise and the national economy, may make the development essentially different from the forecast. It is therefore possible that sawmill industry production, owing to the raw material situation, may be restricted during the 1970s and that the increase in board industry production will be slower than assumed under alternatives 2–4. If so, and if the appropriate input programme (the silvicultural and forest-improvement programme) is observed, it will be possible to expand the paper and cardboard industry more than as described above. Finding the optimum range of products for the forest industry is a problem which should be solved by further studies; the future expansions and modifications of the forest industry could then be guided by the results obtained.

Production figures, by forest industry groups, according to the different development alternatives up to 2000, are given in Table 6 for the whole country. In addition, for development alternative 3, which corresponds to the MERA input programme, the corresponding data is given by wood-supply areas in Table 4.

With the aid of roundwood consumption figures, the quantities of raw material used by the forest industry were calculated on the basis of output figures. When the use of waste is subtracted from the total consumption of raw material, the result indicates the consumption of domestic and imported roundwood.

Practically all chippable waste from sawmilling, apart from that of the small-scale sawmills, is now used as industrial raw material. The increase in its use must therefore remain small in the forecasts even though some of the chippable waste of small-scale sawmills is expected to be used in the future. Sawdust has so far been little used as industrial raw material, but a rapid increase is expected.

Plywood industry waste is so far mainly used as fuel or destroyed. The bulk of this waste has been assumed, in the forecast, to be used for the manufacture of boards and pulp within the next 10–20 years.

Bark waste will most likely be an important raw material for the board industry in the future. Its use has been predicted to start in the mid-1970s and then to increase rapidly. A new board product included in the forecast is bark board (bark humus has been taken into consideration only in bark consumption). The basis

assumed for production of particle board is that, in the future, the intermediate sheets may contain bark up to 30–45 per cent. In the production of fibreboards, it is assumed that the proportion of bark in the raw material of hardboard may be increased to 30–40 per cent. For pulp, the sulphate process will be able to use pine with thin bark, provided its relative amount is not much higher than 5 per cent. The forecast of the use of bark in the cellulose industry is based on this assumption.

Fresh stumps with root spurs (not much older than two years) can be used for the production of sulphate pulp. However, the pulp obtained from stumps is not as good for paper making as that obtained from stems. The greatest impediments to the use of stumps and root spurs are the cleaning, barking, difficulties in transportation, and high cost of harvesting involved. Since new techniques will overcome at least some of these difficulties, the forecast assumes that the use of stumps and root spurs as a raw material will increase slowly and, by the end of the century, amount to 2 million solid m^3 per year. At the moment, over 10 million solid m^3 of stumps and root spurs remains unused in the Finnish forests annually. About 1 million solid m^3 is left on clear-cut areas.[1]

The use of branches for pulp production does not involve the same paper quality problems, but it is best suited for making the middle layers of multi-layer cardboards and in the production of sack paper. Semi-bleached or bleached, branch pulp might replace stemwood celluloses in newsprint and printing papers. The main difficulty is removal of needles which requires a large amount of chemicals and slows down the digestion process. The cost is increased also by the fact that in the sulphate process a special line should be established for branches, since the digesting chemicals differ from those used in stemwood processing. Also, branches can be used for the production of particle boards and fibreboards. Mechanical harvesting of complete trees is requisite for any considerable use of branches. In the early 1970s the quantities of branches so obtained will still be small, but in about ten years perhaps 10 per cent of the total removal will be harvested at treatment centres in the form of complete stems. About 10 million solid m^3 of branches (excluding needles) will accrue annually in connection with cuttings. By 1980, it is therefore possible that nearly 1 million solid m^3 of branches will be available as industrial raw material. The forecast presumes that the difficulties listed above can simultaneously be eliminated. By the end of the century, the use of branches as raw material, according to the present estimate, would exceed 2 million solid m^3.

At present the use of bark, stumps with root spurs and branches as forest industry raw material is still negligible. They form, however, a very considerable raw material reserve. In the forecast, their use by the year 2000 has been estimated to total about 6 million solid m^3. The quantity of raw material involved is so considerable that much more attention should be devoted to studies and experiments concerning the factors which prevent the use of these waste materials. Without such studies, the predicted quantities of waste wood will not be technically available for industrial use. Other supporting measures should also be considered, such as the use of relief work allocations.

The imports of industrial waste wood from the Soviet Union apparently reached their maximum in 1967 at a total quantity of 1.12 million solid m^3. In the forecast, drawn up in cooperation with the Central Association of Finnish Woodworking Industries, Forest Division, the waste wood imports are assumed to decline gradually and cease entirely by 1990.

The collection of material on the quantity of dead trees on the stump and imported roundwood was described earlier (p. 19). The imported quantity, mainly from the Soviet Union, has been assumed to have reached its maximum and to be declining gradually. The five-year trade agreement for 1970-75 confirms this trend. The development is probably associated with the expansion projects of the Soviet forest industry. According to the forecast, the imports will cease almost entirely at the beginning of the 1990s. The composition of imported tree species may be expected to change in that the absolute – and the relative – quantity of birch will increase considerably in the next few years. Hardwood imports will probably continue some-

1. MÄKINEN, VEIKKO O. Männyn juurakoiden kuutiomäärästä ja sen osuudesta vastaavan runkopuun kuutiomäärään. Summary: The volume of pine stump and roots, and its proportion of the stem volume. Metsätaloudellinen Aikakauslehti, 83:2–3. pp. 75–76, 104. Helsinki, 1965.

what longer than softwood imports. The future development depends on a large number of unpredictable factors, and the true roundwood imports may differ considerably from those assumed. There is every reason to try to increase roundwood imports in any way possible.

The forecast of domestic roundwood transfers presumes that transfers from the neighbouring districts to the Päijänne area will increase slightly in the early 1970s owing to the difficult forest balance situation in Päijänne. Subsequently the transfers from one area to another are likely to decline.

The calculation of the forecasts of domestic roundwood used by the forest industry can be seen from Table 8.

33. Estimate of total drain

Tables 9–11 show the calculations of the total drain for the short-term and long-term forecast alternatives. The use of domestic roundwood by the forest industry was calculated in the preceding sections (31–32). The use of fuelwood by industries, roundwood exports, use of roundwood by real estates, other roundwood items, and waste wood have been added, the final result giving total drain.

The use of fuelwood by the forest industry has been forecast separately for each wood-supply area on the basis of the trends in 1955–67, especially the last few years of this period.

Roundwood exports in 1966 and 1967 amounted to only 0.8 million solid m^3. This quantity has been forecast to decline slowly. Since a considerable proportion of these exports comprise special woods some exports will apparently always take place.

The use of roundwood by real estates, mainly as fuelwood, has been forecast on the basis of the quantities of roundwood used by real estates in 1955 and 1965, calculated by the Forest Research Institute in connection with its study of wood uses. The forecasts were calculated separately for every assortment of timber and every tree species, by districts. If it is desired that the use of fuelwood conform to the rate estimated in the forecast, there must be a change in the price ratios of birch fuelwood and/or birch cordwood and imported fuels or electricity so that imported fuels and electricity become relatively cheaper or, which is the same thing, birch cordwood and fuelwood become relatively more expensive. If the price ratio changes considerably, the use of roundwood as fuel may decline even more rapidly than expected. Both government and industry should devote attention to the price ratio between birch cordwood and imported fuels and electricity if it is considered desirable to shift raw material from fuelwood to industrial uses.

Other roundwood consumption items are small (in 1967, only 0.31 million solid m^3). Future trends have been forecast on the basis of use in 1955–67.

The transport loss in the calculation covers only floating losses, forecast on the basis of the trends of the late 1960s. Other transport losses, which are not known but may be assessed as very small, are not included in the figures.

The most important item of waste wood, cutting and clearing waste, has been estimated on the basis of the material of the waste wood study carried out by the Forest Research Institute[1] and the results of the re-measurement of the waste wood study carried out by the State Board of Forestry in 1965–66. The present waste wood percentages have been calculated with the aid of these studies. The percentages have been estimated to remain at their present level up to 1970 and then to decline during every subsequent 10-year period in the West Finland, Päijänne and Saimaa districts by 15 per cent and in North Finland by 20 per cent.

Forest storage sites are included in the above percentages. In the absence of information, other storage losses could not be included in the calculations. The resulting error, however, is not great.

Drain from natural stands in the total drain calculations is almost completely an estimated figure. Therefore, the forecasts of its future trends are necessarily highly approximate.

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1. MIKKOLA, PERTTI. Metsähukkapuun osuus hakkuupoistumasta Etelä-Suomessa. Summary: Proportion of wastewood in the total cut in southern Finland. Folia Forestalia, 74. Helsinki, 1969.

4. FOREST BALANCES

41. The balance in 1960–67

The forest balance is a comparison of the total drain from the forest in a given period with the allowable cut for that period. The forest balance reveals whether the drain and the wood requirements that occasioned it corresponded to the cutting potential, whether forest resources have been excessively reduced or whether some potential has not been exploited, how industry should be developed, and what forestry and forest industry production measures are required to meet the community's wood requirements.

Table 12 gives the 1960–67 forest balance in which the total drain derived from wood consumption is compared with the current allowable cut calculated on the basis of the National Forest Inventory (see. p. 10). The most important conclusions concerning the 1960–67 forest balance situation are:

In *West Finland,* the softwood drain compared with the allowable cut indicates definite undercutting since 1962. Above all, this is attributable to a large reduction in roundwood exports. The use of hardwood has exceeded the allowable cut. As a whole, the cutting potential of the forests has not been exploited in full and this "underuse" has increased since 1962.

The forests of *Päijänne* have been cut more heavily than those of West Finland and Saimaa. However, the distinct overcutting of the early 1960s is no longer evident as far as softwood, especially spruce, is concerned, although the allowable cut for hardwood is increasingly exceeded. On the whole, balance has been reached; cutting of deciduous trees can hardly go on very long at the present rate.

In *Saimaa* the softwood balance has developed favourably. This is a result of the great change in the roundwood export-import ratio and the rapid natural succession of spruce in pine and birch stands. In the hardwood balance the increased industrial use of birch, towards the end of the period, has led to a drain exceeding the allowable cut. But as a whole, the situation is relatively good at the moment.

North Finland is characterized by marked overcutting of pine, visible especially in the northernmost part of the district. Undercutting of birch is almost equal to the overcutting of pine. From the point of view of industrial wood supply, however, the situation is much worse than one would think looking only at the forest balance figures. The reason is that the allowable cut derived from the volume and structure of the growing stock contains about 0.8 million solid m^3 of pine from areas which, according to the current regulations for treating state-owned forests, fall outside intense cuttings.[1]

In the *whole country* the forest balance situation in the 1960s has developed favourably in that the total drain which previously exceeded the allowable cut has now declined to the point of being smaller than the allowable cut. The reasons for this are reduced roundwood exports and increased imports, reduced use of wood as fuel, and the development of business cycles. Geographically, all felling potential has not been utilized in recent years. The major increase in the felling potential for spruce in the allowable cut of southern Finland results from the increase of this species in excess of all earlier estimates. This increase in the supply of spruce was thus not taken into account when new mills were built. As a result, the consumption of hardwood species in southern Finland is increasing so rapidly that local difficulties in obtaining an adequate supply of hardwood may be encountered in the near future.

1. Teollisuusneuvottelukunnan Metsätasetoimikunta. Pohjois-Suomen metsätase vuoteen 2000. (Northern Finland's forest balance to 2000), pp. 75–76. Mimeographed. Helsinki, 1968.

42. The balance up to 1971

The current allowable cut has been worked out to cover 1964–1973. Since the allowable cut increases slowly, the 1971 figures are slightly higher than the mean values of the current allowable cut. The level naturally depends on the silvicultural and forest-improve-

ment programme adopted. Should the input programme correspond to the objectives of the MERA programme, the allowable cut might be increased as from the beginning of the 1970s. But, on the basis of the present financial arrangements it will be impossible to fulfil the objectives of the MERA programme by 1970; therefore, the true allowable cut in 1971 will be considerably lower than the levels of the MERA plan. Figs. 4 a–e show the allowable cuts by district, the true total drain in 1967, and the expected total drain in 1971 corresponding to the different alternatives for forest industry development. The forest balance of each area can be obtained by comparing the volumes of allowable cut with the total drain.

In *West Finland,* implementation by 1971 of the forest industry expansion and modification projects known in the summer of 1969 (alternative III) will result in a slight overcutting of birch only. If all forest owners treat their forests as presupposed by the allowable cut estimates, the forest balance situation in West Finland will not impede the realization of the announced expansion and modification projects.

In *Päijänne*, intense utilization of the 1967 forest industry capacity (alternative II) implies slight overcutting according to the current allowable cut. The expansion and modification projects to be implemented by 1971, which had been announced by summer 1969, are in fact very small in this district and entail no increase in roundwood consumption. The forest balance in this district will be restored within the next few years. Inherent weaknesses are that net imports of roundwood from the neighbouring areas are considerable and that the species composition of the cuttings disagrees with the composition of the allowable cut. The consumption of birch in particular should be shifted to spruce. In addition, most cuttings take place in the northern parts of the district instead of along the southern coast where the forest balance is better. The best short-term target in the Päijänne district is to correct the situation on these points.

In *Saimaa* the forest balance situation at the moment is good, and the existing industrial capacity can be put to effective use as far as forest balance is concerned. However, the post–1967 expansion and modification projects of the forest industry, as known by summer 1969, were so extensive, greater than anywhere else in the country, that they seem to portend considerable overcutting. In Saimaa some of the forest industry expansion and modification projects should be postponed to a later date provided they are still feasible at that time. The actual cuttings of the various tree species demonstrate a considerable disparity with the volumes suggested by the allowable cut. In industrial use, a great deal of the birch and some of the pine should be replaced by spruce. Furthermore, from the point of view of the future forest balance of this district, it is an absolute necessity to carry out the MERA input programme in full, for it would considerably improve the future forest balance situation which seems to be threatened. The forest balance situation is substantially dependent on roundwood imports from Russia. It is therefore advisable to keep the imports at the highest possible level; should imports be significantly reduced the forest balance situation in the district will deteriorate decisively.

In *North Finland,* bearing in mind the reducing effect (0.8 million solid m^3) of the regulations restricting the treatment of state-owned forests, the present forest industry capacity can be put to effective use except in Lapland and northeastern Finland (see below for details). Some of the expansion projects should, for reasons of forest balance, be postponed to date later than has been planned.

