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EFFECTUATING POSSIBILITIES OF WASTE
WOOD UTILIZATION IN FINLAND.
STEP 1.

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Luis E. Astorga S.

EFFECTUATING POSSIBILITIES OF WASTE WOOD UTILIZATION IN FINLAND

Step 1. Model of flow of wood and fibres from forests to consumers

Jätepuun käytön tehostamismahdollisuudet Suomessa

Osa 1

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This publication presents the results of the first step of the project "Effectuating possibilities of waste wood utilization". The method used to make a primary evaluation of wood losses was to build a model of the flow of wood and fibres from the forest to the final consumers of forest products. In this model all the places where wood and fibres are transformed, and therefore losses occur, are defined as "units of transformation".

Based on statistical information for 1972, all the units of transformation were studied and a primary estimation of the losses was made. Because of lack of information, in this first stage it was not possible to separate the wood and fibre that was used as energy (burnt) from that wasted or that the destination of which was unknown. These items together amounted to 56 % of the wood drained from Finnish forest and imported in 1972.

This research project will proceed to study each unit of transformation to determine the losses, their causes and make propositions for the improvements in the use of wood.

Tämä selvitys on osa projektia nimeltä "Jätepuun hyväksikäytön tehostaminen". Jätteiden määrittämiseksi on rakennettu puu- ja kuituvirtoja metsästä kuluttajalle kuvaava malli. Jätteiden syntymistä eri jalostusvaiheissa on tutkittu vuoden 1972 tilastojen pohjalta. Tässä projektin ensi vaiheessa ei tietojen puutteesta johtuen ole ollut mahdollista erottaa jätettä ja energian lähteenä käytettyä puuta ja kuitua toisistaan. Jätteeksi joutui ja energian lähteeksi polttamalla käytettiin vuonna 1972 56 prosenttia Suomen metsistä hakatusta ja maahan tuodusta puusta. Projektin seuraavassa vaiheessa on tarkoitus tutkia yksityiskohtaisesti puu- ja kuitujätteiden syntymistä eri jalostusvaiheissa ja tehdä ehdotuksia puun käytön tehostamiseksi.

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1. OBJECTIVE

11. In the last two decades the consumption of industrial wood has doubled in Finland. This rapid development of the Finnish forest industries has necessitated paying more attention to the possibilities of expansion in the sector because of the risk of a wood shortage in the near future. In this context, the study "Forestry and Forest Industry Production Alternatives in Finland 1970–2015" by Ervasti, Heikinheimo, Kuusela and Mäkinen (1970) shows the possibilities of development of the sector in the future. They discuss alternatives for ensuring the supply of roundwood for the existing and expanding industry. In the discussions about solutions in the short-term, they say that "the industrial expansion and modification projects for the near future should aim primarily at a higher degree of final processing and, associated with this, *improved utilization of raw material...*" (page 6).

The objective of this study is to identify and evaluate the losses of wood and fibre in the different steps in their transformation from forests to consumers, and make propositions for a better use of the material.

12. The concept "better use" in this research is defined as follows:

a) In the process of wood transforming from forest trees to consumer products there are losses of wood and fibre. These losses are caused by inefficiencies in the various processes. Their elimination would make it possible to increase production of forest industry without the need of increasing the output of raw material from the forest.

b) The forest products used by consumers can be recycled. Today, paper especially is recycled in Finland (Palo and Nissilä 1975). Other forest products could also be recycled. An increase in the recycling of forest products may result in:

- an increase in the forest industry production with no need to increase the drain from the forests, or increase imports

- diminished pollution by wood or fibre products.

c) The two meanings of "better use" mentioned above deal with material that is not used at all in the transformation of wood and fibre and is considered "waste". But it is also possible to use a material better than at present. For example, wood could be used for pulp and paper instead of fuel. This is what the authors Ervasti et al. (1970) call in their study "a higher degree of final processing". It means a higher value added for the forest products and the effect of this "better use" should be an increase in the value of forest production in private and social terms. This third concept of better use is not included in the scope of this research because it deals with wood or fibre that is already being used at present. Only in some specific cases it will be necessary to analyse it, especially when waste is used for fuelwood. In any case this aspect of better use of wood, as it is recommended by the authors mentioned above, should be itself a specific theme of research and could be developed at the Finnish Forest Research Institute.

The development of the project will include three steps:

Step 1

In this stage the flows of wood and fibre from the forest to the consumer and exports are studied. The critical points where material is unnecessarily lost are searched. A rough estimation of the losses is also done in this stage.

Step 2

In this stage the amount of losses and their causes are determined. This stage will include also an evaluation of the possibilities of recycling products after their consumption.

Step 3

This stage includes the final conclusions of the possibilities to use wood and fibre

that are lost. In this stage, economic analyses of the "better use" will be needed. They concern each level of transformation of wood and fibre into final products and also the process as a whole.

Only the step 1 of this research is presented in this publication: a model that shows the

flow of wood and fibres from the forest to the consumers and exports and a rough estimate of the losses. After elaborating the flow-model it was clear that the model alone could be used to solve also other problems than those outlined here.

2. BASIC CONCEPT OF THE MODEL

21. Basic equations

The objective of the model is to present a clear picture of the processes of transformation of wood and fibres into final products in order to identify all the possible points where wood or fibre are lost.

If storing is disregarded and no losses exist, the wood taken from the forest plus imports of wood or fibres equals the amount of wood and fibres consumed and exported:

$$(1) \quad TD + I = C + E$$

where:

TD = total drain
I = imports
C = domestic consumption
E = exports

But as we know that some losses exist, it is necessary to add them to the equation (L = losses):

$$(2) \quad TD + I = C + E + L$$

In this equation total drain (TD) imports (I) and exports (E) are fixed amounts of wood and fibre. For the purpose of this research they are only constants, not variables. Consumption (C) and losses (L) are variables. Wood and fibre can be consumed in two ways:

- as goods like paper, furniture, house, etc., and
- as fuel.

In the first case they can almost always be recycled into some other goods or to be used as fuel. In the second case when used for fuel, they are transformed into energy.

Therefore C can be expressed as:

$$C = c + e - r$$

where:

c = consumption of goods made of wood or fibre (domestic)
e = consumption of wood or fibre as energy (domestic)
r = recycled products

The new equation is:

$$(3) \quad TD + I = (c + e - r) + E + L \quad \text{or}$$

$$(4) \quad TD + I + r = (c + e) + E + L$$

In light of equation (4) the objectives of the project "Effectuating possibilities of waste wood utilization" are:

a) Evaluation and making propositions in order to reduce losses (L) as much as possible. This objective agrees with the concept of better use explained in a) in point 12.

b) Evaluate and make propositions in order to increase recycling (r) as much as possible. This objective agrees with the concept of better use explained in b) in point 12.

22. Stages of transformation

The equations previously presented imply a process of transformation of raw material wood and fibre into products that are consumed or exported. This process is initiated in the forests (and borders in the case of imports) and can be presented as a flow of material that is successively transformed through different stages until the final products reach domestic consumers or are exported.

The *first stage of transformation* is in the forest itself where standing trees are transformed into logs or chips and their transport. The first input to the flow is, therefore, the standing timber that is cut, i.e. the volume taken out in the form of logs and chips. Part of this output is directly consumed or exported and the rest is used by the forest industry. Another input is the imported wood and fibre (Figure 1).

The *second stage of transformation* includes all the primary forest industries (sawmills, particle board, fibre board, plywood and veneer, pulp mills, etc.). In these industries the inputs are logs or residues and the outputs are all the products to which they are transformed, including energy. There can also be an internal transfer of raw material in this stage as with the residues that go from sawmills

to pulp mills for example. From the primary forest industries, the products are consumed, exported or sent to other units in the next stage.

The *third stage of transformation* includes secondary forest industries (paper, furniture, toy, packing industry, etc.). Here the inputs come from the first and second stages and the outputs are a wide range of finished forest products. Some of these products still need a transformation before final consumption; paper is further transformed into newspaper, magazines or books, for example. The units that produce this transformation are not generally considered as a part of the forest sector. Therefore, they are considered here as consumers and not as another stage of transformation.

The *fourth stage of transformation* is recycling. In this case the input is formed by all those recyclable products coming from the domestic market (domestic production plus imports), including paperboard, paper, boxes, building materials, etc. The outputs are the products to which they are transformed.

23. Units of transformation

Each stage of transformation contains *units of transformation*, where the modification of wood and fibre occurs. In each of these units there is an input of material and an output of products that can go to the consumers, to exports or to other units

for a new transformation. The units are differentiated by the characteristics of the transformation process and the product that each unit produces (sawnwood, sulphite pulp, furniture, etc.). In some cases part of the output is energy used by the same or another unit.

The basic equation of each transformation unit is:

$$\text{INPUT} = \text{OUTPUT} + \text{LOSSES}$$

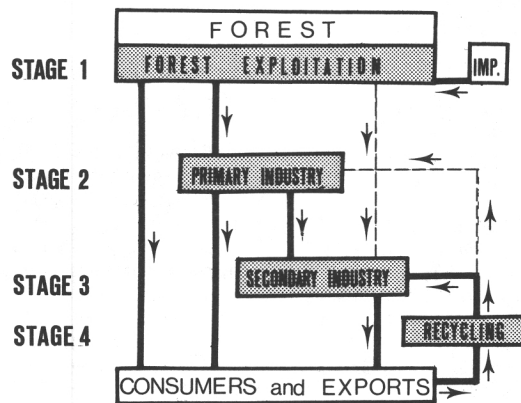
INPUT: wood or fibre
 OUTPUT: products
 - to consumption
 - to other units
 - to exports
 energy

In each unit of transformation there is or there can be a loss. The simplest and primary method to determine the losses is:

$$\text{LOSSES} = \text{INPUT} - \text{OUTPUT}$$

In order to determine all the critical points where material can be lost, it is important to identify all the transformation units that participate in the process. The transportation of material or products from one unit to another unit, to consumers or export will be included as a part of the transformation process of the original unit.

FIGURE 1 : simplified model of the flow of wood and fibres



UNITS OF TRANSFORMATION	
STAGE 1	FOREST EXPLOITATION UNITS
STAGE 2	SAWMILL PLYWOOD AND VENEER PARTICLE BOARD FIBRE BOARD MECHANICAL PULP SEMICHEMICAL PULP SULPHITE PULP SULPHATE PULP OTHER INDUSTRIES
STAGE 3	SECONDARY MECHANICAL INDUSTRY PAPER AND PAPERBOARD
STAGE 4	RECYCLING OF PAPER AND PAPERBOARD

3. PRESENTATION OF THE MODEL

The model has been developed in three forms: 1) as a series of tables where input, output and losses have been calculated from the available statistical information. These calculations appear for all the units and stages where information is available, 2) as a schematic diagram of the flow of wood from forest to consumers, Finland 1972, presented in the central page of this publication, 3) as a series of equations of the different units of transformation presented in the appendix.

The year selected to make all calculations was 1972, the most recent year for which complete information was available at the time of writing. Later in the course of this research project, time-series analyses will be necessary.

To avoid the problem of stock, it will be assumed in this first step of the project that the amount of stocks have no significant variation from year to year.

31. Stage of transformation 1: Forest exploitation

In 1972 the total drain from Finnish forests was 54,83 million m³ including bark, the imports of wood (logs and residues) were 3,38 million m³ including bark (Huttunen 1974, tables 15 and 22). The sum represents the total amount of wood that was available for different uses in Finland in 1972. The primary use of this wood is shown in table 1.

The figures in table 1 give the basic information for the first stage, for which the inputs are the total drain and imports and the outputs all the products consumed in the stage or delivered to industries as raw materials, or exports of primary products, as it is shown in table 2.

All these figures are represented in the schematic diagram of the flow of wood from forests to consumers on the central page. In the upper part are the figures of TD and I and the distribution of these amounts in the different primary uses. The blue colour shows

the flow of raw material (logs, domestic residues from forests and imports of logs and residues) to the forest industry. The red colour represents the material that is lost or burnt (14,02 in this stage). The exports were drawn with green (0,68 in this stage).

32. Stage of transformation 2: Primary forest industry

The first industrial transformation of the wood and fibres is carried out in the primary forest industry, that includes the sawmill industry, plywood and veneer industry, particle board and fibre board industry, pulp industry and other minor industries. The primary forest industry receives the raw material from the forests and imports (42,84 million m³ including bark in 1972) and also there is an internal flow of residues (5,05 million m³ including bark in 1972) from sawmill and plywood and veneer industries to particle board, fibre board and pulp industries. Table 3 presents the flow of raw materials to the primary forest industry.

Each of these industries in stage 2 is a unit of transformation as it was defined in point 23 and can be studied using the equation $INPUT = OUTPUT + LOSSES$. Tables 4–12 present wood and fibre transformation in each unit of the second stage: primary forest industry.

In some units of transformation there are some small changes in volume, which are not considered in the figures appearing in the tables. For example, in the primary industry roundwood, if compared with the final product, has a greater content of water, hence there is a small difference in volume that corresponds to the lower degree of humidity in the product.

33. Stage of transformation 3: Secondary forest industry

The secondary forest industry receives the products of the primary forest industry as raw

material and transforms them into products that are ready or almost ready to be consumed by the public. Some products need another step of transformation to be finally consumed. An example of this is paper that is used for books or printing material. But, as it has been stated before, the units that produce this transformation are not considered as part of the forestry sector, therefore they will be considered as consumers.

The raw materials received by the secondary forest industry are presented in table 13.

For the purpose of this study, the secondary forest industry will be divided into two groups, according to the type of raw material, process and products:

1. The secondary mechanical forest industry that receives raw material from the mechanical primary forest industry (sawmills, veneer and plywood, particle board and fibre board mills, and the group "other industries"). Its products are building materials, houses, furniture, furniture components, boxes, toys, etc.)

2. The paper and paperboard industry that receives raw materials from the pulp industry (mechanical, semichemical, sulphite and sulphate) and transforms them into paper and paperboard.

In this unit the OUTPUT is larger than the INPUT. The reason is the addition of different chemical products in the papermaking process.

34. Stage of transformation 4: Recycling

Recycling the forest products from domestic marked increases the production possibilities without increasing the drain from forest or imports. It also diminishes the pollution caused by forest products. Palo and Nissilä (1975, p. 62) refer to waste paper recycling "...the increasing exploitation of this secondary fibre might be an important marginal addition in solving the wood raw material problem faced by Finland today".

Not only paper and paperboard can be recycled, but many other wood based products as well, some of them in the form of energy. Unfortunately, the information concerning products other than paper do not exist.

Recycling can also be considered as a unit of transformation in which the INPUT is all the wood and fibre based products that reach the domestic market and the OUTPUT the amount of these products that are recycled.

4. FINAL DESTINATION OF WOOD AND FIBRES IN 1972

The previous sections have shown the flows of wood and fibres and given their magnitudes. This section, as a summary, will show the final destination of wood and fibres in 1972, i.e., the destination of the 58,21 mill. cu. m. that were extracted from the forest (TD) and imported (I).

For this it is necessary to quote the equation (4) of section 21 where:

$$TD + I + r = (c + e) + E + L$$

In many units of transformation it has not been possible to separate clearly the wood and

fibres that have been used, for example fuel, from those lost. Besides, in many cases there is no information concerning the final destination of wood and fibres. For these reasons, in this first stage of the research energy and losses and an "unknown" factor (U) are combined:

$$TD + I + r = c + E + (e + L + U)$$

The figures for the values for 1972 of this equation are given in the following sections. All the equations that have been used in the model are in Appendix.

41. Final consumption of forest products in domestic market

There is a flow of products from each stage of transformation to the domestic market. This flow, shown in yellow in the flow diagram on the central pages, is formed as shown in Table 17.

42. Exports (E)

Exports are presented for all the units and stages of transformation with the exception of semichemical pulp, see Table 18.

43. Energy, losses and unknown

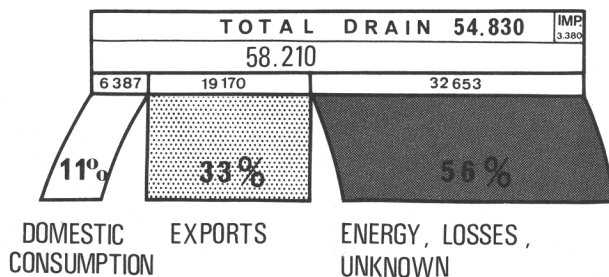
In all units of transformation a part of the output is used as energy, but only in two of them, forest exploitation and the sawmill

industry, has it been possible to determine their figures separately. In all other cases it has not been possible to separate the figures of energy from those of losses. In many units of transformation it has been necessary to add the term "unknown" because there is no good statistical information concerning the transformation process. For these reasons it has been necessary in many units of transformation to handle the figures of energy, losses and unknown together, as can be seen in many tables and specifically in table 19. These figures are represented by red in the flow diagram of the central pages.

44. Summary of the transformation process of wood and fibres in Finland in 1972

The figures given in Tables 2 to 19 are summarized in Figure 2 and in Table 20.

FIGURE 2 : Final destination of wood and fibres in 1972 (figures in 000 m³)



5. DISCUSSION AND FUTURE RESEARCH

The results presented in the previous sections are, at first sight, surprising, especially when observing that about 56 % of the wood and fibres are used as fuel or are lost. Some comments need to be made concerning this figure.