In a review of *Finland as a whole,* the current allowable cut and the total drain should be compared bearing in mind the potential increase in cutting in the near future if the MERA work targets are achieved. The forest resources permit the 1967 forest industry capacity (alternative II) to be kept in effective use. However, expansion and modification plans should be conservatively reviewed in the next few years and the date for their implementation should be extended beyond the projected date. This postponement should give time for the primary programmes of silviculture and forest improvement to take effect and for the internal structure of the relative uses to be changed, after which the consumption might be increased without any "advance use" of timber which would reduce the forest resources. In the expansion and modification projects, a higher degree of final processing and the accompanying increased utilization of raw material should be the primary considerations. Only in the event that the forest balance in a district will still

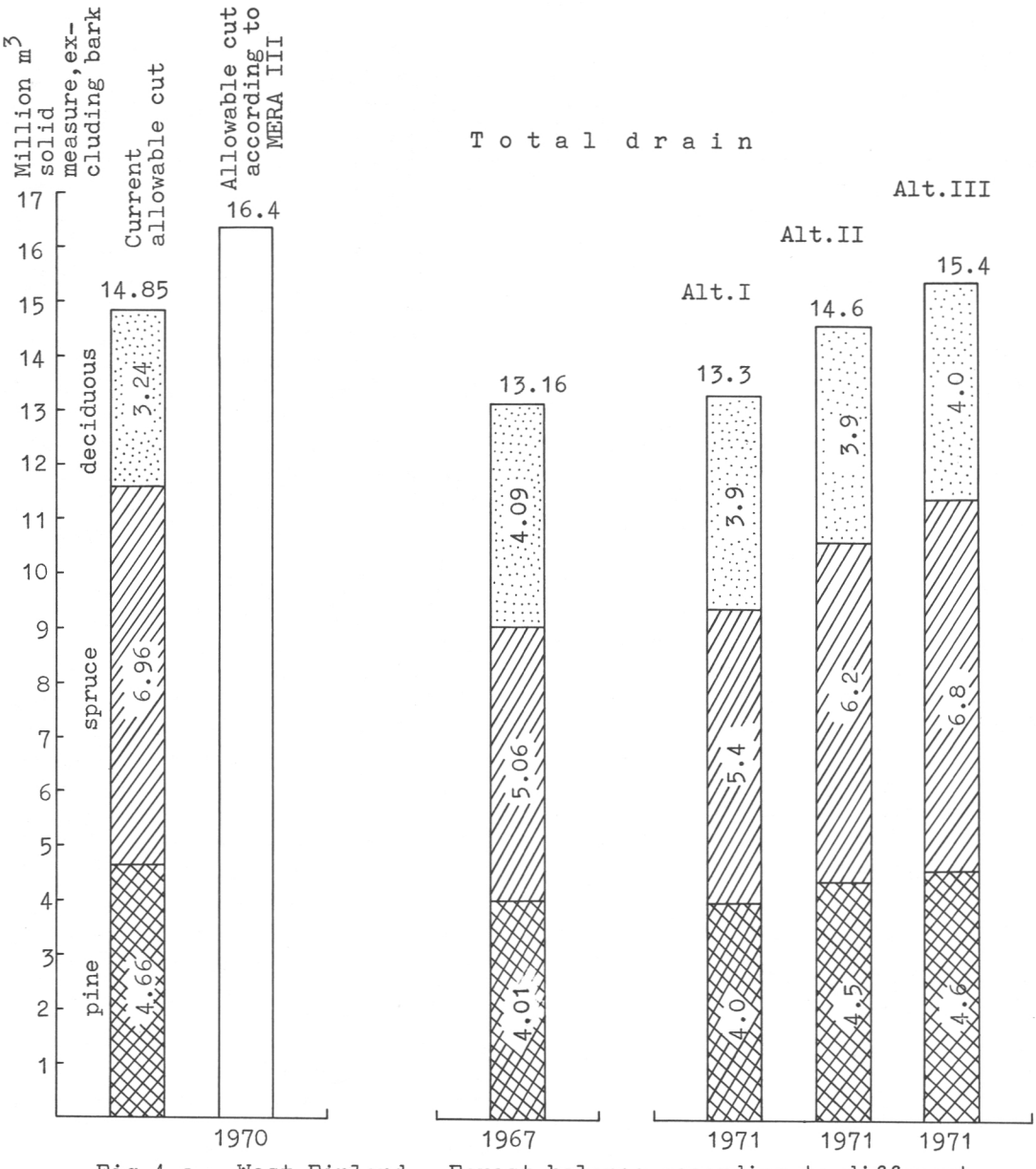


Fig.4 a. West Finland. Forest balance according to different alternative drains (Alt. I-III) in 1967-71.

Explanations: Alternative I. Forest industry output remains at the 1967 level.

Alternative II. The forest industry capacity of 1967 is put into effective use by 1971.

Alternative III. The 1967 forest industry capacity and the additional capacity resulting from expansion and modification projects known to exist up to 1971 will be in effective use by 1971.

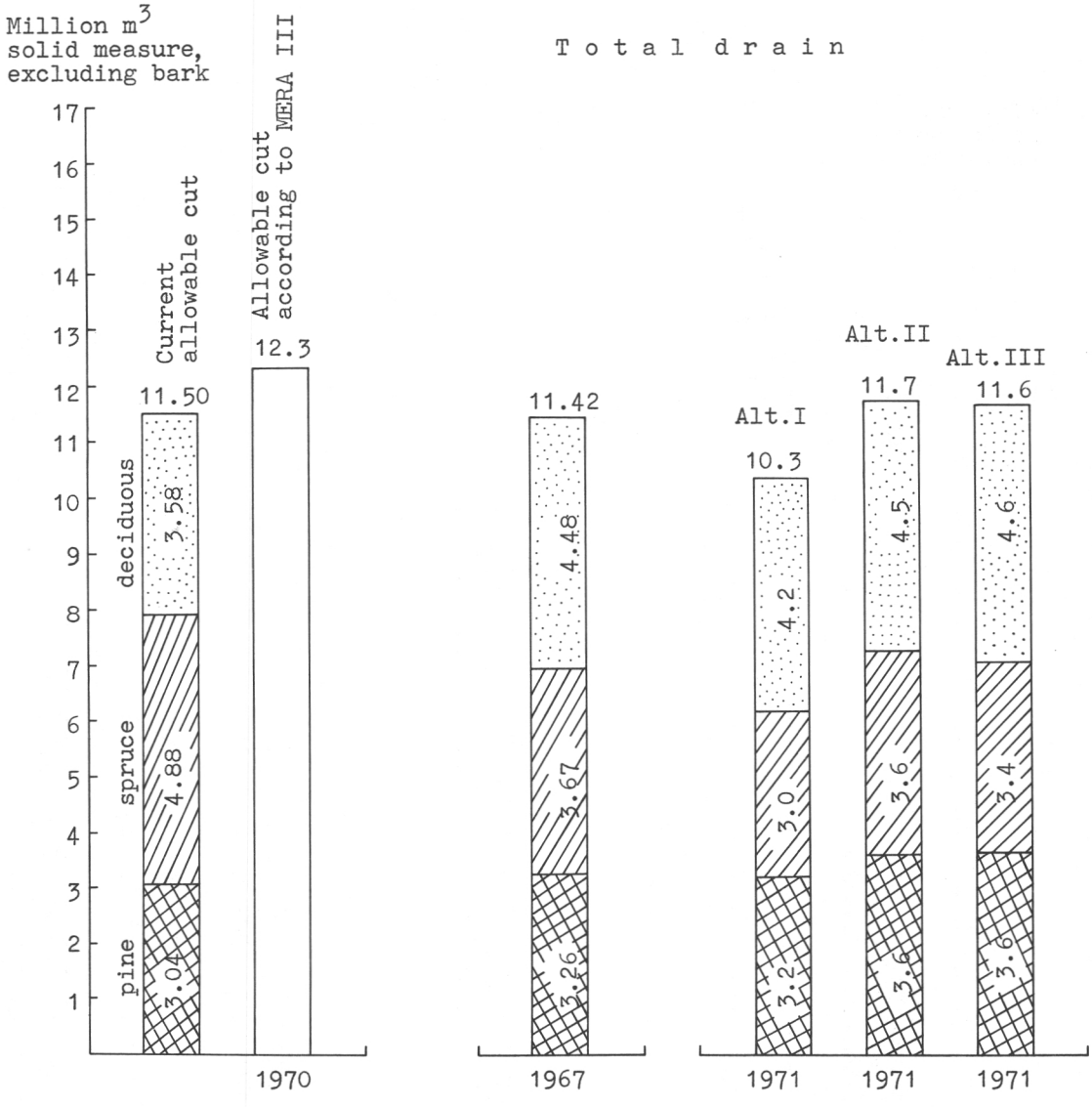


Fig.4 b. Päijänne. Forest balance according to different alternative drains (Alt. I-III) in 1967-71.

Explanations: see notes for Fig.4 a.

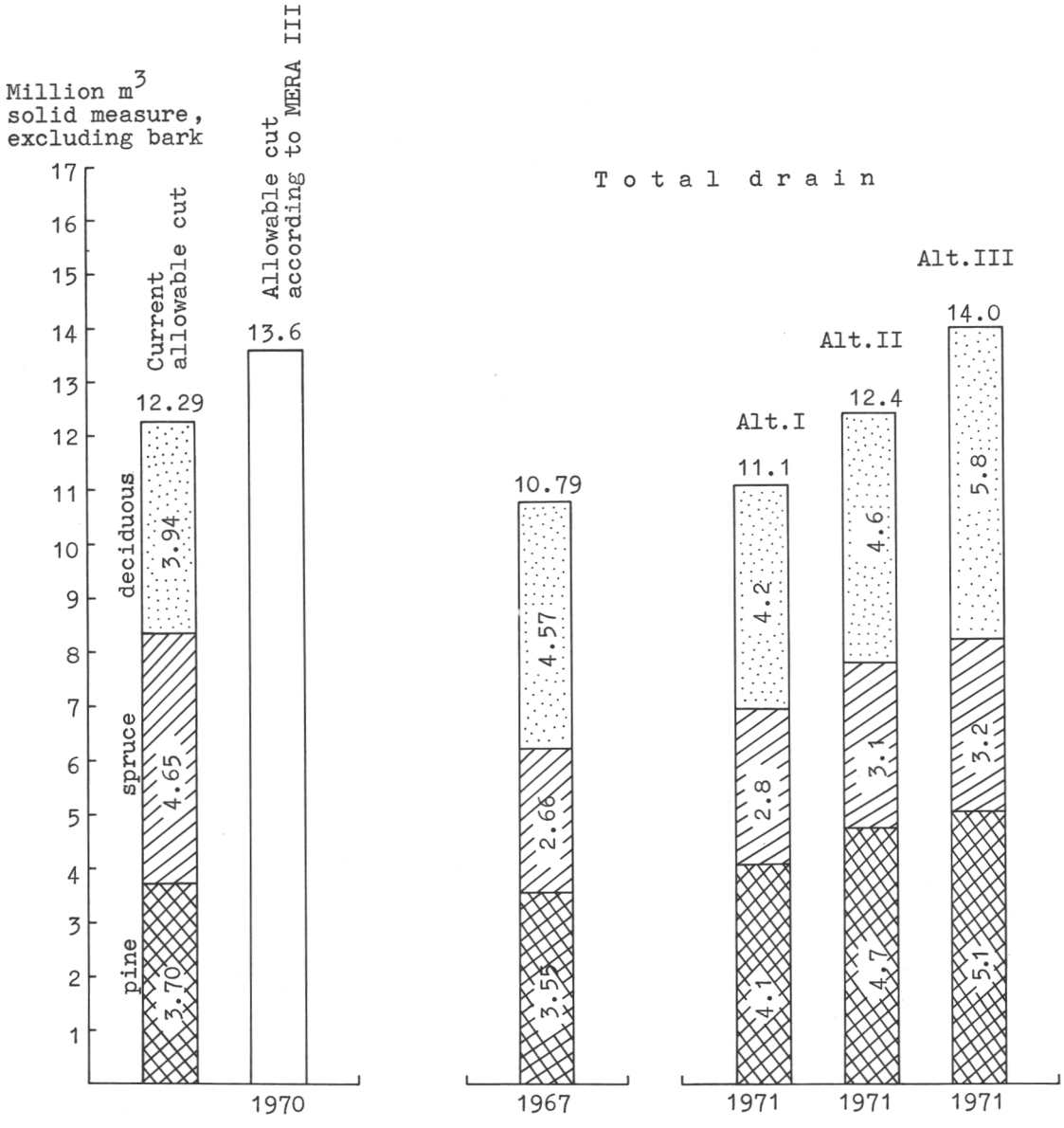


Fig.4 c. Saimaa. Forest balance according to different alternative drains (Alt. I-III) in 1967-71.

Explanations: see notes for Fig.4 a.

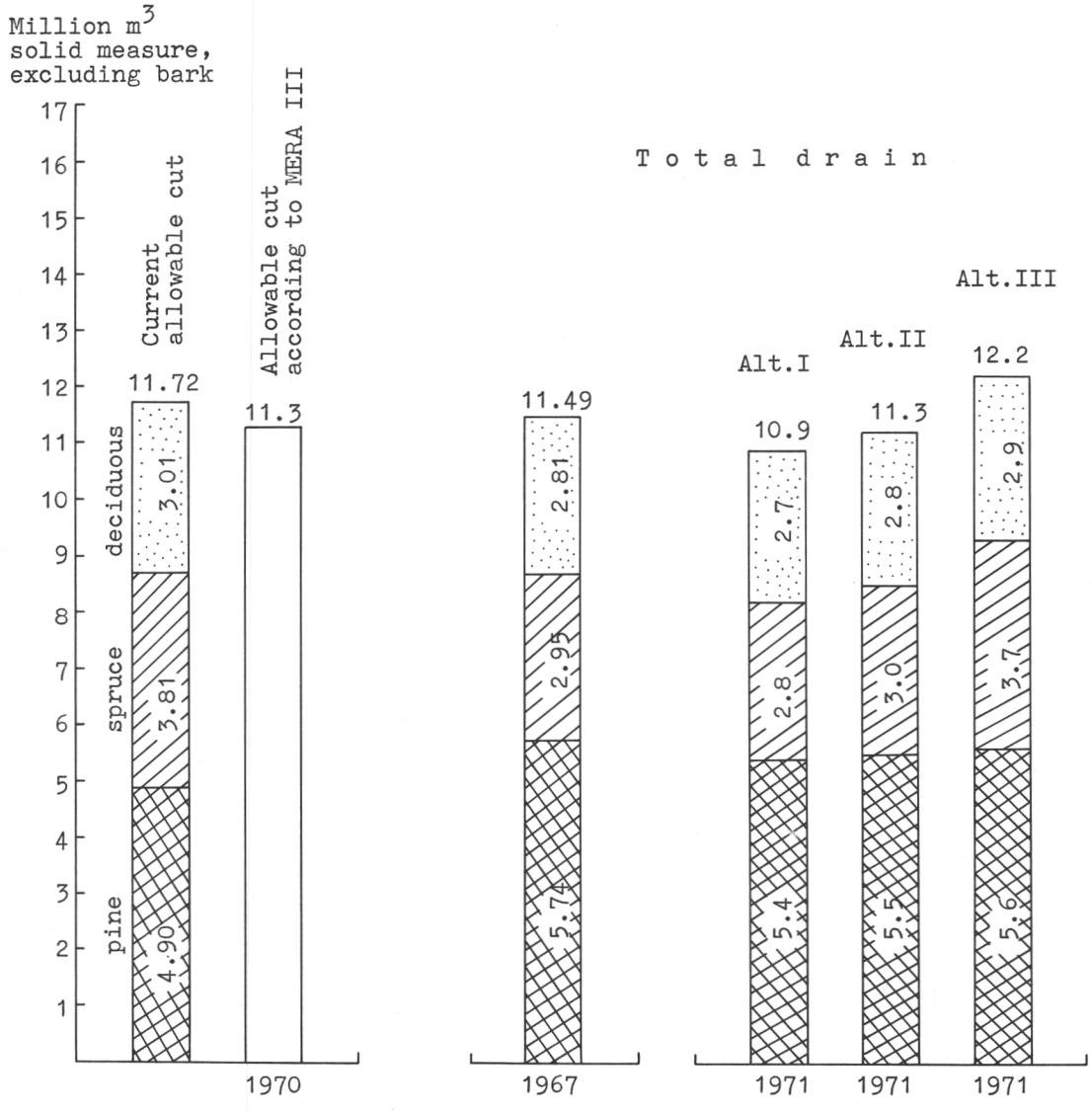


Fig.4 d. North Finland. Forest balance according to different alternative drains (Alt. I-III) in 1967-71.

Explanations: see notes for Fig.4 a.

N.B. The effect of the stipulations restricting the treatment of state-owned forests has not been subtracted from the current allowable cut. The restrictions would reduce the allowable cut by 0.8 million m^3.