1. In this first stage, it has not been possible to separate clearly the proportion that is used as energy from that which is lost in every unit of transformation. In those units where separate figures were obtained (Forest exploitation and Sawmill industry), the results indicate that

approximately half goes to energy and half to losses. But, in other units, such as the pulp units, it is possible that the material used as energy is proportionally higher to the wood and fibre lost. In these units the use of fibres and wood as energy corresponds to the use of bark and cooking liquours which are used to generate energy.

2. The use of wood and fibres to produce energy in a forest industrial process, depends on different factors, among others, the price of alternative fuels and the technology of energy production in the different productive units. In the first case it is clear that all the increments in the price of fuel oil and other fuels will provoke a tendency to replace them with wood in energy production. When the technology of energy production in the plants permits and alternative to fuel oil (as in pulp plants), this alternative will be used.

The figures presented in this work refer to 1972, and this pre-dates the decision of OPEC to increase oil prices. It is therefore possible to suppose that an increase in the use of wood as fuel has occurred since 1973. Such an increase is conditional upon the technological possibilities of transference. If the industrial plants do not have units that permit the change from oil to wood, any increase in the use of wood for fuel will be small. This also means that any recommendation concerning a higher or lower amount of wood used as fuelwood must be based on detailed and careful studies on this matter.

3. The losses in forest exploitation mentioned as "logging and silvicultural waste" are not a real loss from the "ecological" stand point, because wood is an element that is reincorporated into the soil and contributes to maintaining the fertility of the soil. This material does not pollute. What is lost is the cost of harvesting the material that is not extracted from the forest. But these costs can be considered also as part of management costs.

4. Recycling is an aspect that must be studied deeply. It is clear that there are strong

possibilities of increasing it in paper, paperboard and other forest products. But the amount of wood and fibres that reaches the domestic market is only around 11 % of all the wood and fibres used in Finland and not all these products can be recycled. For this reason recycling, rather than easing the problem of raw material supply, should be justified as a means of avoiding pollution problems.

All these observations indicate the need for continuing this project. The preliminary results reveal important questions that should be studied.

The second step should start with an investigation that permits a clear separation of wood and fibre used as energy from those that are lost. It will then be necessary to investigate separately every unit of transformation, starting with those which have presented the highest loss and fuelwood figures. In this second step, it will be necessary to integrate different specialists into the research project, especially technologists. The main subject in this step of research will be the study of the causes of losses.

When the causes of losses are identified, it will be possible to proceed to the third step where the recommendations for loss elimination will be made.

Finally, two observations:

1. If it is considered that an investigation of this nature is important, and that as such are periodically necessary, it will be necessary to improve the sectorial system of the statistics. It will be necessary, for example, to have statistics on the consumption of wood for energy, or to have systematic information on the secondary forest industries.

Such an improvement of the forest statistics could be based upon the transformation units, which are the basic units of the forest productive sector.

2. The flow diagram and the equations presented here are not valid only for this research. They can be used to design other research projects, for teaching and for sectorial planning.

SUMMARY

The aims of this research project are:

a) The identification and evaluation of the losses of wood and fibres in the process of their transformation.

b) The determination of the causes of these losses and the establishment of criteria for a more efficient utilization of this material.

The first stage of the investigation is an attempt to locate those places in the flow of wood and fibres where losses can occur. These are defined as "units of transformation" through which the material is successively transformed until it reaches the final consumer or the country's border. A primary evaluation of the losses is also attempted in this first stage in order to determine the priorities for the next stages of the research project.

Based on the available statistical information for 1972, the units of transformation were studied. For each, an evaluation of the input and output of wood and fibres was made and it was assumed that their difference was the wood and fibre lost in the process or its destination unknown. The "units of transformation" were ordered according to their position in the flow of wood and fibres. The starting point was the forest. This gave cause to elaborate the "Schematic diagram of the flow of wood from forest to consumers", a simplified figure of the productive forest sector, which is in the central page of this publication. It was also possible to develop the set of equations which form a model of the forest productive sector (appendix).

In many cases there were problems of

quantification due to the lack of statistical data. This difficulty was partly solved by employing information on material flows in the forest sector being utilized by Esko Jäätinen, at this Institute.

The final figures for this first stage indicate that in 1972, Finland used 58,21 million cubic metres of wood including bark of which 54,83 million cubic metres were extracted from domestic forests and 3,38 million cubic metres were imported.

The figures for the final use of this wood show the following:

33 million m ³	56 %	– used as energy, lost or its final destination is unknown
19 million m ³	33 %	– exported in form of different products, paper being the most important
6,4 million m ³	11 %	– consumed in Finland.

These preliminary figures, and the fact that separate figures for the wood used as energy and for that which is lost are unavailable, reveal the need for continuing the next stages of this research project. The next step will be a detailed study of each "unit of transformation" in order to determine precisely the amount of wood that is lost and the causes of each loss. With this information a proposition for a better use of the wood can be made. This will constitute the third and final stage of this research.

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SELOSTE

Tämän tutkimuksen tavoitteet ovat:

a) Jätepuun ja -kuidun paikallistaminen metsä- ja puutalouden tuotantoketjussa ja sen määrän alustava arvioiminen.

b) Perusaineiston tuottaminen jatkotutkimuksille, jotka koskevat jätteen syntymisen syitä ja keinojen kehittämistä jätteen määrän vähentämiseksi.

Metsä- ja puutalouden tuotantoketju ulottuu metsässä kasvavasta puusta kuluttajan käytettävissä olevaan valmiiseen tuotteeseen. Tutkimuksessa pyritään paikallistamaan tuotantoketjussa ne kohdat, joissa jätepuuta ja -kuitua syntyy. Nämä kohdat ovat teollisuusaloja, joissa puuta ja kuitua jalostetaan.

Tutkimus perustuu vuoden 1972 tilastoihin. Kukaan teollisuusalaa varten on kehitetty puun ja kuidun alkuperää ja käyttöä kuvaavat taseet. Ne sisältyvät liitteeseen.

Kullekin teollisuusalalle on laskettu raaka-aineena käytetyn ja tuotetun puun ja kuidun määrät. Näiden erotus on poltettu, jätepuuta tai -kuitua tai käyttö on tuntematon. Yhtälöiden pohjalta on laadittu puu- ja kuituvirtoja koskevat laskelmat, jotka ovat taulukoina tekstissä. Keskiarkeamalla oleva kuva on yh-

teenveto näistä laskelmista. Se osoittaa, että Suomessa vuonna 1972 käytettiin 58,21 milj. m³ kuorellista puuta, josta 54,83 milj. m³ on peräisin kotimaan metsistä ja 3,38 milj. m³ on tuotu ulkomailta.

Tutkimuksen mukaan v. 1972 käytetystä puusta:

33 milj. m ³	(56 %)	poltettiin, jäi jätteeksi tai sen käyttö on tuntematon
19 milj. m ³	33 %)	vietiin ulkomaille erilaisina lopputuotteina, valtaosa paperina
6,4 milj. m ³	(11 %)	on kulutettu Suomessa erilaisina lopputuotteina

Tutkimuksen laskelmat ovat luonteeltaan alustavia. Suurin puute on se, ettei ole voitu erottaa toisistaan puuta, joka on poltettu, jonka käyttö on tuntematon ja jätettä. Jatkotutkimuksien tehtävänä on selvittää yksityiskohtaisemmin teollisuusaloittain syntyvä jätepuun ja -kuidun määrä. Vasta sen jälkeen voidaan analysoida keinoja puun ja kuidun hyödyntämiseksi entistä tarkemmin.

RESUMEN

Los objetivos de este proyecto de investigación son:

a) La identificación y evaluación de las pérdidas de madera y fibras que ocurren en el proceso de transformación que va desde el bosque hasta el consumidor.

b) La determinación de las causas de estas pérdidas y recomendaciones para un uso más eficiente de este material.

En esta primera etapa la investigación trata de ubicar los puntos de pérdida, o sea, los lugares del flujo de madera y fibras en donde pueden ocurrir dichas pérdidas. Ellos se definen como las "unidades de transformación" a través de las cuales el material es sucesivamente transformado hasta llegar al consumidor final o a la frontera. También se trata en esta primera etapa de realizar una evaluación primaria de las pérdidas con el objeto de determinar las prioridades de investigación en las siguientes etapas del proyecto.

En base a los antecedentes estadísticos disponibles para el año 1972, se estudiaron las unidades de transformación evaluándose para cada una el "input" y "output" y asumiendo que la diferencia era madera o fibras utilizadas como combustible, pérdidas o simplemente se desconocía la información. Las unidades de transformación se ordenaron de acuerdo al flujo de la madera y fibras cuyo punto de partida es el bosque, lo que permitió elaborar el esquema simplificado del sector forestal productivo que se encuentra en la página central de esta publicación. Permitted, además, elaborar un conjunto de ecuaciones que forman el modelo del sector forestal productivo (apéndice).

En muchos casos hubo problemas de cuantificación por falta de datos estadísticos. Parte de estos problemas fueron resueltos en base a la información sobre materiales del sector forestal de la investigación preliminar de *Esko Jaatinen*.

Las cifras finales de esta primera etapa indican que en 1972 Finlandia utilizó 58,21 millones m³ incluyendo corteza, de los cuales 54,83 millones fueron extraídos de bosques nacionales y 3,38 millones fueron importados.

Las cifras de uso final de esta madera muestran los siguientes resultados:

- 33 mill. m³ 56 % fue utilizado como combustible, perdido o su destino es desconocido
- 19 mill. m³ 33 % se exportó en forma de diferentes productos, siendo el más importante el papel
- 6,4 mill. m³ 11 % se consumió en Finlandia.

Estas cifras preliminares y el hecho de no tener cifras separadas de la madera que se usa como combustible de aquella que se pierde, indican la necesidad de continuar con las otras etapas del proyecto. El próximo paso será el estudio en detalle de cada unidad de transformación para determinar con precisión la cantidad de madera que se pierde y sus causas. Con estos antecedentes se harán, finalmente, proposiciones para un mejor uso de la madera y fibras.

TABLES

Table 1. Primary use of wood in Finland in 1972

Taulukko 1. Puun ensiasteinen käyttö Suomessa vuonna 1972

(mill. m³ incl. bark)
(milj k-m³ kuorellista puuta)

1. Use on farms and in buildings of which 8,01 was fuelwood Kiinteistöjen raakapuun käyttö, josta polttopuuta 8,01			8,48
2. Exports of roundwood Raakapuun vienti			0,68
3. Losses in forest and transport and fuelwood for industries Metsähukkapuu, kuljetushäviö ja teollisuuden polttopuu			6,01
31. Logging and silvicultural waste Metsähukkapuu	5,01		
- recovered residues käytetty hukkapuu	- 0,24	4,77	
32. Mortality Luonnonpoistuma		1,16	
33. Floating losses Uittohäviö		0,02	
34. Fuelwood for industries Teollisuuden polttopuu		0,06	
4. Raw material for the primary forest industry Metsäteollisuuden raaka-aine			42,84
41. Sawmills Sahateollisuus		16,37	
42. Plywood industry Vaneriteollisuus		2,22	
43. Particle board industry Lastulevyteollisuus		0,48	
44. Fibre board industry Kuitulevyteollisuus		0,18	
45. Pulp industry Puumassateollisuus		23,35	
- mechanical pulp industry hioketeollisuus	5,40		
- semi-chemical pulp industry puoliselluloosateollisuus	0,80		
- sulphite pulp industry sulfiittiselluloosateollisuus	6,15		
- sulphate pulp industry sulfaattiselluloosateollisuus	11,00		
46. Other industries Muu teollisuus		0,25	
5. Other uses Muu käyttö			0,20
		Total Yht.	58,21

Source: HUTTUNEN, T. Folia For. 219, tables 2, 9, 12, 26.

Table 2. Forest exploitation

Taulukko 2. Metsän käyttö

(mill. m³ incl. bark)
milj k-m³ kuorellista puuta

<u>INPUT</u> PANOS			58,21
a) Total drain (TD) Kokonaispoistuma		54,83	
b) Imports (I) Tuonti		3,38	
<u>OUTPUT</u> TUOTOS			52,26
a) Raw material for industries (C1i) Teollisuuden raaka-aine		42,84	
b) Consumption (C1f) Kulutus		0,67	
- on farms and in buildings kiinteistöt	0,47		
- other uses muu käyttö	0,20		
c) Energy (e1) Energian käyttö		8,07	
- on farms maatilat	8,01		
- in industries teollisuus	0,06		
d) Exports (E1) Vienti		0,68	
<u>LOSSES (L1)</u> HÄVIKKI			5,95
TD + I = 58,21 C1 = C1i + C1f = 43,51 L1 = 5,95 e1 = 8,07 e1 + L1 = 14,02 E = 0,68			

Table 3. Raw material used by the primary forest industry, 1972
Taulukko 3. Metsäteollisuuden raaka-aine, 1972

(mill. m³ incl. bark)
milj. k-m³ kuorellista puuta

	ROUNDWOOD RAAKAPUU		RESIDUES from JÄTEPUU		TOTAL YHT.
	domestic kotimainen	imported ulkomainen	forest metsästä	imports ulkomailta	
Sawmill industry Sahateollisuus	15,58	0,79			16,37
Plywood and veneer industry Vaneriteollisuus	2,22	0,01			2,22
Particle board industry Lastulevyteollisuus	0,48				0,86
Fibre board industry Kuitulevyteollisuus	0,05	0,13			0,65
Pulp industry Massateollisuus	20,66	2,01	0,23	0,46	27,55
- mechanical hioke	5,25	0,16			5,48
- semichemical puoliselluloosa	0,77	0,03			0,95
- sulphite sulfiittiselluloosa	5,90	0,23	0,01	0,01	7,05
- sulphate sulfaattiselluloosa	8,74	1,59	0,22	0,45	14,07
Other industries Muun teollisuus	0,24				0,25

Source: HUTTUNEN, T. Folia For. 219, table 2.

Table 4. Sawmill industry
Taulukko 4. Sahateollisuus

<u>INPUT</u> (000 m ³ incl. bark) (C _{SM})				16 370
PANOS (000 k-m ³ kuorellista puuta) (C _{SM})				
Roundwood consumption Raakapuun käyttö			16 370	
- imported tuonti	790			
- domestic kotimainen	15 580			
<u>OUTPUT</u> (000 m ³)				12 929
TUOTOS (000 k-m ³)				
Production of sawnwood Sahatavaran tuotanto			7 475	
- to other units (PS _{di}) muille yksiköille		2 565		
- to exports (E _{SM}) vientiin		4 910		
Production of wood residues Jätepuun tuotanto			5 454	
- to other units (PR _{SM}) muille yksiköille		4 553		
- own firm omalle tehtaalle	2 073			
- other firms muille tehtaille	2 480			
- final use (not as fuelwood) (C _{SM}) loppukäyttö (ei polttopuuna)		163		
- construction rakentaminen	7			
- other muu	156			
- use as fuel (e _{SM}) käyttö polttopuuna		739		
<u>LOSSES OR UNKNOWN</u> (000 m ³) (L _{SM} + U _{SM})				3 441
JÄTETTÄ TAI TUNTEMATONTA				

Sources: Yearbook of forest statistics, 1973. Tables 5.1.1, 6.1.1, 7.1.1.

HUTTUNEN, T. The sawmill industry in Finland in 1972. Folia For. 193.

Table 5. Plywood and veneer industry
Taulukko 5. Vaneriteollisuus

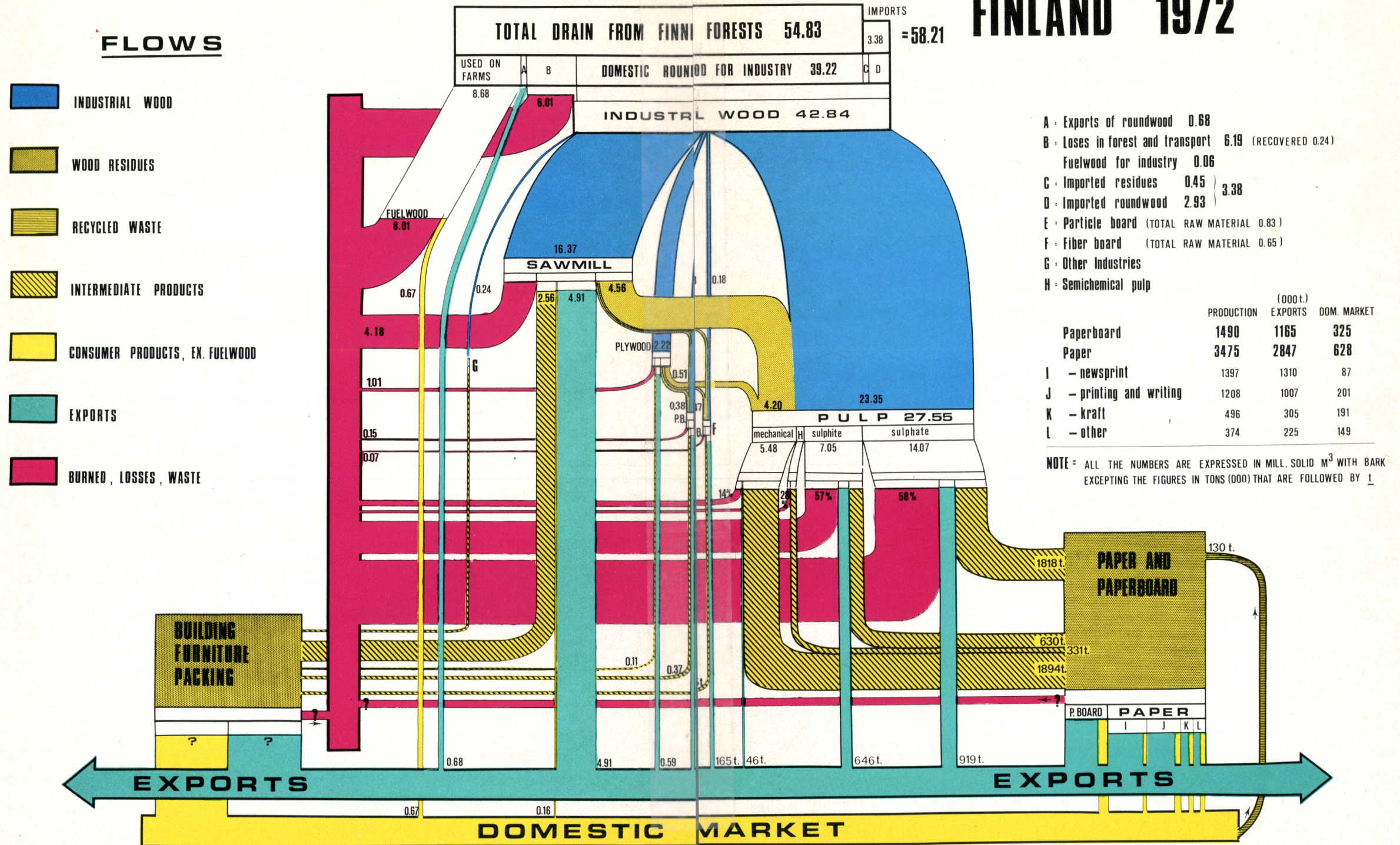
<u>INPUT</u> (000 m ³ incl. bark) (C _{PV})			2 220
PANOS (000 k-m ³ kuorellista puuta) (C _{PV})			
Roundwood Raakapuu		2 200	
<u>OUTPUT</u> (000 m ³)			1 208
TUOTOS (000 k-m ³)			
Production of plywood and veneer Vanerin tuotanto		701	
- to other units (PP _{Vi}) muille yksiköille	106		
- to exports (E _{PV}) vientiin	595		
Production of residues (RR _{PV}) 1/ Jätepuun tuotanto		507	
<u>BURNT, LOSSES AND UNKNOWN</u> (000 m ³) (e _{PV} + L _{PV} + U _{PV})			1 012
POLTETTUA, JÄTETTÄ JA TUNTEMATONTA (000 k-m ³)			