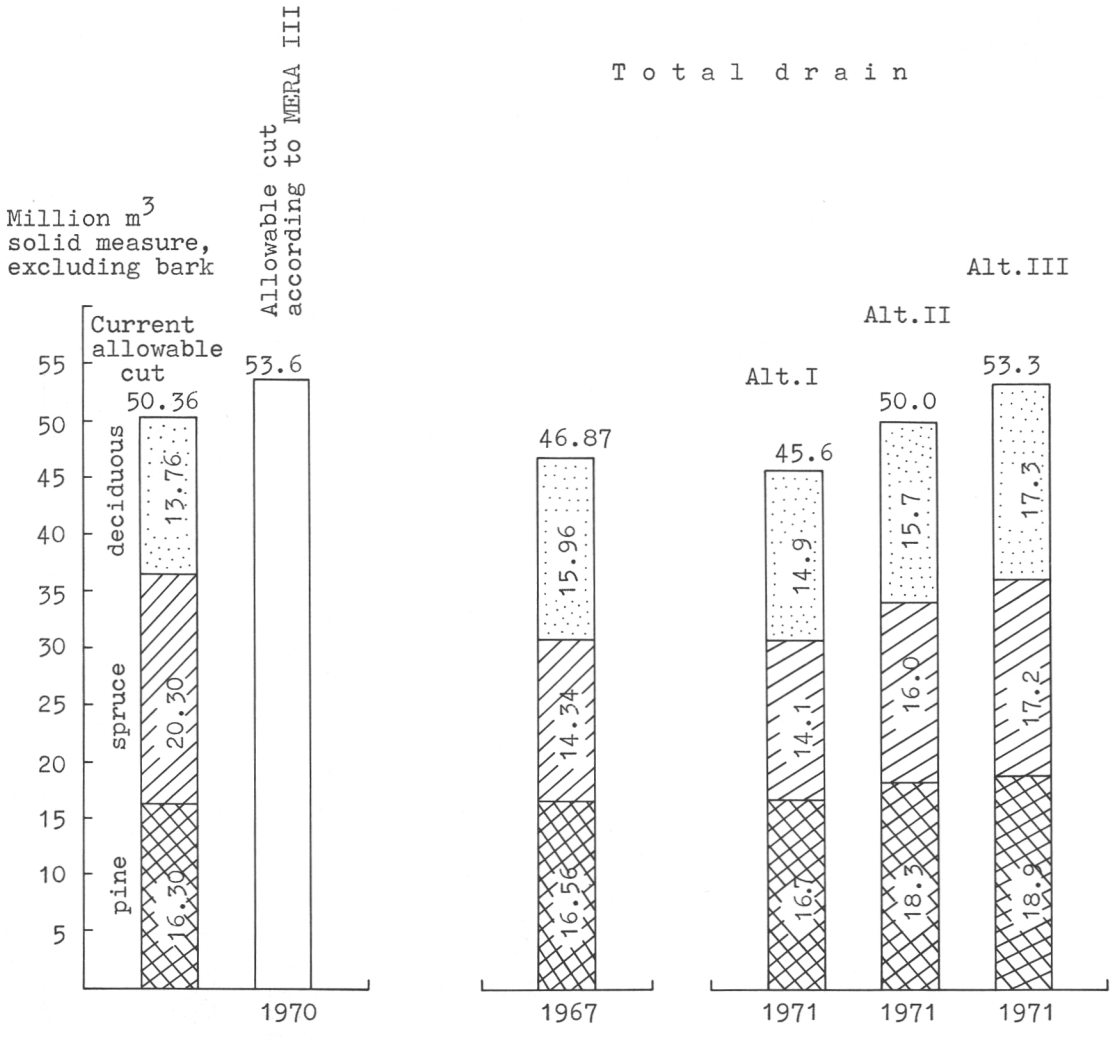


Fig.4 e. All Finland. Forest balance according to different alternative drains (Alt. I-III) in 1967-71.

Explanations: see notes for Fig.4 a and Fig.4 d.

permit it should steps be taken to expand primary forest industry. It is also worth noting that the realization of the MERA input programme, which at the moment is not at all certain, would markedly improve the changes of industrial expansion in the near future.

The above conclusions are based on an allowable cut which, according to the biological and technological production factors, can be termed sustainable. The cut and supply of timber depend on other factors as well. In several instances above, overcutting was reported to have taken place over extensive areas whereas elsewhere, especially in the southern, southwestern and western parts of the country, there had been undercutting and the forests had aged so much that their increment had diminished. Since on the overcut areas the supply of timber has declined, and is likely to go on declining, and since the utilization of forest has not been intensified accordingly on the undercut areas, it is uncertain whether the current allowable cut can be sustained in the near future without special forest policy measures. The reducing effect of this factor on the supply of timber in the undercut areas amounts to something like 3 million solid m^3 and this figure may increase. Unless intense cutting and regeneration is extended to the forests of all owners, realization of the expansion and modification projects of the forest industry will jeopardize sustained yield forestry. The factors which induce forest owners to abstain from timber sales in the undercut areas should be promptly analyzed and forest policy steps should be taken in an effort to offset this adverse effect.

The estimates indicate that a subtantial increase in the use of spruce is advisable in almost all of southern Finland. Here the deciduous growing stock has diminished greatly. Since this will before long lead to reduced cutting and supply of deciduous timber, preparative steps should be taken; for example, replacing birch with spruce in industrial use and modifying the price ratio between birch fuelwood and imported fuels (or electricity) so that the use of birch for fuel would diminish at the fastest possible rate. Sufficient attention should also be devoted to developing the supply of birch which will be required in the future.

Before the expansion projects are started on a large scale full certainty should be obtained concerning the programme of silviculture and primary forest improvement (the input programme) which will be carried out in the next few years and the forest policy measures that will be taken to ensure the fulfilment of the input programme throughout the whole country.

43. The balance up to 2000

Fig. 5 shows the allowable cuts according to the various input programmes up to 2015 and the corresponding total drains up to 2000 according to the forest industry production alternatives. In addition, another alternative according to which forest industry output remains at the 1971 level is included. This alternative would imply a continuous decrease in the total drain and shows that it is not sensible in the future to give up all forest industry expansion or be restricted solely to improving the degree of final procressing. Following the principle of conservative estimating (for reasons, see p. 17) the forest industry development alternatives 2–4 have been worked out so that the total drains they presuppose are slightly below the allowable cuts of the corresponding input programme. The *forest industry expansion projects justified by implementation of the different input programmes can be seen from the yield increase percentages of the forest industry groups presented on pp. 20–22 and from the output figures per industry group given in Table 6.*

Figs. 6 a–d show the allowable cut according to the MERA programme and the forest industry development alternative 3 which correspond to this input programme, classified by wood-supply areas. The regional output increase percentages for the forest industry under this expansion programme are given on p. 21 and the corresponding yield figures per industrial group in Table 7. These figures reveal that the chances of expanding the forest industry vary considerably from district to district. The possibilities in the 1970s depend decisively on the

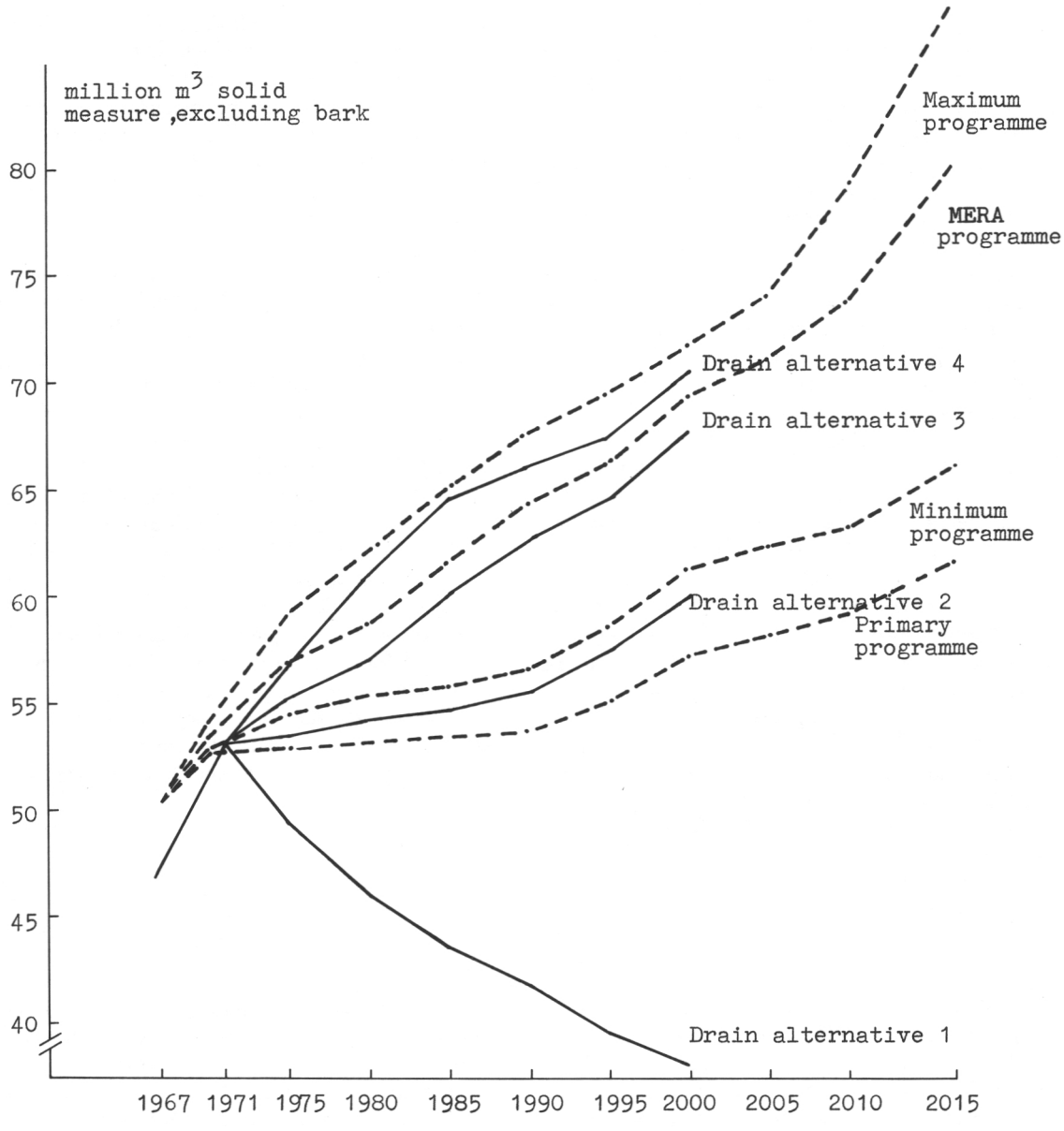


Fig.5. Allowable cuts in Finnish forests with various input programmes and the corresponding total drain alternatives, 1967-2000.

Explanation: Drain alternatives (=forest industry development alternatives), see pp. 20-25. Input programmes, see p. 10 f.

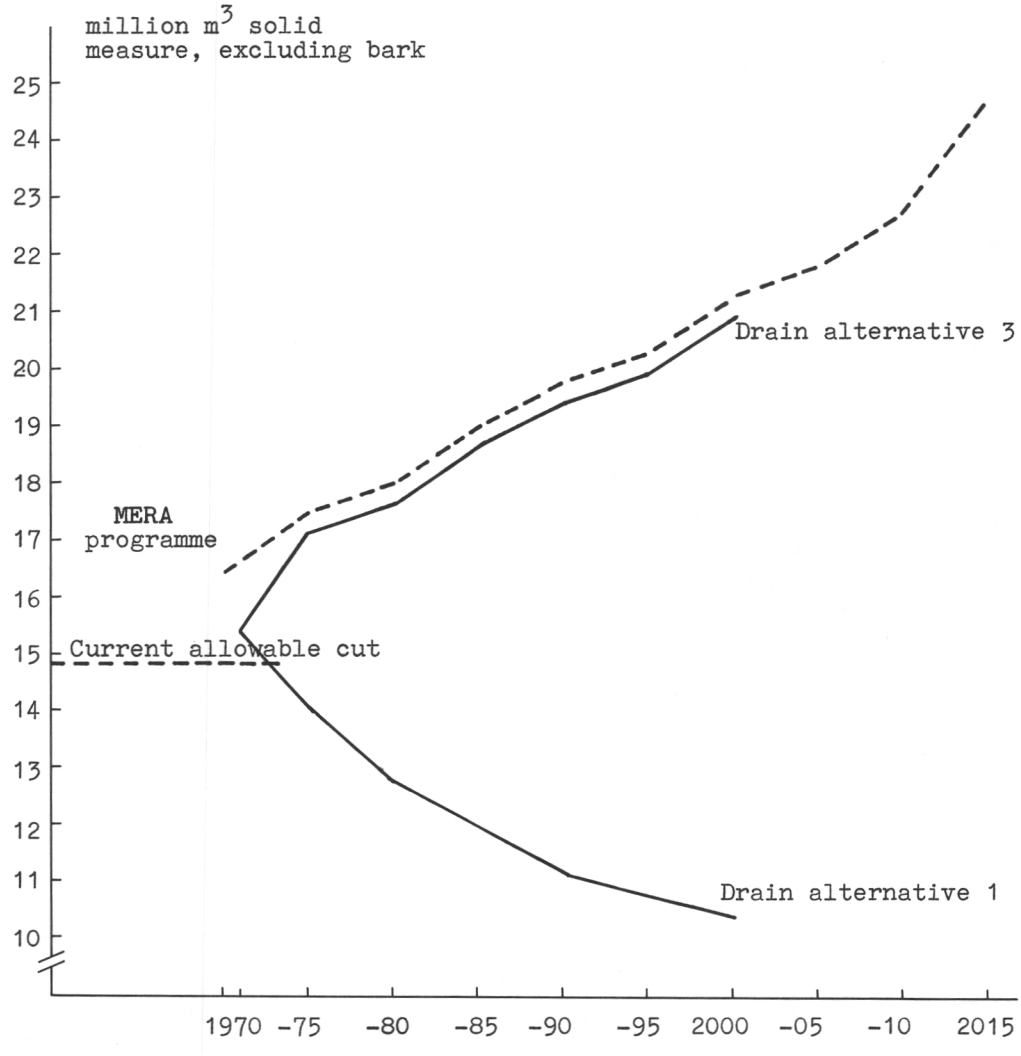


Fig.6 a. West Finland. Forest balance up to 2000. The current allowable cut and that corresponding to the MERA input programme.

The drain alternative 3 is based on the forest industry development alternative corresponding to the last-mentioned allowable cut (see pp.20-21).

Drain alternative 1 presupposes that primary forest industry is not expanded after 1971.

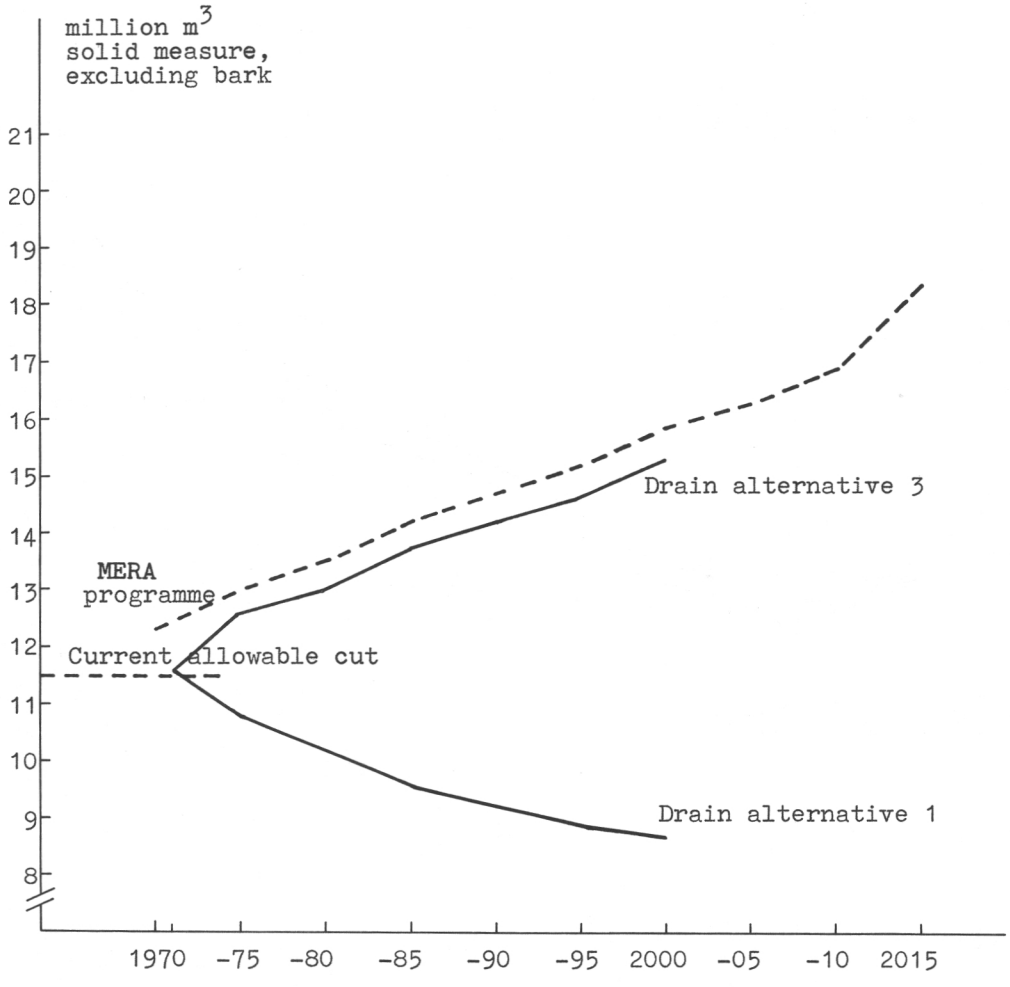


Fig.6 b. Päijänne. Forest balance up to 2000. The current allowable cut and the cut corresponding to the **MERA** input programme.

The drain alternative 3 is based on the forest industry development alternative corresponding to the last-mentioned allowable cut (see **pp. 20-21**).

Drain alternative 1 presupposes that primary forest industry is not expanded after 1971.

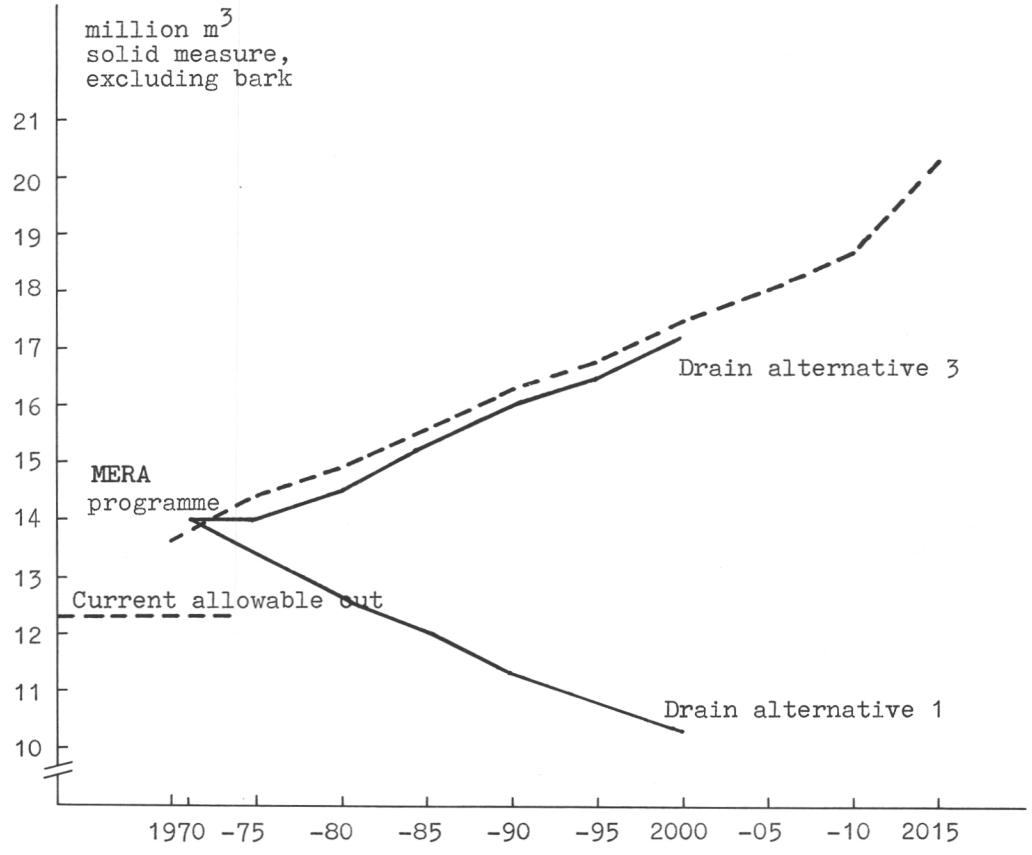


Fig.6 c. Saimaa. Forest balance up to 2000. The current allowable cut and the cut corresponding to the MERA input programme.

The drain alternative 3 is based on the forest industry development alternative corresponding to the last-mentioned allowable cut (see pp. 20-21).

Drain alternative 1 presupposes that primary forest industry is not expanded afetr 1971.

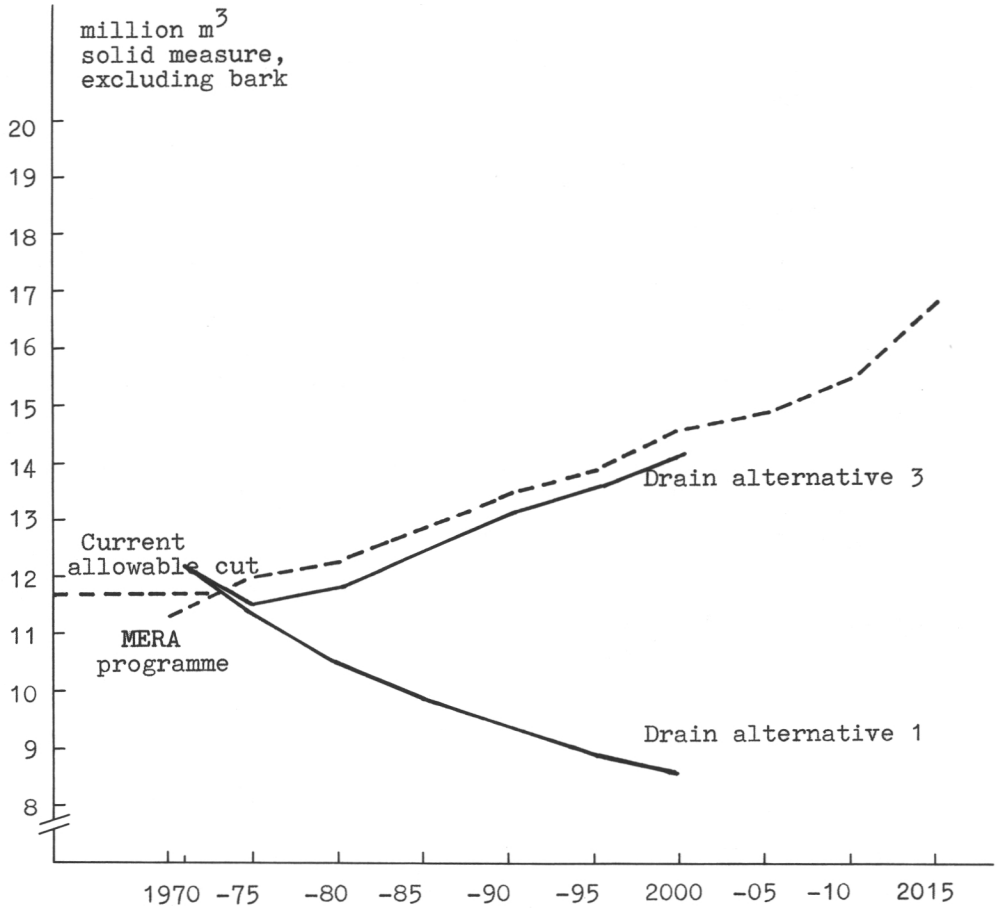


Fig.6 d. North Finland. Forest balance up to 2000. The current allowable cut and the cut corresponding to the MERA input programme.

The drain alternative 3 is based on the forest industry development alternative corresponding to the last-mentioned allowable cut (see pp. 20-21).

Drain alternative 1 presupposes that primary forest industry is not expanded after 1971.

N.B. The effect of the stipulations restricting the treatment of state-owned forests has not been subtracted from the current allowable cut. The restrictions would reduce the allowable cut by 0.8 million m^3.

forest balance situation at the beginning of the decade. If forest industry expansions by 1971 have resulted in overcutting, the growth percentages will remain small. After 1971 the situation is best for further expansions in *West Finland.* In *Päijänne,* forest balance will be reached in the early half of the 1970s, and the chances for industrial expansion will then be relatively good. However, the district will for some time remain largely dependent on roundwood imports from other districts. In *Saimaa,* the expansions known to have been planned up to 1971 are considerable. They will weaken the forest balance so much that the expansion projects of the early half of the 1970s must be restricted to a minimum if wood supply in the future is to be assured. The best solution would be to concentrate on improving the degree of final processing. In *North Finland* the situation will be much the same as in Saimaa.

The northernmost part of the country, Lapland, must be discussed separately since its situation is exceptional. The Forest Balance Committee of the Industrial Delegation came to the conclusion that in Lapland not even the existing forest industry capacity can be operated at an optimum rate in this century. This is true even if a highly intense silvicultural and primary forest improvement programme is implemented. If sustained yield forestry is observed in Lapland, if operations are planned so that cuttings need not be reduced in the future owing to a decline in growing stock, primary forest industry cannot be expanded beyond its present level.

The basis on which domestic roundwood transfers were forecast was the present forest balance situation in the different supply areas. The resulting estimate was that transfers from the neighbouring areas to the Päijänne district will slightly increase in the early 1970s, after which they will being to decline gradually. The forecasts of the forest balance situation show, however, that it is highly probable that transfers at least from Saimaa to Päijänne must be reduced by the early 1970s. The error inherent in roundwood transfer forecasts of this kind must be borne in mind when regional possibilities for forest industry development are considered.

The industrial output growth percentages in the various districts approach one another in the second half of the 1970s since the forest balance situation according to calculations will have reached equilibrium by then. It must be borne in mind, however, that the true situation in the late 1970s will depend on what forestry and forest industry policy will have been applied prior to that time.

The only alternative considered acceptable in the present study is sustained yield forestry. But research is required to find out whether well-rounded development of the national economy does actually presuppose this type of forestry.

5. COST AND PROFITABILITY OF FOREST IMPROVEMENT PROGRAMMES

51. Possibilities and limitations of comparison

The profitability of the minimum, MERA and maximum programmes for the national economy will be compared below in three ways:

a) *at the stumpage price level,* taking into consideration only the tree-growing phase of forestry, up to the sale of standing timber, with stumpage price used as the price of the yield;

b) *at the delivery price level,* considering, in addition to the above, roundwood harvesting from the cutting site to a long-distance transport route as part of the production process, the yield being priced using the delivery price at the road side; and

c) *at the national economy level,* with the increase in yield produced by the forest improvement programmes priced at the export prices of final products, including all corollary effects as far as possible.

The profitability comparison will be carried out theoretically at each level so that the *increases*[1] in forest improvement according to the minimum, MERA and maximum programmes *over the primary programme* in 1970–2015 are priced and compared with the corresponding yield increases expressed in the form of allowable cuts and calculated for the primary programme (Table 13) at each of the three price levels.

At the stumpage price level and delivery price level the comparison of profitability is carried out by calculating the internal interest for return increases and cost increases discounted to 1970; in other words, by determining the rate of interest at which the return increases discounted to 1970 equal the cost increases similarly discounted. This is the expected rate of return on the investment. The internal rate of return was determined graphically as shown in Fig. 7.

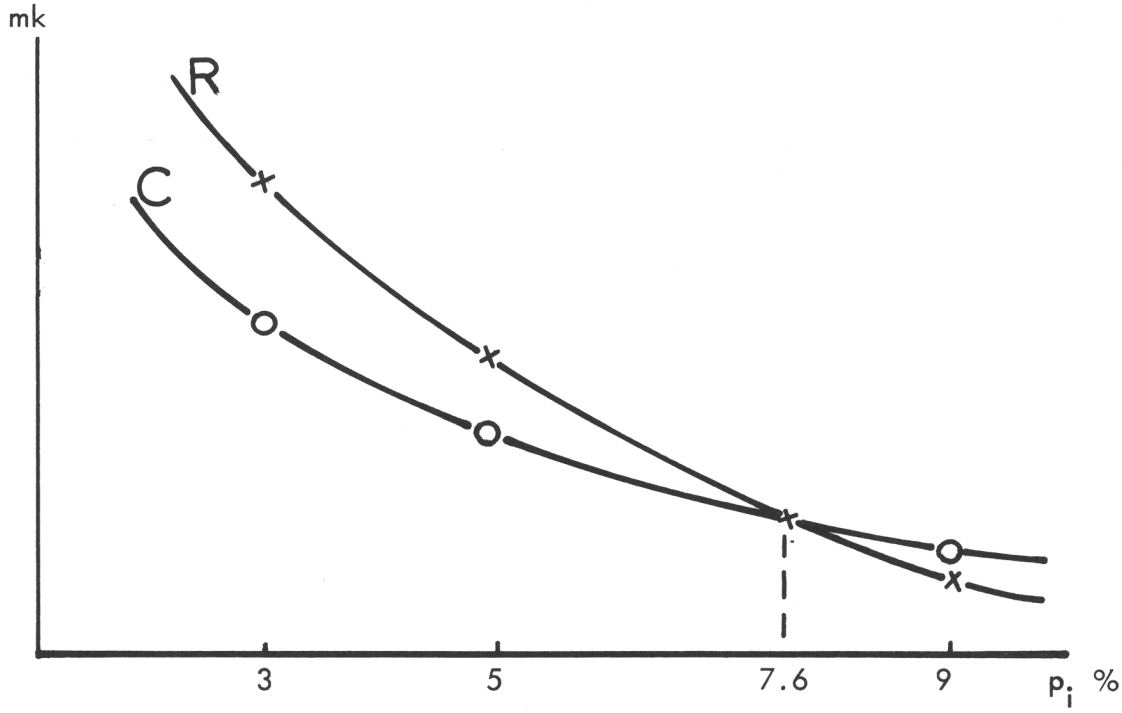


Fig. 7 Determination of the internal rate of interest.

1. See pp. 13–14 (amendments by HEIKURAINEN).

Calculation of the present value of return increases in 1970 at a few alternative rates of interest gave the points required to plot the curve (R) of return increases. The curve (C) of cost increases was obtained similarly. The point of intersection defines the internal rate of return (p_i), which in the case of the figure was 5.6 per cent.

In order that dissimilarity in the final growing stocks under the different programmes (in 2015) should not hamper the comparison, that part of the final growing stock which exceeded that of the primary programme for the minimum, MERA and maximum programmes was also priced at the above prices, discounted to 1970 and added to the discounted value of return increases.

The increase in the final growing stock has been taken into account in this way at both the stumpage price and delivery price levels for only one of the alternative calculations. For comparison, those same calculations were also carried out disregarding the differences in the final growing stock.

The calculation methods described above have their limitations and shortcomings. It is perhaps most important to bear in mind that here, as in forestry as a whole, calculations must be made to cover extremely long periods. In actual fact, the 45-year period employed here (1970–2015) is too short. For afforestation of arable land, for example, practically nothing but the cost will be included, since returns are not realized until after 2015.

Within the framework of such long calculation periods the price and cost estimates naturally are less than realistic and the comparability of the rates of returns with those of most other sectors of economic life is thereby reduced. The construction industry would be one of the most comparable sectors, but as far as is known, no internal interest has been calculated for it, at least not in Finland.

The calculations are most reliable when used for internal comparisons as is the case in this study when examining the mutual profitability of the proposed programmes.

In addition to the weaknesses listed, it should be borne in mind that the ultimate basis of the allowable cuts corresponding to all the input programmes of the present study is the principle of sustained or progressive yield; the yield programme must be built on the current situation, but the future yield must be *constantly rising*. No compulsory decrease in cuttings due to biological and technical reasons is permissible, not even temporarily.

This stipulation which limits the timing of production is based on the idea that the Finnish society will not tolerate wide fluctuations in operational volume of sectors as important as forestry and the export industry based mainly on forestry. For this reason, every effort must be made to limit the fluctuations to those arising for economic reasons (business cycles).