Sources: Yearbook of forest statistics 1973. Folia For. 255. Tables 5.1.6, 6.1.1, 7.1.1.

1/ Calculated as a difference between the total "wood residues from industries" (HUTTUNEN, T. Folia For. 219, table 3 minus the residues.

A SCHEMATIC DIAGRAM OF THE FLOW OF WOOD FROM FORESTS TO CONSUMERS

FINLAND 1972



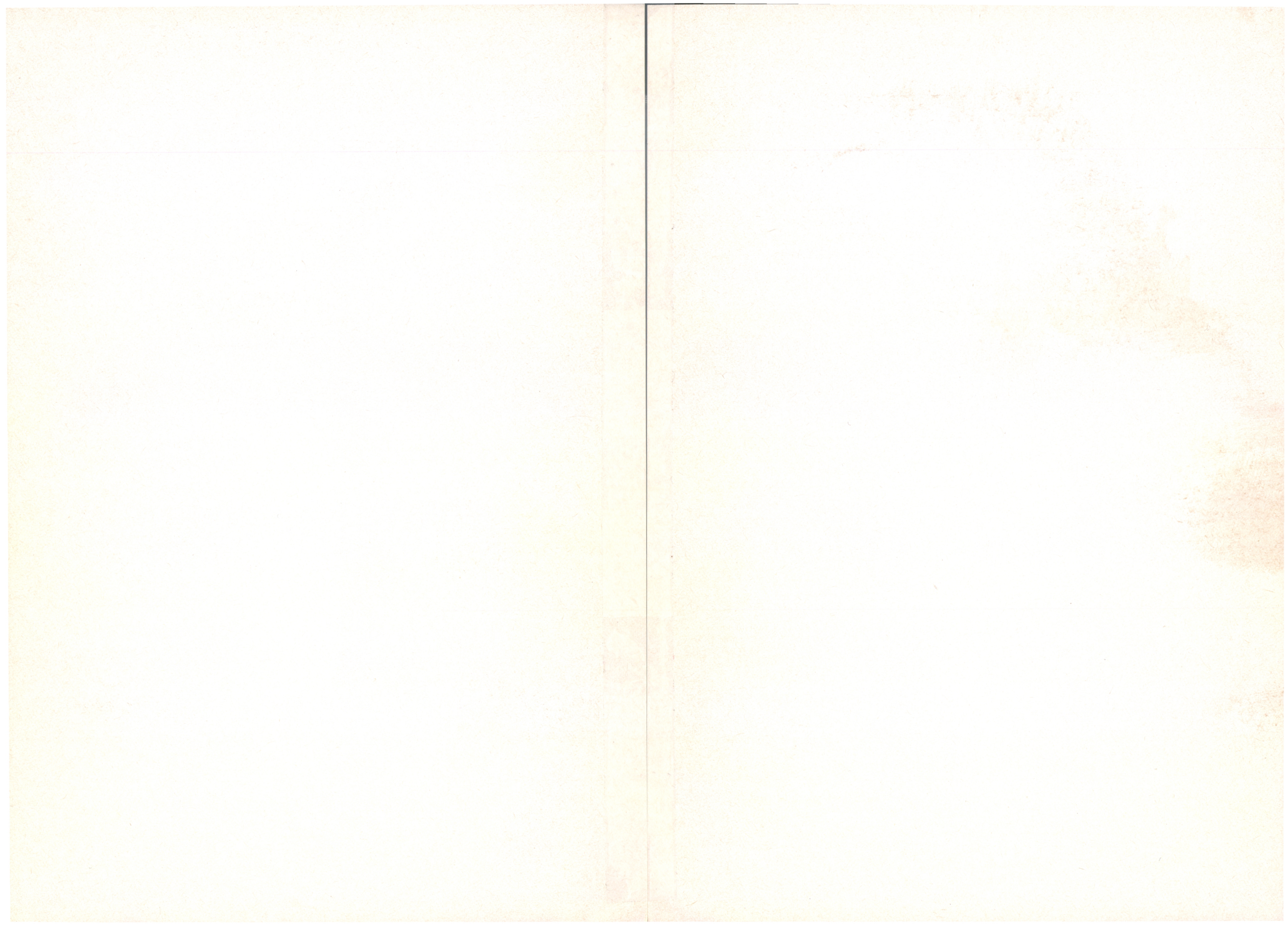


Table 6. Particle board industry
Taulukko 6. Lastulevyteollisuus

<u>INPUT</u> (000 m ³ incl. bark)			860
PANOS (000 k-m ³ kuorellista puuta)			
Roundwood Raakapuuta		480	
Residues from industries Teollisuusjätepuuta		380	
<u>OUTPUT</u> (000 m ³)			705
TUOTOS (000 k-m ³)			
Production Tuotanto		705	
- domestic market (PPBi) kotimaan markkinoille	371		
- exports (E _{PB}) vientiin	334		
<u>BURNT, LOSSES AND UNKNOWN</u> (e _{PB} + L _{PB} + U _{PB})			155
POLTETTUA, JÄTETTÄ JA TUNTEMATONTA			

Source: Yearbook of forest statistics, 1973. Folia For. 255. Tables 5.1.4, 6.1.1., 7.1.1.

Table 7. Fibre board industry
Taulukko 7. Kuitulevyteollisuus

<u>INPUT</u> (000 m ³ incl. bark)			650
PANOS (000 k-m ³ kuorellista puuta)			
Roundwood Raakapuuta		180	
- domestic kotimaista	50		
- imported tuontipuuta	130		
Residues from industries Teollisuusjättepuuta		470	
<u>OUTPUT</u> (000 m ³)			579
TUOTOS (000 k-m ³)			
Production (260 000 ton) Tuotanto (260 000 tonnia)		579	
- to other units (95 000 ton) (PFBi) muille yksiköille (95 000 tonnia)	210		
- exports (165 000 ton) (E _{FB}) vientiin (165 000 tonnia) ^{FB}	369		
<u>BURNT, LOSSES, UNKNOWN</u> (e _{FB} + L _{FB} + U _{FB}) 11% 1/ POLTETTUA, JÄTETTÄ, TUNTEMATONTA			71

Sources: 1/ JAATINEN, E. Materials and energy flows in the Finnish forest sector. Preliminary estimations. Unpublished manuscript. 1976.

Yearbook of forest statistics, 1973. Folia For. 255. Tables 5.1.4., 6.1.1., 7.1.1.

Note: In his manuscript ESKO JAATINEN has calculated all the figures of input-output in tons of "dry material". To be used in this research, they were transformed into percentages and applied to the figures taken from the forest statistics. This was made for tables 7 to 12. This procedure presents a problem because the percentages were applied to volume figures that contain water.

Table 8. Mechanical pulp industry
Taulukko 8. Hioketeollisuus

<u>INPUT</u>	(000 m ³ incl. bark)		5 480
PANOS	(000 k-m ³ kuorellista puuta)		
	Roundwood Raakapuuta		5 410
	- domestic kotimaista	5 250	
	- imported tuontipuuta	160	
	Residues from industries Teollisuusjätepuuta		80
<u>OUTPUT</u>	(000 m ³)		4 720
TUOTOS	(000 k-m ³)		
	Production (1 940 000 ton) Tuotanto (1 940 000 tonnia)		
	- to other industries (1 894 000 ton) (PMPi) muille teollisuuden aloille (1 894 000 tonnia)		4 626
	- exports (46 000 ton) (E _{MP}) vientiin (46 000 tonnia)		94
<u>BURNT, LOSSES, UNKNOWN</u>	1/ (e _{MP} + L _{MP} + U _{MP})		760

Sources: 1/ JAATINEN, E. Materials and energy flows in the Finnish forest sector. Preliminary estimations. Unpublished manuscript. 1976.

Yearbook of forest statistics, 1973. Folia For. 255. Tables 5.1.4, 6.1.1., and 7.1.1.

Table 9. Semichemical pulp industry
Taulukko 9. Puoliselluloosateollisuus

<u>INPUT</u> (000 m ³ incl. bark)			950
PANOS (000 k-m ³ kuorellista puuta)			
Roundwood Raakapuuta		800	
- domestic kotimaista	770		
- imported tuontipuuta	30		
Residues from domestic industries Kotimainen teollisuusjätepuuta		150	
<u>OUTPUT</u> (000 m ³)			684
TUOTOS (000 k-m ³)			
Production (331 000 ton) (PSPi) Tuotanto (331 000 tonnia)		684	
- to other units (331 000 ton) muille yksiköille (331 000 tonnia)	684		
<u>BURNT, LOSSES, UNKNOWN</u> ^{1/} (e _{SP} + L _{SP} + U _{SP})			266
POLTETTUA, JÄTETTÄ, TUNTEMATONTA			

Sources: ^{1/} JAATINEN, E. Materials and energy flows in the Finnish forest sector. Preliminary estimations. Unpublished manuscript. 1976.

Yearbook of forest statistics, 1973. Folia For. 255. Tables 5.1.4., 6.1.1., and 7.1.1.

Table 10. Sulphite pulp industry
Taulukko 10. Sulfiittiselluloosateollisuus

<u>INPUT</u> (000 m ³ incl. bark)			7 050
PANOS (000 k-m ³ kuorellista puuta)			
Roundwood Raakapuuta		6 130	
- domestic kotimaista	5 900		
- imported tuontipuuta	230		
Residues Jätepuuta		920	
- from domestic forests kotimaan metsistä	10		
- from domestic industries kotimainen-teollisuusjätepuu	900		
- imported tuontijätepuu	10		
<u>OUTPUT</u> (000 m ³)			3 030
TUOTOS (000 k-m ³)			
Production (1 276 000 ton) Tuotanto (1 276 000 tonnia)		3 030	
- to other units (630 000 ton) (PSIPi) muille yksiköille (630 000 tonnia)	1 485		
- to exports (646 000 ton) (E _{SIP}) vientiin (646 000 tonnia)	1 545		
<u>BURNT, LOSSES, UNKNOWN</u> ^{1/} (e _{SIP} + L _{SIP} + U _{SIP}) POLTETTUA, JÄTETTÄ, TUNTEMATONTA			4 020

Sources: 1/ JAATINEN, E. Materials and energy flow in the Finnish forest sector. Preliminary estimations. Unpublished manuscript. 1976.

Yearbook of forest statistics, 1973. Folia For. 255. Tables 5.1.4., 6.1.1., and 7.1.1.

Table 11. Sulphate pulp industry
Taulukko 11. Sulfaattiselluloosateollisuus

<u>INPUT</u> (000 m ³ incl. bark)			14 070
PANOS (000 k-m ³ kuorellista puuta)			
Roundwood Raakapuuta		10 330	
- domestic kotimaista	8 740		
- imported tuontipuuta	1 590		
Residues Jätepuuta		3 740	
- from domestic forests kotimaan metsistä	220		
- from domestic industries kotimainen-teollisuusjätepuu	3 070		
- imported tuontijätepuu	450		
<u>OUTPUT</u> (000 m ³)			5 900
TUOTOS (000 k-m ³)			
Production (2 737 000 ton) Tuotanto (2 737 000 tonnia)		5 900	
- to other units (1 818 000 ton) (PSAPi) muille yksiköille (1 818 000 tonnia)	3 894		
- to exports (919 000 ton) (E _{SAP}) vientiin (919 000 tonnia) (E _{SAP})	2 006		
<u>BURNT, LOSSES, UNKNOWN</u> ^{1/} (e _{SAP} + L _{SAP} + U _{SAP})			8 170
POLTETTUA, JÄTETTÄ, TUNTEMATONTA			

Sources: JAATINEN, E. Materials and energy flow in the Finnish forest sector. Preliminary estimates. Unpublished manuscript. 1976.

Yearbook of forest statistics, 1973. Folia For. Tables 5.1.4., 6.1.1., and 7.1.1.

Table 12. Other industries
Taulukko 12. Muu teollisuus

<u>INPUT</u>	(000 m ³ incl. bark)		250
PANOS	(000 k-m ³ kuorellista puuta)		
	Roundwood		240
	Raakapuuta		
	- domestic	240	
	kotimaista		
	Residues		10
	Jätepuuta		
	- from industries	10	
	teollisuudelta		
<u>OUTPUT</u>	The products of these industries are many and varied, such as skis, boats, etc. For this reason, and because there are no statistics available for them it is not possible to quantify the output. It will therefore be considered that all the input is used. 1/		
TUOTOS	Näiden teollisuudenalojen tuotteita on monenlaisia esim. suksia, veneitä, jne. Koska tilastoja ei ole saatavissa näistä, ei myöskään ole mahdollista arvioida kokonaistuotosta. Siksi oletetaan että koko panos on käytetty. 1/		
<u>LOSSES, BURNT, UNKNOWN</u>	(e ₀ + L ₀ + U ₀)		?
JÄTETTÄ, POLTETTUA, TUNTEMATONTA			

Sources: Yearbook of forest statistics, 1973. Folia For. 193. Table 5.1.1.

1/ HUTTUNEN, T. Verbal information (20.10.76).

Table 13. Raw materials to the secondary forest industry from the primary forest industry

Taulukko 13. Toisen asteen metsäteollisuuden raaka-aineet jotka ovat peräisin ensimmäisen asteen metsäteollisuudesta

<u>From mechanical primary forest industry</u>		<u>000 units</u>
Ensiasteen mekaanisesta metsäteollisuudesta		000 yksikköä
- Sawmill industry Sahateollisuudesta	2 565	m ³
- Plywood and veneer industry Vaneriteollisuudesta	106	m ³
- Particle board industry Lastulevyteollisuudesta	371	m ³
- Fibre board industry Kuitulevyteollisuudesta	95	ton
 <u>From pulp industry</u>		
Puumassateollisuudesta		
- Mechanical pulp industry Hioketeollisuudesta	1 894	ton
- Semicheical pulp industry Puoliselluloosateollisuudesta	331	ton
- Sulphite pulp industry Sulfiittiselluloosateollisuudesta	630	ton
- Sulphate pulp industry Sulfaattiselluloosateollisuudesta	1 818	ton

Table 14. Secondary mechanical forest industry
 Taulukko 14. Toisen asteen mekaaninen metsäteollisuus

<u>INPUT</u>	(000 m ³)	
PANOS		
Sawnwood (PSdi) Sahatavara		2 565
Plywood and veneer (PPVi) Vaneri		106
Particle board (PPBi) Lastulevy		371
Fibre board (95 000 ton) (PFBi) Kuitulevy (95 000 tonnia)		210
<u>OUTPUT</u>	(PSMFI)	
TUOTOS	There are no statistics that would further divide the products of this unit. Therefore it is not possible to determine the OUTPUT and the LOSSES for it. The product can be divided into: Tilastot eivät esitä tämän yksikön tuotteita tarkemmin. Siksi ei voida määritellä sen TUOTOSTA ja JÄTTBITÄ. Tuote voidaan jakaa:	
	1. Buildings and material for buildings Rakennuksiin ja rakennusmateriaaleihin	
	2. Furnitures and parts of furnitures Huonekaluihin	
	3. Packing and materials for packing Pakkauksiin ja pakkausmateriaaleihin	
	4. Others: toys, etc. Muu: leikkikalut, jne.	