As a result of this limiting stipulation, the programmes could not propose solutions which would often have seemed economically favourable, such as regeneration of overmature and other low-yielding forest at such a rapid rate that for example, the sawmill industry subsequently would be required to operate for some time at much less than full capacity. The requirement of sustained yield therefore means that the present generation makes a sacrifice by refraining from even profitable fellings in order to ensure constant production for future generations.

However, a further consequence of the sustained yield requirement is that the steps taken to accelerate the future growth rates of the forests may at the same time reduce the sacrifice required of the present generation in favour of the constancy of future production. One example is that the current afforestation of arable land may exert some *immediate* influence on the allowable cut although afforestation in itself naturally cannot yield timber until about 30 years after the planting.

Hence, the sustained yield requirement leads to the result that the profitability calculations of this study give the forest improvement programmes a *higher* rate of internal interest than would have been the case if no sustained yield requirement were posited. The correct procedure on this point would apparently have been to consider the degree of utilization and employment requirements of forest industry in the calculations and then to build optimum programmes of production for the various levels of silvicultural intensity. Calculations of this type, however, are not yet possible. The above train of thought may be elucidated by the schematic illustration in Fig. 8.

The current structure of Finnish forests (an above-normal number of mature stands and extensive areas of distinctly low-yielding forests) presupposes that the highest possible expecta-

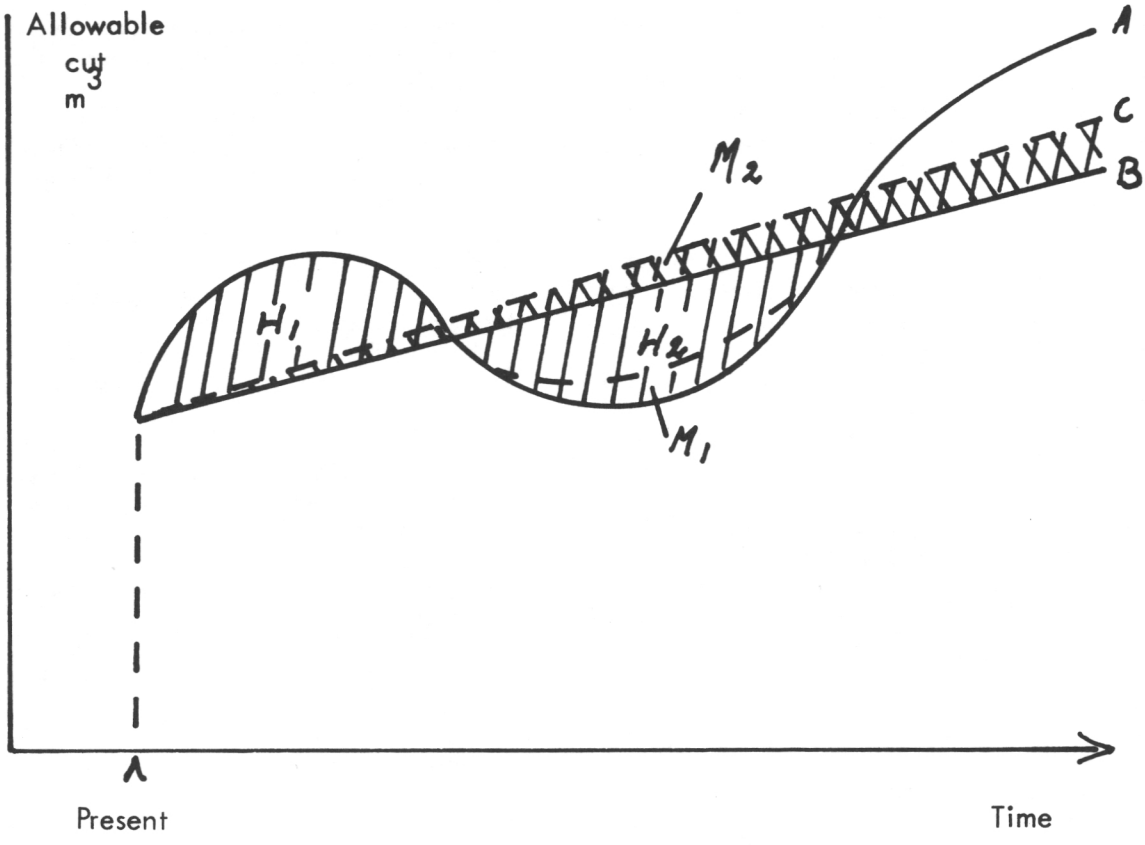


Fig. 8 Effect of the sustained yield requirement on the planning of the allowable cut.

tion value of *stumpage-price* earnings can be reached by an undelayed sale of the low-yielding and mature stands and immediate regeneration of these areas to produce seedling stands of full yield. From this point of view, the optimum felling programme would assume the form of Curve A in Fig. 8: at first steeply rising, but then, for one or more decades, very much lower cuts while waiting for the growth of the newly planted trees. The result of this pronounced fluctuation in the total cutting would be, for example, in the early phase a shortage in the labour force and mill capacity, which would make it compulsory to export timber in the form of roundwood at an unreasonably low level of processing. In the subsequent phase, with decreased cutting, the difficulties would be the opposite: unemployment of both manpower and processing capacity.

Although in the near future both the manpower reserve and the industrial capacity would suffice for even a considerable increase in production (e.g. if the oldest sawmills were worn out by running them continuously at full capacity), the current opinion is that society is responsible for seeing to the employment of future generations and the efficient use of available capital. For this reason the felling programme is planned so that the annual cut increases rectilinearly (Curve B) with the resulting total cut in the next few years being smaller by the area H_1 than according to Plan A. In this way, the roundwood, shortage caused by programme A can be "filled" by as much as the area H_2 yields. H_1 is therefore the sacrifice in the near future that is made in favour of the coming generation. This sacrifice, however, can be reduced by intensified silviculture, e.g. by drainage in the next few years to such an extent that the next generation can increase fellings by the area M_1. When the cutting possibilities for the future generation increase in this way, the present generation needs to sacrifice less and may raise its programme by M_2 to the level C. In this way, increasing the security of the future

generation also makes it possible to increase yields somewhat in the very near future.

It is natural that conditions do not always permit the above procedure, e.g. if the forests are composed mainly of young stands. This rectilinearly progressive felling programme is optimal only in exceptional cases. In this case, however, it was not possible to calculate any true optimum programmes.

52. Prices, returns and costs

The unit costs used in all the forest improvement programmes were the following 1965 unit costs for the whole country:

forest regeneration	447 mk/hectare
afforestation of arable land	535 mk/hectare
forest fertilization	133 mk/hectare
forest drainage	150 mk/hectare

The yields were priced using the following use-structures for the yield, with allowance made for the dissimilarities in the industrial development alternatives.

Solid m^3 excluding bark

	Primary	Minimum	MERA	Maximum
Coniferous saw logs	0.27	0.25	0.20	0.17
Veneer birch	0.04	0.04	0.04	0.05
Spruce pulpwood	0.13	0.16	0.23	0.23
Pine pulpwood	0.23	0.24	0.27	0.33
Birch pulpwood	0.09	0.08	0.04	0.03
Small-sized coniferous wood	0.03	0.02	0.02	0.01
Other roundwood	0.14	0.14	0.12	0.11
Waste wood	0.07	0.07	0.08	0.07
Total	1.00	1.00	1.00	1.00

The price of the yield was determined with the aid of prices for 1968 taken from a trend (the price curve indicating the main direction) calculated on the basis of long-term price series as follows (the prices for veneer birch and birch pulpwood were, however, the means of the 1965–68 prices):

	mk/solid m^3	
	Stumpage price	Delivery price
Coniferous saw logs	31.68	41.18
Veneer birch	30.18	41.35
Spruce pulpwood	19.79	39.58
Pine pulpwood	12.81	32.03
Birch pulpwood	4.42	17.68
Small-sized Coniferous wood	3.68	14.72
Other roundwood	4.00	16.00

Thus, due to dissimilarities in the use-structures, the cubic metre price for the programmes was not the same:

	mk/solid m^3	
Programme	Stumpage price	Delivery price
primary	16.35	29.56
minimum	16.35	29.91
MERA	16.29	30.56
maximum	16.29	31.18

In comparisons at the national economy level, the export prices of both 1965 and 1968 were used as shown below. The difference between them is mostly a result of the 1967 devaluation.

		1965	1968
sawn goods	mk/std	710	805
plywood	mk/m^3	468	640
particle board	mk/m^3	197	234
fibreboard	mk/ton	265	301
newsprint	mk/ton	397	514

53. Profitability at the stumpage price level

The cost increases entailed by the minimum, MERA and maximum programmes over and above the *primary programme* were compared with the return increases resulting from the corresponding increased allowable cuts at the stumpage price level by calculating the internal rate of return (see also Table 14).

Since among the various programmes the final growing stocks in 2015 are highly different in volume, the calculations have allowed for this by subtracting the final growing stock of the primary programme from the final growing stocks of the minimum, MERA and maximum programmes, each priced at the stumpage prices mentioned in Section 52. These returns were discounted to 1970 as were all the returns. The calculation is based on the assumption that the increase in the final growing stock compared with the primary programme can be sold. The internal rates of return were as follows:

	Internal rate of return, per cent; increase in final growing stock-	
From primary programme	included	excluded
– to minimum programme	23	23
– to MERA programme	8	6
– to maximum programme	6	0

The steep decline in the rate of return percentages as the degree of intensity is increased shows clearly how, as investment increases, the increase in returns diminishes (the law of diminishing returns). It would manifest itself even more clearly if the rate of return percentages were calculated for the increases from the minimum programme to the MERA programme, and from the MERA programme to the maximum programme.

The calculated rates of return can perhaps somehow be understood in light of the fact that the Finnish business community considers an internal rate of return of 12–15 per cent a suitable return on investment, but that calculations at the national economic level should disregard the taxation of the enterprise, which is about 50 per cent of the profits. If taxation is disregarded, a private enterprise would demand an internal rate of return of 6–8 per cent.

At the stumpage price level, the forest improvement costs were calculated to equal those presented at the beginning of Section 52. Other costs of tree growing (sale, marking for sale, etc.) were not included in the calculations. This means that the best alternative use of production power expended on forest improvement measures is assumed to be as profitable as in forest improvement work. This assumption apparently overestimates the profitability of the alternative use of manpower in forest improvement work. It would therefore be more realistic, at the macroeconomic level, to use costs lower than those used in the calculation. The disregarding of some, admittedly relatively small, cost items in tree growing, however, has an opposite effect and hence the final result here may be comparatively accurate.

54. Profitability at the delivery price level

The difference between the delivery price (roundwood cut and hauled to a long-distance transport route) and the stumpage price is called the logging costs. It consists mostly of wages.

If the internal rate of return is calculated at this delivery price level so that the best alternative price of the manpower employed in harvesting and short-distance transport is taken to be the wages actually paid in timber harvesting and short-distance transport, the additions to the returns and the costs at the stumpage price level are equal and therefore cancel each other. The internal rate of return will then be the same as in the previous calculation at the stumpage price level.

This assumption is incorrect, at least in conditions such as the present, when nearly 10 per cent of the forest labour force is continuously unemployed. For this reason, the internal rate of return at the delivery price level was calculated assuming the alternative opportunity cost of roundwood logging to be, first, 90 per cent and, then, 50 per cent of the logging cost. In the former case, the internal rates of return were calculated by also taking into consideration the increase in the final growing stock. The results were the following:

Alternative cost of logging labour force, 90 per cent

From primary programme	Internal rate of return, per cent; increase in final growing stock- included	excluded
– to minimum programme	50 +	50 +
– to MERA programme	10	9
– to maximum programme	7	3

Alternative cost of logging labour force, 50 per cent

From primary programme	Internal rate of return, per cent; excluding the final growing stock
– to minimum programme	50 +
– to MERA programme	40
– to maximum programme	30

These results indicate, primarily, that if an activity involving a considerable labour input, as timber harvesting still does today, can use a labour force whose best possible alternative employment is distinctly less favourable, a shift of labour to employment in this sector may prove highly profitable from the point of view of the whole national economy. The greater the difference between true and alternative costs, the more favourable is such a shift and the less pronounced is the law of diminishing returns.

Investment calculations in which stumpage prices are the only forestry returns included, with returns from work entirely excluded, may lead to mistaken conclusions concerning the order of profitability of the investments at the national economy level. Also, for enterprises which, like most farms in Finland, employ family members or permanently hired labour in forestry, investment calculations must pay attention to the alternative potential uses of manpower.

The procedure used in the calculations at the delivery price level can be illustrated by imagining a farm run by a family (or some other case where income distribution is no problem). If the farm, for reasons mentioned above, can start selling more timber than before, the increase in returns equals the increase in stumpage value provided harvesting uses hired labour. But if the timber is harvested by the manpower the farm normally has, and if sufficient manpower is available on the farm to harvest the increased fellings, the returns increase both by the increase in stumpage price and the logging cost of the harvesting. This seldom happens, but manpower can be transferred to this new job from another activity, e.g. agriculture, where it produces less value added than in harvesting timber. The value added obtained in agriculture then represents the alternative cost (opportunity cost) which forestry should credit to agriculture in order to obtain agricultural manpower for increased harvesting of timber. The alternative (opportunity) cost above was estimated at 90 per cent of the logging wages, which means that the value added obtained from the manpower transfer equalled 10 per cent of the logging wages.

When long periods of time (1970–2015) are involved, it may seem unrealistic to assume that throughout this period Finland might obtain this 10 per cent increase in value added. However, 25 per cent of the labour force in Finland is still employed in agriculture and forestry; unemployment is common especially in forestry; and the concealed under-employment in agriculture is also chronic. Against this background, the 10 per cent estimate might not be exaggerated.

55. Profitability at the national economy level

At the level of the whole national economy, it was not possible to compare all items which increase returns and costs as a result of an expansion of a forest improvement programme when actually realized. The calculations were restricted to estimating the increase in the production of the woodworking industry following the adoption of the successive programmes, using the 1965 export prices. On the basis of this estimate, the 1965 input-output tables (more recent tables were not available) were used to calculate the corresponding increase in the 1975 gross national product, at market prices. The calculations were carried out using the following approximate-value procedure.

The product structure of the increases in allowable cuts, in the form of processed products, was assumed to be the same as when progressing from forestry-production develop-

ment alternative 1 to alternative 2, from alternative 1 to alternative 3, and from alternative 1 to alternative 4 (see Table 6) in 1980, 1990 and 2000, respectively. These increases in forest industry production were assumed to be exported and were therefore priced at the 1965 export prices (see Section 52), calculated as price sums, and divided by the volume (including waste) of the roundwood required to produce this output. This value which one cubic metre of removal had at the time of export was then used in pricing the increases in allowable cut on transition from the primary programme to the minimum, MERA and maximum programmes (Table 15).

The export income increases obtained for 1980, 1990 and 2000 were transformed, by industrial branches, into national product increases with the aid of the 1965 input-output matrix. The results are presented in Table 15.

When export income was transformed into national income, only imports necessitated by the increase in export income were taken into account and subtracted. Since these imports are relatively small for the woodworking industry (they include certain chemicals for the paper industry and the glues for the plywood industry), the coefficients are very close to 1.

When the results are interpreted, it should also be borne in mind that the increases in national income calculated in this way are gross increases in that the investment these increases may require in the timber and paper industry and the side-effects of these investments have not been taken into account. Nor have the possible production-reducing effects of manpower transfer to this sector from other sectors (e.g. agriculture) been considered. In other words, the calculations have been made assuming that the national economy will have unlimited manpower and production capital for creation of these increases in export income simply by raising the degree of utilization, that is to say, by reducing the "unemployment" of manpower and production capital.

This assumption naturally cannot be entirely true. The calculated increase in national income will have its price, perhaps in the form of reduced agricultural yield, reduced housing production caused by the increased need of manpower for industrial investment, or machines and raw material which may have to be bought from abroad. On the other hand, the effect of new investment in industry has its other side, too. If there has been unutilized production capacity in a sector of the national economy directly or indirectly affected by the investment in employing underemployed manpower or capital, the effect will be one of increasing the national income.

It is difficult and complicated to take into account all corollary effects of additional forestry investment in a calculation of this type. Much more basic knowledge was needed, and a computer should have been available. The Institute of Economics, University of Bradford (England) has developed methods for similar purposes and there is hope that they will be made available for Finland in the future.

From the results of Table 15 we may conclude that investment in forestry calculated as income yielded by the end products is apparently more profitable than when estimated at the stumpage price or delivery price level.

1. The main work targets of the input programmes and their total influence on timber production, 1970-2015.

Programme	Year	Work targets				Achievements		
		Regeneration	Afforestation of arable land	New drainage	Fertilization	Volume	Increment[1]	Allowable cut[1]
		1000 hectares				million m^3 solid measure excluding bark		
Primary	1970	140	-	250	120	1 201	47.7	52.6
	75	140	-	250	120	1 172	48.8	52.7
	80	140	-	250	120	1 153	51.5	53.2
	85	140	-	250	120	1 144	56.0	53.4
	90	140	-	-	120	1 159	61.2	53.6
	95	140	-	-	120	1 194	66.1	55.1
	2000	140	-	-	120	1 243	71.5	57.3
	05	140	-	-	120	1 322	75.6	58.2
	10	140	-	-	120	1 424	80.4	59.3
	15	140	-	-	120	1 567	85.6	61.9
Minimum	1970	150	3	250	140	1 200	47.7	52.8
	75	150	10	250	200	1 169	50.3	54.5
	80	150	10	250	300	1 149	52.8	55.3
	85	150	10	250	300	1 140	58.4	55.9
	90	150	10	-	300	1 157	64.4	56.7
	95	150	-	-	300	1 196	70.2	58.7
	2000	150	-	-	300	1 252	76.4	61.2
	05	150	-	-	300	1 333	81.2	62.2
	10	150	-	-	300	1 449	86.7	63.2
	15	150	-	-	300	1 592	92.6	66.2
MERA	1970	170	10	350	240	1 192	47.7	53.6
	75	225	30	325	550	1 161	52.0	56.9
	80	250	30	170	650	1 145	58.3	58.7
	85	250	30	170	700	1 152	67.2	61.7
	90	225	30	-	700	1 189	77.0	64.3
	95	225	-	-	700	1 264	86.6	66.2
	2000	200	-	-	700	1 362	96.5	69.3
	05	200	-	-	700	1 506	105.2	71.0
	10	200	-	-	700	1 681	114.2	73.8
	15	200	-	-	700	1 902	122.6	80.2
Maximum	1970	230	10	250	300	1 185	47.6	54.1
	75	300	30	250	800	1 155	53.7	59.3
	80	300	30	250	1 000	1 142	63.1	62.1
	85	300	30	250	1 000	1 158	72.1	65.1
	90	250	30	-	1 000	1 199	82.6	67.8
	95	250	-	-	1 000	1 289	94.5	69.5
	2000	250	-	-	1 000	1 419	105.6	71.8
	05	250	-	-	1 000	1 601	117.6	74.1
	10	250	-	-	1 000	1 831	129.1	79.0
	15	250	-	-	1 000	2 090	139.7	87.7

[1] See pp. 13-14.

2. Influence of the work targets of input programmes on growth (G) and allowable cut (A), 1970-2015.

Programme	Year	Artificially regenerated stands		Naturally regenerated stands		Afforestation of arable land		Effect of drainage[1)]		Effect of fertilization	Increment at present	Loss of currently growing forest	Total	
		G	A	G	A	G	A	G	A	G & A	G & A	A	G	A
		million m^3 solid measure excluding bark												
Primary	1970	0.8	-	0.3	-	-	-	1.5	1.1	0.9	44.2	6.4	47.7	52.6
	75	2.3	-	1.0	-	-	-	2.5	1.4	1.4	41.6	8.3	48.8	52.7
	80	5.2	-	1.9	-	-	-	3.9	1.9	1.7	38.8	10.8	51.5	53.2
	85	9.9	-	3.2	-	-	-	5.3	2.8	1.9	35.7	13.0	56.0	53.4
	90	16.0	0.6	4.5	-	-	-	6.4	3.6	1.9	32.4	15.1	61.2	53.6
	95	23.2	2.4	6.0	-	-	-	7.1	4.6	1.9	27.9	18.3	66.1	55.1
	2000	30.4	5.5	7.4	0.5	-	-	7.6	5.6	1.9	24.2	19.6	71.5	57.3
	05	37.7	9.4	8.1	2.1	-	-	8.0	6.8	1.9	19.9	18.1	75.6	58.2
	10	45.0	13.9	9.0	4.3	-	-	7.5	8.0	1.9	17.0	14.2	80.4	59.3
	15	51.6	20.0	9.8	6.4	-	-	7.0	9.0	1.9	15.3	9.3	85.6	61.9
Minimum	1970	0.8	-	0.3	-	0.0	-	1.5	1.1	0.9	44.2	6.6	47.7	52.8
	75	2.4	-	0.9	-	0.0	-	2.5	1.4	1.9	42.6	8.6	50.3	54.5
	80	5.4	-	1.8	-	0.0	-	3.9	1.9	3.1	38.6	11.7	52.8	55.3
	85	10.4	-	3.0	-	0.0	0.0	5.3	2.8	4.2	35.5	13.4	58.4	55.9
	90	16.8	0.6	4.2	0.0	0.2	0.1	6.4	3.6	4.6	32.2	15.6	64.4	56.7
	95	24.5	2.6	5.6	0.0	0.5	0.1	7.1	4.6	4.9	27.6	18.9	70.2	58.7
	2000	32.2	5.9	6.9	0.5	0.9	0.2	7.6	5.6	5.0	23.8	20.2	76.4	61.2
	05	39.9	10.0	7.6	2.0	1.3	0.3	8.0	6.8	5.0	19.4	18.7	81.2	62.2
	10	47.7	14.7	8.4	4.0	1.7	0.4	7.5	8.0	5.0	16.4	14.7	86.7	63.2
	15	54.8	21.3	9.2	6.0	1.9	0.6	7.0	9.0	5.0	14.7	9.6	92.6	66.2

continued on next page

2. Influence of the work targets of input programmes on growth (G) and allowable cut (A), 1970-2015. Continued.

Programme	Year	Artificially regenerated stands		Naturally regenerated stands		Afforestation of arable land		Effect of drainage[1)]		Effect of fertilization	Increment at present	Loss of currently growing forest	Total	
		G	A	G	A	G	A	G	A	G & A	G & A	A	G	A
		million m^3 solid measure excluding bark												
MERA	1970	0.8	-	0.2	-	0.0	-	1.2	1.3	1.1	43.9	7.3	47.7	53.6
	75	2.8	-	0.7	-	0.0	-	2.9	1.6	4.4	41.2	9.7	52.0	56.9
	80	7.1	-	1.4	-	0.0	-	4.4	2.0	7.2	38.2	11.3	58.3	58.7
	85	14.5	-	2.3	-	0.2	-	5.8	2.9	9.3	35.1	14.4	67.2	61.7
	90	23.9	0.8	3.3	-	0.6	0.1	7.0	3.8	10.7	31.5	17.4	77.0	64.3
	95	35.1	3.7	4.3	-	1.5	0.3	7.7	4.8	11.2	26.8	19.4	86.6	66.2
	2000	45.8	8.3	5.4	0.5	2.7	0.6	8.2	5.8	11.4	23.0	19.7	96.5	69.3
	05	56.4	14.1	6.0	1.5	4.0	0.9	8.6	7.0	11.4	18.8	17.3	105.2	71.0
	10	67.0	20.7	6.6	3.0	5.1	1.3	8.1	8.2	11.4	16.0	13.2	114.2	73.8
	15	76.6	29.7	7.1	4.5	5.8	1.7	7.3	9.2	11.4	14.4	9.3	122.6	80.2
Maximum	1970	0.9	-	0.2	-	0.0	-	1.5	1.1	1.3	43.7	8.0	47.6	54.1
	75	3.5	-	0.6	-	0.0	-	2.5	1.4	6.2	40.9	10.8	53.7	59.3
	80	8.8	-	1.2	-	0.0	-	3.9	1.9	11.4	37.8	11.0	63.1	62.1
	85	17.8	-	2.0	-	0.2	0.0	5.3	2.8	13.2	33.6	15.5	72.1	65.1
	90	28.9	1.0	2.8	-	0.6	0.1	6.4	3.6	14.1	29.8	19.2	82.6	67.8
	95	41.9	4.4	3.7	0.0	1.5	0.3	7.1	4.6	14.5	25.8	19.9	94.5	69.5
	2000	54.9	10.0	4.6	0.5	2.7	0.6	7.6	5.6	14.5	21.3	19.3	105.6	71.8
	05	67.9	17.0	5.1	1.0	4.0	0.9	8.0	6.8	14.5	18.1	15.8	117.6	74.1
	10	80.9	25.0	5.6	3.0	5.1	1.3	7.5	8.0	14.5	15.5	11.7	129.1	79.0
	15	92.8	36.0	6.1	4.0	5.8	1.7	7.0	9.0	14.5	13.5	9.0	139.7	87.7

1) See pp. 13-14.

3. Development of allowable cut,[1] 1970-2015. The cut according to the MERA programme specified by wood supply districts.

Year	Primary programme	Minimum programme	MERA programme					Maximum programme
			All Finland	West Finland	Päijänne	Saimaa	North Finland	
	million m^3 solid measure excluding bark							
1970	52.6	52.8	53.6	16.4	12.3	13.6	11.3	54.1
75	52.7	54.5	56.9	17.5	13.0	14.4	12.0	59.3
80	53.2	55.3	58.7	18.0	13.5	14.9	12.3	62.1
85	53.4	55.9	61.7	19.0	14.2	15.6	12.9	65.1
90	53.6	56.7	64.3	19.8	14.7	16.3	13.5	67.8
2000	57.3	61.2	69.2	21.3	15.9	17.5	14.6	71.8
05	58.2	62.2	71.0	21.8	16.3	18.0	14.9	74.1
10	59.3	63.2	73.8	22.7	16.9	18.7	15.5	79.0
15	61.9	66.2	80.2	24.7	18.4	20.3	16.8	87.7

[1] See pp. 13-14.

4. Forest industry production alternatives I-III[1], 1967-1971.

Branch	Unit	Output								
		West Finland			Päijänne			Saimaa		
		Alt.I 1967 1971	Alt.II 1971	Alt.III 1971	Alt.I 1967 1971	Alt.II 1971	Alt.III 1971	Alt.I 1967 1971	Alt.II 1971	Alt.III 1971
Sawmill industry										
- sawmills of industrial statistics	1 000 std	307	400	400	282	330	330	267	290	290
- small-scale sawmills	1 000 std	108	126	126	38	46	46	40	54	54
Plywood industry	1 000 m^3	78	96	122	199	242	278	298	364	446
Particle board industry	1 000 m^3	127	110	137	38	78	98	65	64	251
Fibreboard industry	1 000 tn	38	40	42	72	82	90	96	110	122
Mechanical pulp industry	1 000 tn	171	202	409	843	1 004	951	191	230	251
Hemicellulose industry	1 000 tn	-	-	-	116	145	169	55	114	256
Sulphate pulp industry	1 000 tn	398	410	425	562	598	613	907	1 021	1 106
Sulphite pulp industry	1 000 tn	568	611	665	326	352	343	179	191	190
Other	..	..	..	..	..	..	..	..	..	..

Branch	Unit	Output						Capacity		
		North Finland			All Finland			All Finland		
		Alt.I 1967 1971	Alt.II 1971	Alt.III 1971	Alt.I 1967 1971	Alt.II 1971	Alt.III 1971	Alt.I 1967 1971	Alt.II 1971	Alt.III 1971
Sawmill industry										
- sawmills of industrial statistics	1 000 std	211	180	180	1 067	1 200	1 200	1 573	1 573	1 573
- small-scale sawmills	1 000 std	18	34	34	204	260	260	..	..	..
Plywood industry	1 000 m^3	-	-	-	575	702	846	781	781	939
Particle board industry	1 000 m^3	-	-	34	230	252	520	296	296	611
Fibreboard industry	1 000 tn	-	-	-	205	232	254	258	258	282
Mechanical pulp industry	1 000 tn	248	299	465	1 454	1 735	2 076	1 928	1 928	2 307
Hemicellulose industry	1 000 tn	32	36	75	203	295	500	311	311	527
Sulphate pulp industry	1 000 tn	604	651	674	2 473	2 680	2 818	2 822	2 822	2 966
Sulphite pulp industry	1 000 tn	305	320	359	1 378	1 474	1 557	1 552	1 552	1 639
Other	..	..	..	..	..	..	..	..	..	..

[1] See definitions p. 18.

5. Calculation of the use of domestic roundwood by forest industry and logging districts, 1967-1971

District and alternative[1]	Industrial use of wood raw material	Waste wood					Imported roundwood	Roundwood transfers (net exports + net imports)	Industrial use of domestic roundwood by logging districts[2]
		Domestic				Imported waste wood			
		Chipped sawmill waste	Sawdust	Plywood industry waste	Dead trees on the stump				
	million m^3 solid measure excluding bark								
West Finland									
1971 Alt. I	9.55	0.78	0.15	0.06	-	0.02	0.14	+0.08	8.49
Alt. II	10.96	0.93	0.17	0.06	-	0.02	0.14	+0.08	9.73
Alt. III	11.72	0.93	0.17	0.06	-	0.02	0.14	+0.08	10.49
Päijänne									
1971 Alt. I	10.16	0.60	0.17	0.09	-	0.06	0.43	-1.53	7.28
Alt. II	11.61	0.74	0.18	0.09	-	0.06	0.43	-1.53	8.59
Alt. III	11.54	0.74	0.18	0.10	-	0.06	0.43	-1.53	8.51
Saimaa									
1971 Alt. I	9.22	0.60	0.14	0.18	0.00	0.47	0.73	+0.96	8.06
Alt. II	10.50	0.66	0.15	0.18	0.00	0.47	0.73	+0.96	9.27
Alt. III	11.99	0.66	0.15	0.20	0.00	0.47	0.73	+0.96	10.73
North Finland									
1971 Alt. I	7.27	0.45	0.05	-	0.17	-	0.17	+0.48	6.92
Alt. II	7.52	0.40	0.05	-	0.17	-	0.17	+0.48	7.21
Alt. III	8.39	0.40	0.08	-	0.17	0	0.17	+0.48	8.05
All Finland									
1971 Alt. I	36.20	2.43	0.52	0.32	0.17	0.55	1.47	-	30.74
Alt. II	40.60	2.74	0.55	0.32	0.17	0.55	1.47	-	34.80
Alt. III	43.65	2.74	0.58	0.36	0.17	0.55	1.47	-	37.79

1) See definitions p. 18.

2) Industrial use of domestic roundwood by logging districts has been obtained by subtracting the uses of industrial waste wood and imported roundwood from the total industrial wood raw material use, taking into account roundwood transfers from one district to another.

6. Forest industry production alternatives 1-4,[1] 1971-2000. All Finland.

Branch	Unit	Output				
		Alternative 2				
		1971	1975	1980	1990	2000
Sawmill industry	1 000 std	1 460	1 490	1 520	1 520	1 520
Plywood industry	1 000 m^3	846	939	1 045	1 221	1 362
Bark board industry	1 000 m^3	-	25	101	200	300
Particle board industry	1 000 m^3	520	624	733	907	1 061
Fibreboard industry	1 000 tn	254	284	320	383	437
Pulp industry	1 000 tn	6 951	7 708	8 639	10 033	11 866
Other	..	..	..	..	..	..

Branch	Unit	Output				
		Alternative 3				
		1971	1975	1980	1990	2000
Sawmill industry	1 000 std	1 460	1 490	1 520	1 520	1 520
Plywood industry	1 000 m^3	846	950	1 072	1 289	1 478
Bark board industry	1 000 m^3	-	25	101	200	300
Particle board industry	1 000 m^3	520	653	802	1 084	1 391
Fibreboard industry	1 000 tn	254	292	340	435	528
Pulp industry	1 000 tn	6 951	8 120	9 239	11 633	13 513
Other	..	..	..	..	..	..