Table 15. Paper and paperboard industry
Taulukko 15. Paperi- ja kartonkiteollisuus

			000 m ³ 000 k-m ³	
<u>INPUT</u> (000 ton)				4 803
PANOS				
Mechanical pulp (PMPi) Puuhioke	1 894		(4 626 m ³)	
Semichemical pulp (PSPi) Puoliselluloosa	331		(684 m ³)	
Sulphite pulp (PSIPi) Sulfiittiselluloosa	630		(1 485 m ³)	
Sulphate pulp (PSAPI) Sulfaattiselluloosa	1 818		(3 894 m ³)	
Recycled paper and paperboard ^{1/} Jätepaperin ja -kartongin käyttö	130 ^{2/}			
<u>OUTPUT</u> (000 ton)				4 965
TUOTOS				
Paper (PP) Paperi	3 475		(7 482 m ³)	
- domestic consumption (PPd) kotimainen kulutus	628			
- exports (EPP) vientii	2 847			
Paperboard (PPB) Kartonki	1 490		(3 207 m ³)	
- domestic consumption (PPBd) kotimainen kulutus	325			
- exports (EPPB) vientii	1 165			
<u>BURNT, LOSSES and UNKNOWN</u> POLTETTUA, JÄTETTÄ ja TUNTEMATONTA				?

Sources: Yearbook of forest statistics, 1973. Folia For. 225. Tables 6.1.1. and 7.1.1.

^{1/} PALO, M. & NISSILÄ, O. Waste paper recycling: Economic and ecological prospects. Commun. Inst. For. Fenn. 82(5). Table 6.

^{2/} This figure is not included in the total input.

Note: The figures in m³ of the input in this table were taken from tables 8 to 10. And those of the output were calculated based on the percentage distribution of the input in relation with the output.

Table 16. Recycling of waste paper and paperboard
 Taulukko 16. Jätepaperin ja -kartongin käyttö

<u>INPUT</u> (000 ton)		690
PANOS (000 tonnia)		
Amount of paper and paperboard that reaches the domestic market:		
Kotimaan markkinoiden paperin ja kartongin käyttö		
paper paperi	628 1/	
paperboard kartonki	325 1/	
	<hr/>	
total domestic kotimainen käyttö yht.	953	
exports of converted paper paperin ja kartongin jalosteiden vienti	- 290 2/	
	<hr/>	
	663	
imports of paper and paperboard paperin ja kartongin tuonti	27	
	<hr/>	
	690	
 <u>OUTPUT</u> (000 ton)		130
TUOTOS (000 tonnia)		
Paper and paperboard recycled Jätepaperin ja -kartongin käyttö	130 3/	
 <u>NOT RECYCLED</u> KÄYTTÄMÄTTÄ JÄÄVÄ JÄTEPAPERI JA KARTONKI		560 4/

Sources: 1/ Yearbook of forest statistics, 1973. Folia For. 255.

2/ Suomen virallinen tilasto - Ulkomaankauppa, osa 1 1972, Helsinki 1973.

3/ PALO, M. & NISSILÄ, O. Waste paper recycling: economic and ecological prospects. Commun. Inst. For. Fenn. 82(5). Table 6.

4/ Not all the paper that reaches the market can be recycled. About 15% of the paper (as tissue paper for example) and paperboard cannot be recycled (PALO, M. & NISSILÄ, O. 1975, page 75).

Table 17. Final domestic consumption of forest products in each stage of transformation in 1972 expressed roundwood equivalents (consumption for energy excluded)

Taulukko 17. Puun ja kuidun kotimainen loppukäyttö muuksi kuin polttoaineeksi tuotantoketjun eri vaiheissa, raakapuun määränä ilmaistuna

		000 m ³ 000 k-m ³
a) Consumption of products from the stage forest exploitation, without an industrial transformation (C1F) Metsänkäyttövaiheen puun muu kuin teollinen käyttö		670
b) Final consumption of products from the primary forest industry Ensiasteinen metsäteollisuuden loppukäyttö		
- sawmill industry (cSM) sahateollisuus		163
- other industries (c ₀) muu teollisuus		250
c) Consumption of products from the Secondary Mechanical Forest Industry (PSMFI). As in this case there are no available figures of the output, figures of the input will be used. Toisen asteen mekaaninen metsäteollisuuden tuotteiden käyttö (PSMFI). Koska tässä ei ole käytettävissä tuotoksen määrää, sen tilalla käytetään panoksen määrää.		
- sawnwood (PSdi) sahatavara		2 565
- plywood and veneer (PPVi) vaneri		106
- particle board (PPBi) lastulevy		371
- fibre board (95 ton) (PFBi) kuitulevy (95 tonnia)		210
d) Consumption of products from the paper and paperboard industry ^{1/} Paperi- ja kartonkiteollisuuden tuotteiden käyttö ^{1/}		
- paper (PPd) paperi	628 ton	
- paperboard (PPBd) kartonki	325 ton	
	953 ton	2 052
TOTAL YHTEENSÄ		6 387

^{1/} Figures of exports of converted paper are included.
Sisältää paperin ja kartongin jalosteet.

Table 18. Exports of forest products from Finland in 1972 expressed in roundwood equivalent

Taulukko 18. Metsätuotteiden vienti Suomesta 1972 ilmaistuna raakapuun määränä

Unit of Transformation Työstöyksikkö	000 m ³ 000 k-m ³
1. Forest exploitation (roundwood) (E ₁)	680
2. Sawnwood (E _{SM}) Sahatavara	4 910
3. Plywood and veneer (E _{PV}) Vaneri	595
4. Particle board (E _{PB}) Lastulevyt	334
5. Fibre board (E _{FB}) (165 000 ton) Kuitulevyt	369
6. Mechanical pulp (E _{MP}) (46 000 ton) Puuhioke	94
7. Semichemical pulp (E _{SP}) Puoliselluloosa	-
8. Sulphite pulp (E _{SIP}) (646 000 ton) Sulfiittiselluloosa	1 545
9. Sulphate pulp (E _{SAP}) (919 000 ton) Sulfaattiselluloosa	2 006
10. Secondary mechanical industry Toisen asteen mekaaninen teollisuus	?
11. Paper and paperboard Paperi ja kartonki	8 637
- paper (E _{PP}) (2 874 000 ton) paperi	
- paperboard (E _{PPB}) (1 165 000 ton) kartonki	
TOTAL YHTEENSÄ	19 170

Table 19. Energy (E), Losses (L) and Unknown (U) of 1972, expressed in roundwood equivalent
Taulukko 19. Poltettua (E), jätettä (L) ja tuntematonta (U) vuonna 1972 ilmaistuna reakapuun määränä

Unit of Transformation Työstöyksikkö	000 m ³ 000 k-m ³		
	E	L	E + L + U
1. Forest exploitation (e ₁ + L ₁) Metsän käyttö	8 070	5 950	14 020
2. Sawmill Sahateollisuus e _{SM} + (L _{SM} + U _{SM})	738	3 441	4 179
3. Plywood and veneer (e _{PV} + L _{PV} + U _{PV}) Vaneriteollisuus			1 012
4. Particle board Lastulevyteollisuus (e _{PB} + L _{PB} + U _{PB})			155
5. Fibre board Kuitulevyteollisuus (e _{FB} + L _{FB} + U _{FB})		760	71
6. Mechanical pulp (e _{MP} + L _{MP} + U _{MP}) Hioketeollisuus			760
7. Semichemical pulp Puoliselluloosateollisuus (e _{SP} + L _{SP} + U _{SP})			266
8. Sulphite pulp Sulfiittiselluloosateollisuus (e _{SIP} + L _{SIP} + U _{SIP})			4 020
9. Sulphate pulp Sulfaattiselluloosateollisuus (e _{SAP} + L _{SAP} + U _{SAP})			8 170
10. Other industries (e _o + L _o + U _o) Muu teollisuus			?
11. Secondary mechanical industry (e + L + U) SMFI Toisen asteen mekaaninen teollisuus			?
12. Paper and paperboard Paperi- ja kartonkiteollisuus (e + L + U) PPB			?
TOTAL YHTEENSÄ	8 808	9 462	32 653
% from 58 210 _{sta}	15%	16%	56%

Table 20. Summary of the transformation process of wood and fibres in Finland 1972
Taulukko 20. Puun ja puukuidun työstöprosessi Suomessa 1972