Branch	Unit	Output				
		Alternative 4				
		1971	1975	1980	1990	2000
Sawmill industry	1 000 std	1 460	1 490	1 520	1 520	1 520
Plywood industry	1 000 m^3	846	964	1 109	1 372	1 604
Bark board industry	1 000 m^3	-	50	200	400	600
Particle board industry	1 000 m^3	520	676	845	1 142	1 461
Fibreboard industry	1 000 tn	254	295	346	448	548
Pulp industry	1 000 tn	6 951	8 481	10 207	12 481	14 232
Other	..	..	..	..	..	..

[1] See definition, pp. 20-22. According to Alternative 1 the industrial output remains the same throughout the period, 1971-2000. That is to say, it remains the same as in all the alternatives for the initial year 1971.

7. Forest industry production alternative 3 (corresponding to the MERA programme)[1] by wood supply districts, 1971-2000.

Branch	Unit	Output									
		West Finland					Päijänne				
		1971	1975	1980	1990	2000	1971	1975	1980	1990	2000
Sawmill industry	1 000 std	526	546	566	566	566	376	381	386	386	386
Plywood industry	1 000 m^3	122	139	160	198	231	723	311	350	419	479
Bark board industry	1 000 m^3	0	9	30	60	90	0	8	30	60	90
Particle board industry	1 000 m^3	137	184	239	351	490	98	120	144	186	227
Fibreboard industry	1 000 tn	42	50	62	87	112	90	103	118	148	177
Pulp industry	1 000 tn	1 499	2 110	2 451	3 182	3 680	2 076	2 533	2 783	3 343	3 775
Other	..	..	..	..	..	..	..	..	..	..	..

Branch	Unit	Output									
		Saimaa					North Finland				
		1971	1975	1980	1990	2000	1971	1975	1980	1990	2000
Sawmill industry	1 000 std	344	349	354	354	354	214	214	214	214	214
Plywood industry	1 000 m^3	446	500	562	672	768	-	-	-	-	-
Bark board industry	1 000 m^3	0	8	31	60	90	0	0	10	20	30
Particle board industry	1 000 m^3	251	306	367	475	582	34	43	52	72	92
Fibreboard industry	1 000 tn	122	139	160	200	239	-	-	-	-	-
Pulp industry	1 000 tn	1 803	1 877	2 137	2 701	3 200	1 573	1 600	1 868	2 407	2 858
Other	..	..	..	..	..	..	..	..	..	..	..

[1] For definition, see pp. 20-21.

8. Calculation of the use of domestic roundwood by forest industry, 1971-2000. All Finland.

Alternative[1] and year	Industrial use of wood raw material	Waste wood								Imported roundwood	Domestic roundwood used by industry[2]
		Domestic							Imported waste wood		
		Chipped sawmill waste	Sawdust	Plywood industry waste	Bark	Branches	Stumps with root spurs	Dead trees on the stump			
	million m^3 solid measure excluding bark										
Alt.1											
1971	43.65	2.74	0.58	0.36	0.00	0.00	0.00	0.17	0.55	1.47	37.78
1975	43.68	2.84	0.98	0.61	0.09	0.40	0.20	0.15	0.40	1.15	36.85
1980	43.71	2.96	1.22	0.84	0.21	0.80	0.50	0.12	0.25	0.68	36.13
1985	43.74	3.01	1.36	1.10	0.47	1.30	1.00	0.09	0.10	0.23	35.08
1990	43.78	3.05	1.44	1.19	0.64	1.70	1.50	0.05	-	0.12	34.09
1995	43.81	2.08	1.46	1.26	0.80	2.10	1.80	0.05	-	0.00	33.25
2000	43.81	3.12	1.48	1.26	0.90	2.30	2.00	0.05	-	0.00	32.69
Alt.2											
1971	43.65	2.74	0.58	0.36	0.00	0.00	0.00	0.17	0.55	1.47	37.78
1975	47.34	2.84	0.98	0.64	0.16	0.40	0.20	0.15	0.40	1.15	40.42
1980	51.90	2.96	1.22	1.02	0.50	0.80	0.50	0.12	0.25	0.68	43.85
1985	54.98	3.01	1.36	1.36	0.94	1.30	1.00	0.09	0.10	0.23	45.60
1990	58.42	3.05	1.44	1.63	1.29	1.70	1.50	0.05	-	0.12	47.64
1995	62.41	3.08	1.46	1.89	1.66	2.10	1.80	0.05	-	0.00	50.36
2000	66.42	3.12	1.48	2.00	1.93	2.30	2.00	0.05	-	0.00	53.54
Alt.3											
1971	43.65	2.74	0.58	0.36	0.00	0.00	0.00	0.17	0.55	1.47	37.78
1975	49.02	2.84	0.98	0.64	0.16	0.40	0.20	0.15	0.40	1.15	42.09
1980	54.49	2.96	1.22	1.02	0.51	0.80	0.50	0.12	0.25	0.68	46.43
1985	60.09	3.01	1.36	1.40	0.97	1.30	1.00	0.09	0.10	0.23	50.64
1990	65.32	3.05	1.44	1.70	1.36	1.70	1.50	0.05	-	0.12	54.40
1995	69.31	3.08	1.46	1.99	1.77	2.10	1.80	0.05	-	0.00	57.06
2000	74.07	3.12	1.48	2.21	2.07	2.30	2.00	0.05	-	0.00	60.83
Alt.4											
1971	43.65	2.74	0.58	0.36	0.00	0.00	0.00	0.17	0.55	1.47	37.78
1975	50.51	2.84	0.98	0.66	0.24	0.40	0.20	0.15	0.40	1.15	43.49
1980	58.49	2.96	1.22	1.06	0.77	0.80	0.50	0.12	0.25	0.68	50.12
1985	64.64	3.01	1.36	1.47	1.36	1.30	1.00	0.09	0.10	0.23	54.73
1990	69.13	3.05	1.44	1.83	1.88	1.70	1.50	0.05	-	0.12	57.56
1995	73.13	3.08	1.46	2.22	2.44	2.10	1.80	0.05	-	0.00	59.98
2000	77.71	3.12	1.48	2.41	2.87	2.30	2.00	0.05	-	0.00	63.48

1) For definitions, see pp. 20-22.

2) Industrial use of domestic roundwood by logging districts has been obtained by subtracting the uses of industrial waste wood and imported roundwood from the total industrial wood raw material consumption.

9. Calculation of total drain by logging districts, 1967-71.

District and year	Domestic roundwood used by industry[1]			Industrial fuelwood	Roundwood used by real estates	Roundwood exports	Other roundwood consumption	Transportation loss	Cutting and clearing waste[1]			Natural losses	Total drain[1]		
	Alt.I	Alt.II	Alt.III						Alt.I	Alt.II	Alt.III		Alt.I	Alt.II	Alt.III
	million m^3 solid measure excluding bark														
West Finland															
1967	7.70	7.70	7.70	0.08	3.70	0.34	0.10	0.01	1.17	1.17	1.17	0.06	13.16	13.16	13.16
1971	8.49	9.73	10.49	0.07	3.32	0.17	0.06	0.00	1.11	1.18	1.23	0.06	13.28	14.59	15.40
Päijänne															
1967	8.03	8.03	8.03	0.12	2.25	0.13	0.08	0.00	0.78	0.78	0.78	0.04	11.42	11.42	11.42
1971	7.28	8.59	8.51	0.12	2.01	0.08	0.10	0.00	0.69	0.77	0.77	0.04	10.32	11.71	11.63
Saimaa															
1967	7.50	7.50	7.50	0.06	1.87	0.17	0.05	0.01	1.02	1.02	1.02	0.11	10.79	10.79	10.79
1971	8.06	0.27	10.73	0.08	1.74	0.08	0.06	0.01	0.98	1.08	1.23	0.11	11.11	12.42	14.03
North Finland															
1967	7.25	7.25	7.25	0.01	1.43	0.12	0.08	0.06	1.75	1.75	1.75	0.79	11.49	11.49	11.49
1971	6.92	7.21	8.05	0.04	1.31	0.14	0.06	0.05	1.62	1.67	1.82	0.78	10.90	11.26	12.24
All Finland															
1967	30.47	30.47	30.47	0.28	9.25	0.76	0.31	0.08	4.72	4.72	4.72	1.00	46.87	46.87	46.87
1971	30.74	34.80	37.79	0.30	8.38	0.46	0.29	0.06	4.40	4.71	5.05	0.98	45.61	49.98	53.50

[1] For definition of the alternatives, see p. 18 .

10. Calculation of total drain, 1971-2000. All Finland.

Year	Domestic roundwood used by industry[1]				Industrial fuelwood	Roundwood used by real estates	Roundwood exports	Other roundwood consumption	Transportation loss	Removal[1]			
	Alt.1	Alt.2	Alt.3	Alt.4						Alt.1	Alt.2	Alt.3	Alt.4
	million m^3 solid measure excluding bark												
1971	37.78	37.78	37.78	37.78	0.30	8.38	0.46	0.29	0.06	47.28	47.28	47.28	47.28
1975	36.85	40.42	42.09	43.49	0.24	6.75	0.31	0.23	0.04	44.43	48.00	49.67	51.06
1980	36.13	43.85	46.43	50.12	0.19	4.90	0.21	0.16	0.04	41.64	49.35	51.94	55.63
1985	35.08	45.60	50.64	54.73	0.15	4.11	0.14	0.11	0.03	39.63	50.15	55.19	59.28
1990	34.09	47.64	54.40	57.56	0.12	3.36	0.10	0.09	0.02	37.78	51.33	58.10	61.25
1995	33.25	50.36	57.06	59.98	0.10	2.92	0.08	0.07	0.02	36.44	53.55	60.24	63.17
2000	32.69	53.54	60.83	63.48	0.08	2.51	0.06	0.06	0.02	35.42	56.27	63.56	66.21

Year	Cutting and clearing waste[1]				Natural losses	Total drain[1]			
	Alt.1	Alt.2	Alt.3	Alt.4		Alt.1	Alt.2	Alt.3	Alt.4
	million m^3 solid measure excluding bark								
1971	5.05	5.05	5.05	5.05	0.98	53.30	53.30	53.30	53.30
1975	4.30	4.60	4.65	4.88	0.92	49.65	53.52	55.24	56.86
1980	3.52	4.12	4.23	4.62	0.85	46.01	54.32	57.02	61.10
1985	3.03	3.78	4.06	4.44	0.79	43.45	54.72	60.04	64.51
1990	2.57	3.45	3.82	4.11	0.73	41.09	55.51	62.65	66.09
1995	2.25	3.28	3.62	3.87	0.68	39.37	57.50	64.54	67.71
2000	1.96	3.10	3.45	3.65	0.62	38.01	59.99	67.64	70.48

[1] For definition of the alternatives, see pp. 20-22.

11. Calculation of total drain by logging districts according to the forest industry production alternative 3 (which corresponds to the MERA programme),[1] 1971-2000.

District and year	Domestic roundwood used by industry	Industrial fuelwood	Roundwood used by real estates	Roundwood exports	Other roundwood consumption	Transportation loss	Cutting and clearing waste	Natural losses	Total drain
	million m^3 solid measure excluding bark								
West Finland									
1971	10.49	0.07	3.32	0.17	0.06	0.00	1.23	0.06	15.40
1975	12.96	0.05	2.68	0.10	0.05	0.00	1.21	0.05	17.11
1980	14.30	0.04	2.01	0.06	0.04	0.00	1.10	0.05	17.61
1990	16.91	0.03	1.40	0.02	0.02	0.00	0.99	0.04	19.42
2000	18.86	0.02	1.07	0.01	0.02	0.00	0.90	0.04	20.92
Päijänne									
1971	8.51	0.12	2.01	0.08	0.10	0.00	0.77	0.04	11.63
1975	9.89	0.09	1.65	0.06	0.08	0.00	0.77	0.03	12.58
1980	10.91	0.08	1.20	0.04	0.06	0.00	0.72	0.03	13.04
1990	12.57	0.05	0.81	0.02	0.03	0.00	0.66	0.03	14.17
2000	14.03	0.03	0.60	0.01	0.02	0.00	0.60	0.02	15.33
Saimaa									
1971	10.73	0.08	1.74	0.08	0.06	0.01	1.23	0.11	14.03
1975	11.16	0.06	1.42	0.06	0.05	0.00	1.14	0.10	14.00
1980	12.20	0.05	1.04	0.04	0.03	0.00	1.06	0.10	14.54
1990	14.15	0.03	0.71	0.02	0.02	0.00	0.98	0.09	16.00
2000	15.65	0.02	0.54	0.01	0.01	0.00	0.90	0.07	17.22
North Finland									
1971	8.05	0.04	1.31	0.14	0.06	0.05	1.82	0.78	12.24
1975	8.08	0.03	1.00	0.09	0.05	0.03	1.53	0.73	11.54
1980	9.02	0.02	0.66	0.06	0.03	0.03	1.34	0.67	11.83
1990	10.77	0.01	0.44	0.03	0.02	0.02	1.19	0.57	13.06
2000	12.28	0.01	0.30	0.03	0.01	0.02	1.04	0.48	14.18

[1] For definitions, see pp. 20-21.

12. Allowable cut and forest balance (undercut +, overcut -) by wood supply districts, 1960-67.

Year	West Finland				Päijänne			
	Pine	Spruce	Deciduous	Total	Pine	Spruce	Deciduous	Total
	1 000 m^3 solid measure excluding bark							
Current allowable cut	4657	6957	3238	14852	3045	4875	3578	11498
Forest balance								
1960	+338	-713	-524	-899	-908	-122	-106	-1135
1961	+249	-871	-569	-1189	-1275	-243	-201	-1718
1962	+697	+632	-568	+760	-1141	+480	-356	-1017
1963	+746	+1053	-672	+1127	-1217	+595	-479	-1101
1964	+528	+589	-700	+417	-603	+348	-770	-1025
1965	+941	+859	-764	+1036	-197	+575	-1084	-705
1966	+753	+1490	-754	+1489	-235	+1054	-1182	-364
1967	+649	+1894	-851	+1692	-219	+1202	-909	+74

	Saimaa				North Finland[1]			
	Pine	Spruce	Deciduous	Total	Pine	Spruce	Deciduous	Total
	1 000 m^3 solid measure excluding bark							
Current allowable cut	3702	4653	3937	12292	4899	3812	3010	11721
Forest balance								
1960	-519	+513	+491	+486	-762	-120	+735	-147
1961	-996	+288	+441	-267	-1258	-564	-716	-1106
1962	-697	+806	+332	+441	-1148	-36	+770	-415
1963	-962	+1219	+192	+448	-571	+27	+813	+269
1964	-33	+1206	+74	+1247	-1009	-63	+789	-283
1965	+335	+1344	-135	+1543	-232	-16	+565	+316
1966	+324	+1662	-235	+1752	-284	+480	+502	+699
1967	+148	+1997	-645	+1501	-840	+867	+204	+229

	All Finland			
	Pine	Spruce	Deciduous	Total
	1 000 m^3 solid measure excluding bark			
Current allowable cut	16303	20297	13763	50363
Forest balance				
1960	-1851	-442	+597	-1696
1961	-3279	-1389	+388	-4280
1962	-2290	+1882	+178	-231
1963	-2005	+2894	-147	+743
1964	-1118	+2080	-606	+356
1965	+847	+2762	-1419	+2191
1966	+559	+4686	-1669	+3575
1967	-261	+5959	-2201	+3497
1968[x]	-980	+6210	-2460	+2770

1) The effect of the stipulations issued for the treatment of state-owned forests in North Finland (which reduces the allowable cut by 0.8 million m^3 solid measure) has been disregarded in the allowable cut.

x) Advance information.

13 a. Annual returns and costs to correspond to the various alternative input programmes, 1970-2015.