000 m³
000 k-m³

Stage of Transformation Työvaihe	Unit of Transformation Työstöyksikkö	Input Panos	Output Tuotos		Energy + Losses + Unknown Poltettua + Jätettä + Tuntematonta			
			Inter- mediate Consumption Välitön käyttö	Final Domestic Consumption Kotimainen. Loppukäyttö	Exports Vienti	E	L	E + L + U
1. Forest Metsä	Forest exploitation Metsän käyttö	58 210	48 840	670	680	8 070	5 950	14 020
2. Primary forest industry Ensiasteen metsäteollisuus	Sawmill Sahateollisuus Plywood and veneer Vaneriteollisuus Particle board Lastulevyteollisuus Fibre board Kuitulevyteollisuus Mechanical pulp Hioketeollisuus Semicemical pulp Puoliselluloosateollisuus Sulphate pulp Sulfiittiselluloosateollisuus Sulphate pulp Sulfaattiselluloosateollisuus Other industries Muu teollisuus	16 370 2 220 860 650 5 480 950 7 050 14 070 250	7 118 613 371 710 4 626 684 1 485 3 894	163 595 334 369 94 - 1 545 2 006	4 910 595 334 369 94 - 1 545 2 006	738	3 441	4 179 1 012 155 71 760 266 4 020 8 170
3. Secondary forest industry Toisen asteen metsäteollisuus	Mechanical secondary forest industry Toisen asteen mekaaninen metsäteollisuus Paper and paperboard Paperi ja kartonkiteollisuus	2 565 106 371 210 4 626 684 1 485 3 894		3 252 2 052	8 637			8 808 9 391 32 653

APPENDIX

BASIC EQUATIONS

- (1) $TD + I = C + E$
- (2) $TD + I = C + E + L$
- (3) $TD + I = (c + e - r) + E + L$
- (4) $TD + I + r = (c + e) + E + L$
- (5) $TD + I + r = c + E + (e + L + U)$

FIRST STAGE: FOREST EXPLOITATION (table 2)

- (6) $TD + I = C_1 + E_1 + e_1 + L_1$
 - (7) $C_1 = C_{1i} + C_{1f}$
 - (8) $TD + I = C_{1i} + C_{1f} + e_1 + E_1 + L_1$
- $$54,83 + 3,38 = \frac{42,84}{(9)} + \frac{0,67}{(22)} + \frac{8,07}{(24)} + \frac{0,68}{(23)} + \frac{5,95}{(24)}$$

Note: All the figures are expressed in mill. m³ with bark, excepting the figures in tons (recycling) that are followed by t.

The number in parenthesis () indicate the equation to which the amount above has been sent.

SECOND STAGE: PRIMARY FOREST INDUSTRY

Raw material (table 1)

- (9) $C_{1i} = C_{SM} + C_{PV} + C_{PB} + C_{FB} + C_{MP} + C_{SP} + C_{SIP} + C_{SAP} + C_O$
- $$42\ 840 = \frac{16\ 370}{(10)} + \frac{2\ 200}{(11)} + \frac{480}{(13)} + \frac{180}{(14)} + \frac{5\ 400}{(15)} + \frac{800}{(16)} + \frac{6\ 150}{(17)} + \frac{11\ 000}{(18)} + \frac{240}{(19)}$$

Sawmill (table 4)

- (10) $C_{SM} = PS_{di} + E_{SM} + PR_{SM} + e_{SM} + c_{SM} + (L_{SM} + U_{SM})$
- $$16\ 370 = \frac{2\ 565}{(20)} + \frac{4\ 910}{(23)} + \frac{4\ 553}{(12)} + \frac{738}{(24)} + \frac{163}{(22)} + \frac{3\ 441}{(24)}$$

Plywood and Veneer (table 5)

- (11) $C_{PV} = PPV_i + E_{PV} + PR_{PV} + (e_{PV} + L_{PV} + U_{PV})$
- $$2\ 200 = \frac{106}{(20)} + \frac{595}{(23)} + \frac{507}{(12)} + \frac{1\ 012}{(24)}$$

Residues (from domestic industry)

- (12) $PR_{SM} + PR_{PV} = R_{PB} + R_{FB} + R_{MP} + R_{SP} + R_{SIP} + R_{SAP} + R_O$
- $$4\ 553 + 507 = \frac{380}{(13)} + \frac{470}{(14)} + \frac{80}{(15)} + \frac{150}{(16)} + \frac{900}{(17)} + \frac{3\ 070}{(18)} + \frac{10}{(19)}$$

Particle board (table 6)

$$(13) \quad C_{PB} + R_{PB} = PPB_i + E_{PB} + (e_{PB} + L_{PB} + U_{PB})$$
$$480 + 380 = \frac{371}{(20)} + \frac{334}{(23)} + \frac{155}{(24)}$$

Fibre board (table 7)

$$(14) \quad C_{FB} + R_{FB} = PFB_i + E_{FB} + (e_{FB} + L_{FB} + U_{FB})$$
$$180 + 470 = \frac{210}{(20)} + \frac{369}{(23)} + \frac{71}{(24)}$$

Mechanical pulp (table 8)

$$(15) \quad C_{MP} + R_{MP} = PMP_i + E_{MP} + (e_{MP} + L_{MP} + U_{MP})$$
$$5\,400 + 80 = \frac{4\,626}{(21)} + \frac{94}{(23)} + \frac{760}{(24)}$$

Semichemical pulp (table 9)

$$(16) \quad C_{SP} + R_{SP} = PSP_i + E_{SP} + (e_{SP} + L_{SP} + U_{SP})$$
$$800 + 150 = \frac{684}{(21)} + 0 + \frac{266}{(24)}$$

Sulphite pulp (table 10)

$$(17) \quad C_{SIP} + R_{SIP} = PSIP_i + E_{SIP} + (e_{SIP} + L_{SIP} + U_{SIP})$$
$$6\,150 + 900 = \frac{1\,485}{(21)} + \frac{1\,545}{(23)} + \frac{4\,020}{(24)}$$

Sulphate pulp (table 11)

$$(18) \quad C_{SAP} + R_{SAP} = PSAP_i + E_{SAP} + (e_{SAP} + L_{SAP} + U_{SAP})$$
$$11\,000 + 3\,070 = \frac{3\,894}{(21)} + \frac{2\,006}{(23)} + \frac{8\,170}{(24)}$$

Other industries (table 12)

$$(19) \quad C_O + R_O = c_O + E_O + (e_O + L_O + U_O)$$
$$240 + 10 = \frac{250}{(22)} + 0 + 0$$

THIRD STAGE: SECONDARY FOREST INDUSTRY

Secondary mechanical forest industry (table 14)

$$(20) \quad PS_{di} + PPV_i + PPB_i + PFB_i = PSMFI$$

$$2\,565 + 106 + 371 + 210 = \frac{3\,252}{(22)}$$

Paper and paperboard industry (table 15)

$$(21) \quad PMP_i + PSP_i + PSIP_i + PSAP_i = PP + PPB$$

$$4\,626 + 684 + 1\,485 + 3\,894 = 7\,482 + 3\,207 = 10\,689$$

$$PP + PPB = (PP_d + PPB_d) + (E_{PP} + E_{PPB})$$

$$10\,689 = \frac{2\,052}{(22)} + \frac{8\,637}{(23)}$$

SUMMARY: FINAL DESTINATION OF WOOD AND FIBRES

Final domestic consumption (c)

$$(22) \quad c = C_{1f} + c_{SM} + c_0 + PSMFI + (PP_d + PPB_d)$$

$$c = 670 + 163 + 250 + 3\,252 + 2\,052$$

$$c = \underline{6.387}$$

Exports (e)

$$(23) \quad E = E_1 + E_{SM} + E_{PV} + E_{PB} + E_{FB} + E_{MP} + E_{SP} + E_{SIP} + E_{SAP} + E_{PP} + E_{PPB}$$

$$E = 680 + 4\,910 + 595 + 334 + 369 + 94 + 0 + 1\,545 + 2\,006 + 8\,637$$

$$E = \underline{19.170}$$

Energy, Losses and Unknown (e + L + U)

$$(24) \quad e + L + U = e_1 + L_1 + e_{SM} + (L_{SM} + U_{SM}) + (e_{PV} + L_{PV} + U_{PV}) + (e_{PB} + L_{PB} + U_{PB}) + \\ (e_{FB} + L_{FB} + U_{FB}) + (e_{MP} + L_{MP} + U_{MP}) + (e_{SP} + L_{SP} + U_{SP}) + (e_{SIP} + L_{SIP} + U_{SIP}) + \\ (e_{SAP} + L_{SAP} + U_{SAP}) + (e_0 + L_0 + U_0) + (e + L + U)_{SMFI} + (e + L + U)_{PP + PPB}$$

$$e + L + U = 8\,070 + 5\,950 + 738 + 3\,441 + 1\,012 + 155 + 71 + 760 + 266 + 4\,020 +$$

$$= 8\,170 + 0 + 0 + 0$$

$$e + L + U = 32\,653$$

$$(5) \quad TD + I + r = c + E + (e + L + U)$$

$$TD + I + r = 6\,387 + 19\,170 + 32\,653 + 130 \text{ t.}$$

$$58\,210 + r = 58\,210 + 130 \text{ t.}$$

$$c = 6\,387 \quad 11 \%$$

$$E = 19\,170 \quad 33 \%$$

$$e + L + U = 32\,653 \quad 56 \%$$

$$r = 130 \text{ ton.}$$



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