1. Total returns[1]

Year	Primary programme	Minimum programme	MERA programme	Maximum programme
	million mk/year			
1970	860.0	863.5	873.0	881.5
1975	861.5	891.0	927.0	966.0
1980	870.0	904.0	958.0	1 011.5
1985	873.0	914.0	1 005.0	1 060.5
1990	876.5	927.0	1 047.5	1 104.5
1995	901.0	959.5	1 078.5	1 132.0
2000	937.0	1 000.5	1 129.0	1 169.5
2005	951.5	1 017.0	1 156.5	1 207.0
2010	969.5	1 033.5	1 202.0	1 287.0
2015	1 012.0	1 082.5	1 306.5	1 428.5

1) Calculated on the basis of 1968 prices.

2. Total costs[2]

Year	Primary programme	Minimum programme	MERA programme	Maximum programme
	million mk/year			
1970	116.0	125.0	166.0	185.5
1975	116.0	139.0	238.5	294.0
1980	116.0	150.0	240.0	320.5
1985	116.0	150.0	246.5	320.5
1990	78.5	112.5	209.5	283.0
1995	78.5	107.0	193.5	245.0
2000	78.5	107.0	182.5	245.0
2005	78.5	107.0	182.5	245.0
2010	78.5	107.0	182.5	245.0
2015	78.5	107.0	182.5	245.0

2) Calculated on the basis of 1965 cost data.

13 b. Total costs distributed according to the different forest improvement measures, 1970-2015.

13 b.

1. Primary programme

Year	Regenerated stands	Forest fertilization	Afforestation of arable lands	Drainage[1]	Total
	million mk/year				
1970	62.6	16.0	-	37.5	116.0
1975	62.6	16.0	-	37.5	116.0
1980	62.6	16.0	-	37.5	116.0
1985	62.6	16.0	-	37.5	116.0
1990	62.6	16.0	-	-	78.5
1995	62.6	16.0	-	-	78.5
2000	62.6	16.0	-	-	78.5
2005	62.6	16.0	-	-	78.5
2010	62.6	16.0	-	-	78.5
2015	62.6	16.0	-	-	78.5

2. Minimum programme

Year	Regenerated stands	Forest fertilization	Afforestation of arable lands	Drainage[1]	Total
	million mk/year				
1970	67.1	18.6	1.8	37.5	125.0
1975	67.1	29.3	5.4	37.5	139.0
1980	67.1	39.9	5.4	37.5	150.0
1985	67.1	39.9	5.4	37.5	150.0
1990	67.1	39.9	5.4	-	112.5
1995	67.1	39.9	-	-	107.0
2000	67.1	39.9	-	-	107.0
2005	67.1	39.9	-	-	107.0
2010	67.1	39.9	-	-	107.0
2015	67.1	39.9	-	-	107.0

3. MERA programme

Year	Regenerated stands	Forest fertilization	Afforestation of arable lands[2]	Drainage[1]	Total
	million mk/year				
1970	76.0	31.9	5.4	52.5	166.0
1975	100.6	73.2	16.1	48.8	238.5
1980	111.8	86.5	16.1	25.5	240.0
1985	111.8	93.1	16.1	25.5	246.5
1990	100.6	93.1	16.1	-	209.5
1995	100.6	93.1	-	-	193.5
2000	89.4	93.1	-	-	182.5
2005	89.4	93.1	-	-	182.5
2010	89.4	93.1	-	-	182.5
2015	89.4	93.1	-	-	182.5

4. Maximum programme

Year	Regenerated stands	Forest fertilization	Afforestation of arable lands[2]	Drainage[1]	Total
	million mk/year				
1970	102.8	39.9	5.4	37.5	185.5
1975	134.1	106.4	16.1	37.5	294.0
1980	134.1	133,0	16.1	37.5	320.5
1985	134.1	133.0	16.1	37.5	320.5
1990	111.8	133.0	16.1	-	283.0
1995	111.8	133.0	-	-	245.0
2000	111.8	133.0	-	-	245.0
2005	111.8	133.0	-	-	245.0
2010	111.8	133.0	-	-	245.0
2015	111.8	133.0	-	-	245.0

1) The last year of drainage is 1986.

2) The last year of afforestation of arable land is 1991.

14. Costs and stumpage price returns according to the input programmes calculated for 5-year periods, 1968–2015, and discounted (5 and 3 per cent) to 1970[1].

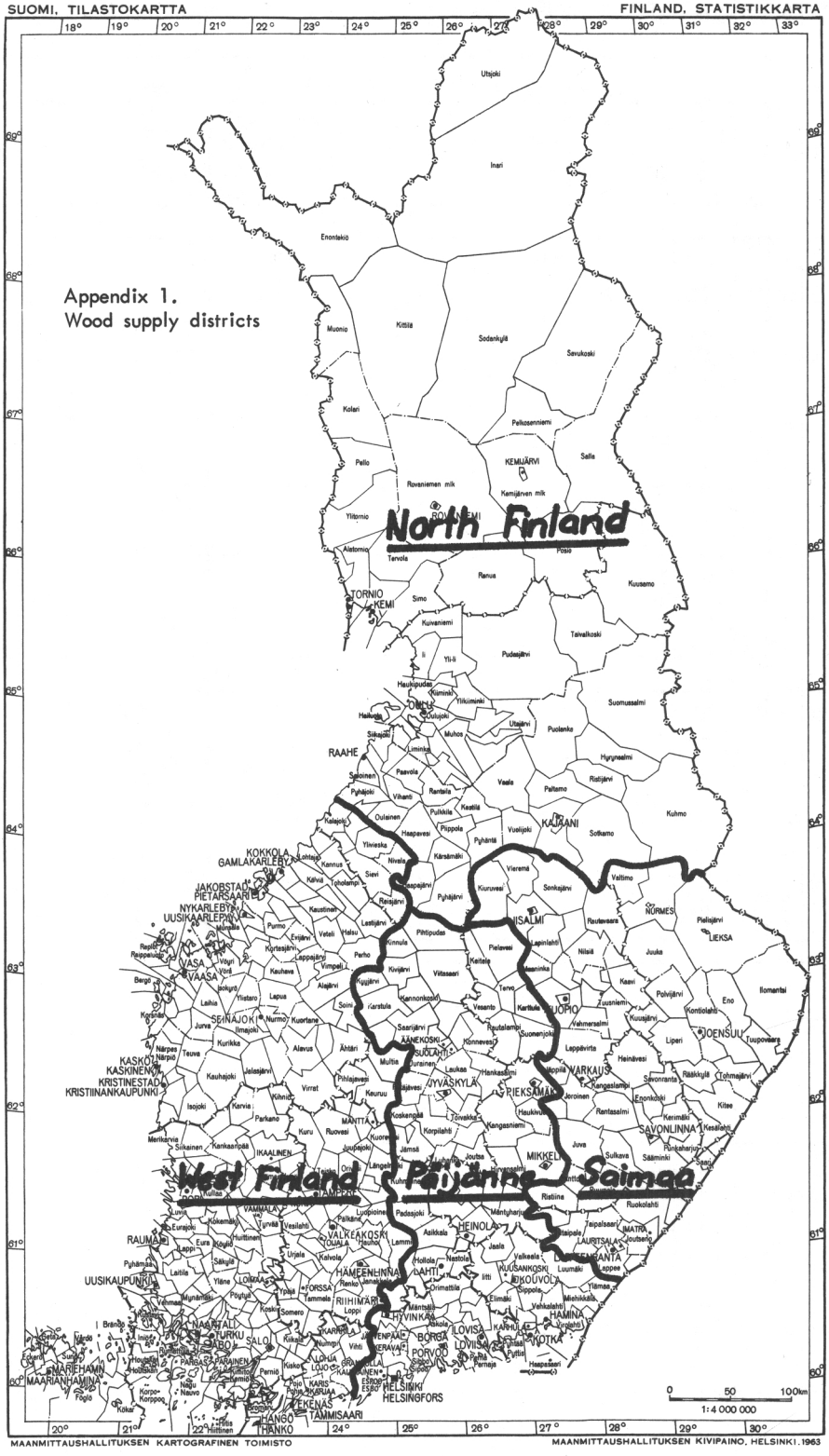
Middle year of the period	Costs million mk discounted (5 per cent) to 1970				Costs million mk discounted (3 per cent) to 1970				Costs expressed as a percentage of the returns			
	Primary	Minimum	MERA	Maximum	Primary	Minimum	MERA	Maximum	Primary	Minimum	MERA	Maximum
	Million mk per 5-year period											
1970	582	614	748	912	581	614	750	917	13.5	14.2	17.2	20.7
1975	456	545	883	1147	501	600	972	1264	13.5	15.6	24.5	30.2
1980	357	457	772	987	432	553	934	1194	13.3	16.4	26.2	31.7
1985	263	345	599	747	350	459	797	994	12.5	15.6	24.7	29.2
1990	148	210	391	487	218	308	573	714	8.9	12.0	19.8	23.3
1995	116	158	284	362	188	256	459	585	8.7	11.1	17.9	21.6
2000	87	119	203	272	162	221	376	505	8.4	10.7	16.2	20.9
2005	71	97	166	222	140	190	325	435	8.3	10.5	15.8	20.3
2010	56	76	130	174	122	164	280	376	8.1	10.4	15.2	19.0
2015	28	38	64	86	64	87	149	200	7.9	9.9	14.0	17.1

Middle year of the period	Returns million mk discounted (5 per cent) to 1970				Returns million mk discounted (3 per cent) to 1970			
	Primary	Minimum	MERA	Maximum	Primary	Minimum	MERA	Maximum
	Million mk per 5-year period							
1970	4310	4327	4361	4417	4304	4320	4353	4410
1975	3383	3499	3627	3794	3720	3847	3987	4170
1980	2676	2782	2942	3113	3239	3367	3560	3767
1985	2105	2204	2420	2557	2804	2936	3223	3406
1990	1655	1751	1972	2086	2428	2569	2894	3060
1995	1333	1420	1591	1676	2154	2294	2570	2706
2000	1040	1110	1249	1298	1932	2063	2321	2411
2005	865	924	1048	1097	1692	1809	2051	2147
2010	691	736	854	916	1488	1585	1839	1974
2015	355	380	457	501	826	885	1065	1168

1) The difference in the final growing stock under the various programmes has been disregarded.

15. The increase in export revenue compared with the Primary programme made possible by the alternative input programmes and the allowable cuts based on them in 1980, 1990 and 2000 at 1965 prices, and the gross national product (GNP) increases calculated at market prices with the 1965 input-revenue matrix and as shares of the total national product in 1965.

Year and product	From Primary programme to Minimum programme		From Primary programme to MERA programme		From Primary programme to Maximum programme		Coefficient GNP/export revenue
	Export revenue	National product	Export revenue	National product	Export revenue	National product	
	million mk/year						
1980							
Sawn goods	10	9	19	18	26	24	0.936
Plywood	23	21	47	42	73	65	0.893
Particle board	10	9	25	22	38	34	0.893
Fibreboard	4	4	10	9	15	13	0.872
Newsprint	165	141	406	346	767	654	0.853
Total	213	183	507	437	918	790	
Per cent of GNP		0.71		1.69		3.06	
1990							
Sawn goods	9	8	20	19	24	22	
Plywood	38	34	96	86	140	125	the same
Particle board	16	14	52	46	69	62	coefficients
Fibreboard	7	6	22	19	29	25	
Newsprint	262	223	861	734	1244	1061	
Total	332	286	1050	904	1506	1295	
Per cent of GNP		1.11		3.50		5.01	
2000							
Sawn goods	7	7	16	15	19	18	
Plywood	42	37	111	99	156	139	the same
Particle board	19	17	64	57	81	72	coefficients
Fibreboard	8	7	27	24	34	30	
Newsprint	337	287	971	828	1267	1080	
Total	413	356	1189	1023	1557	1339	
Per cent of GNP		1.38		3.96		5.19	


SUOMI. TILASTOKARTTA
FINLAND. STATISTIKKARTA
Appendix 1.
Wood supply districts
North Finland
West Finland
Päijänne
Saimaa
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MAANMITTAUSHALLITUKSEN KARTOGRAFINEN TOIMISTO
MAANMITTAUSHALLITUKSEN KIVIPAINO, HELSINKI. 1963

Appendix 2. Forecast of sawmill industry production, 1971-2000.

Year	West Finland			Päijänne		
	Sawmills in the industrial statistics	Small-scale sawmills	Total	Sawmills in the industrial statistics	Small-scale sawmills	Total
	1 000 std					
1971	400	126	526	330	46	376
1975	420	126	546	335	46	381
1980	440	126	566	340	46	386
1985	440	126	566	340	46	386
1990	440	126	566	340	46	386
1995	440	126	566	340	46	386
2000	440	126	566	340	46	386

Year	Saimaa			North Finland		
	Sawmills in the industrial statistics	Small-scale sawmills	Total	Sawmills in the industrial statistics	Small-scale sawmills	Total
	1 000 std					
1971	290	54	344	180	34	214
1975	295	54	349	180	34	214
1980	300	54	354	180	34	214
1985	300	54	354	180	34	214
1990	300	54	354	180	34	214
1995	300	54	254	180	34	214
2000	300	54	354	180	34	214

Year	All Finland		
	Sawmills in the industrial statistics	Small-scale sawmills	Total
	1 000 std		
1971	1200	260	1460
1975	1230	260	1490
1980	1260	260	1520
1985	1260	260	1520
1990	1260	260	1520
1995	1260	260	1520
2000	1260	260	1520

Appendix 3.

Consumption of the principal forest-industry products in Europe (excluding the Soviet Union) in 1960-65 and alternative forecasts up to 1980.

Year	Sawn goods		Plywood and blockboard		Particle board		Fibreboard		Paper and cardboard	
	Consumption or estimated consumption, million m^3	Mean annual change compared with the first year of the 5-year period, per cent	Consumption or estimated consumption, million m^3	Mean annual change compared with the first year of the 5-year period, per cent	Consumption or estimated consumption, million m^3	Mean annual change compared with the first year of the 5-year period, per cent	Consumption or estimated consumption, million ton	Mean annual change compared with the first year of the 5-year period, per cent	Consumption or estimated consumption, million ton	Mean annual change compared with the first year of the 5-year period, per cent
1950	61.8	..	1.38	..	0.02	..	0.60	..	10.48	..
1955	70.4	2.8	1.99	8.8	0.28	250.0	1.05	15.0	15.10	8.8
1960	76.1	1.6	2.77	7.8	1.33	75.0	1.57	9.9	21.33	8.3
1965	85.9	2.6	3.75	7.1	3.71	35.8	2.38	10.3	28.86	7.1
1970										
low estimate	89.2	0.8	4.5	4.0	6.5	15.0	2.9	4.4	37.7	6.1
middle estimate	89.8	0.9	4.5	4.0	6.6	15.6	2.9	4.4	38.2	6.5
high estimate	89.8	0.9	4.6	4.5	6.6	15.6	2.9	4.4	38.9	7.0
1975										
low estimate	92.3	0.7	5.2	3.1	8.5	6.2	3.4	3.4	47.8	5.4
middle estimate	93.7	0.9	5.3	3.6	8.9	7.0	3.5	4.1	50.9	6.6
high estimate	94.1	1.0	5.5	3.9	9.2	7.9	3.5	4.1	53.6	7.6
1980										
low estimate	94.5	0.5	5.9	2.7	10.0	3.5	3.8	2.4	59.9	5.1
middle estimate	96.5	0.6	6.1	3.0	10.7	4.0	4.0	2.9	66.5	6.1
high estimate	98.4	0.9	6.3	2.9	11.5	5.0	4.1	3.4	72.8	7.2

Source: FAO/ECE. 1969. European timber trends and prospects 1950-80. An interim review. Volume I. Supplement 7 to Volume XXI of the Timber Bulletin for Europe. Geneva, pp. 36-37, 41 and 64.

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Forest resources in the Forestry Board Districts of Etelä-Pohjanmaa, Vaasa and Keski-Pohjanmaa in 1968. 3,—

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Leaf rust on aspen in Finnish Lapland. 1,—

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