

R E P O R T
O N
THE SURVEY FOR THE DEVELOPMENT PLAN
OF THE FOREST RESOURCES IN CHILE

MARCH 1964

OVERSEAS TECHNICAL COOPERATION AGENCY
TOKYO, JAPAN



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P R E F A C E

The Government of Japan, in response to a request from Chilean Government, entrusted to the Overseas Technical Cooperation Agency (OTCA) the task of conducting a preliminary survey in Chile to help the implementation of the Development Plan of the Forest Resources. The OTCA fully realizing the importance of the Development Plan of the Forest Resources in Chile organized a five-member team of experts and dispatched it to Chile on November 19, 1963 for about 30 days on-the-spot survey under the leadership of Dr. K. Kitahara, Assistant Professor of Tokyo University.

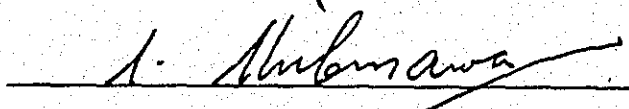
The OTCA which was established on July 1, 1962, serves as an executing agency of the Japanese Government to conduct Japan's government-level technical cooperation to Asia, Near and Middle East, Africa and Latin America. Its principal activities are acceptance of overseas trainees, assignment of technical experts, establishment of overseas technical cooperation centers and conduction of preliminary surveys for development projects.

It is my sincere hope that this report will prove to be useful in the field of the Development Plan of the Forest Resources in Chile and will also help to foster closer technical ties and better understanding between Chile and Japan.

Lastly, on behalf of the OTCA, I wish to take this opportunity to express our greatest appreciation and sincere thanks to the various agencies of Chilean Government for their precious help and cooperation given to the Survey Team, without which it would not been possible for the Team to conduct smoothly the survey on the spot.

March, 1964.

Shinichi Shibusawa
Director General



Overseas Technical Cooperation Agency

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OVERSEAS TECHNICAL COOPERATION AGENCY

TOKYO, JAPAN

I. The Introduction

The Survey Team for the Development Plan of the Forest Resources was dispatched to Chile by The Japanese Government and stayed there from November 19 to December 16 1963.

The Team visited Santiago at first, and then travelled through central part of Chile to Puerto Montt by a government car, investigating the forest resources, and flew from Puerto Montt to Coihauque by Chilean Air Force airplane to investigate a virgin forest in the southern part of Chile. On the way, we visited many sawmills, pulp and paper mills, particleboard plants and furniture plants, with excellent assistance and kind guidance by a Chilean engineer of Forest Bureau of the Ministry of Agriculture.

We are very grateful for kindness shown to us by many people, publicly or privately. We certainly owe much to kind help of many Chileans that we could go anywhere without any trouble and difficulty even in the Southern part of Chile. Once we were forced to land at Alto Palena, very near the border line of Chile and Argentine, but the border guards and village people were very kind and generous.

We shall never forget that precious experience.

We also appreciate the opportunity to study an excellent plantation of Insignis Pine and a virgin forest in Chile from the scientific and economic standing points. For, these forests shall be taken a close up evaluation all over the world in the near future, especially by Japan which has maintained good relationship and friendship with Chile for many years.

In Chile, we saw many difficult but very interesting problems caused by special conditions of Chile. The study on the utilization of wood must be done from both scientific and economic view points.

From these points, we would like to mention some of our ideas for the utilization. Due to such a short time of staying in Chile, it will be impossible to understand the problems fully in detail without having some faults and errors. We hope, however, this report might help in some ways in utilizing the resources and developing forest industry.

The members of the Team are as follows:

Chief : Dr. Kakuichi KITAHARA

Assistant Professor Department of Forest Products,
Faculty of Agriculture, Tokyo University.

(Specialist in Sawmill, Plywood, Fiberboard,
Particleboard.)

Member : Mr. Toyotaro TAKEDA

Chief of Wood Working Section, Tohoku Branch of
Industrial Research Institute.

(Specialist in Handicraft.)

" : Mr. Minoru SHINSHO

Acting Manager of Forest Engineering Section,
Oji Paper Mill Co.

(Specialist in Forestry and Forest Engineering.)

" : Mr. Toshio YAMADA

Acting Manager of Research Section, Marketing
Research and Planning Department, Jujo Paper Mill Co.

(Specialist in Marketing.)

Member : Mr. Hiromitsu MORIYAMA

Member of Engineering Section, Sanyo Pulp Manf. Co.

(Specilist in Engineering of Pulp.)

I I. F o r e s t r y

1. Afforestation

We have heard and read on the plantation of Insignis Pine, Eucalyptus and improved poplar in Chile through forest journals or independent volumes.

We examined the plantations with unaided eyes, and were surprised at its nice condition and its richness and potentialities in forest resources.

There seemed to be no problem in Chile so long as these species are planted, because we saw no failure in the plantation and no wood diseases in the forest.

In Japan we had to clean planting area three times a year on an average for the past eight years and struggle against wood diseases. For example, 60,000 hectares of the larix plantation sustained damage in Hokkaido last year, 1963.

Insignis Pine grows very fast. The forest can have 465 cubic meters in stock in 20 years, but Japanese forest of Sugi (*Chamaecyparis obtusa* Sieb et Zucc.), which grows fastest in Japan, has only 200 cubic meters in stock in 30 years on the best site quality of locality.

Chile is a Heaven for foresters in the literal meaning.

But it is a regret that we could not see good management in the virgin forest in Southern part of Chile. There are very good wood resources, especially hardwoods, but they are being extinguished by farmers on forest fires without the useful utilization.

This fact depends upon some opinions of forest owners, the economic conditions, the demand in market, the wood technology, and so on. We would like to investigate the utilization of wood resources as much as possible from a standpoint of engineers, who specialize in wood technology, as well as in paper and pulp manufacturing, and write some comments and suggestions on it in the following chapters.

2. Logging

There shall be no problems in planting area with Insignis Pine, Eucalyptus and improved poplar, for timbers have almost the same quality in size, and almost all forests stand on gently sloping hills. The logging machine, including yarder, shall be easily used if a forester wants.

In virgin forests, logging shall be not so easy as in planted forests, for virgin forests stand mainly on the mountains with seven slopes and partly on hills.

There shall be possibility in using logging machines. It might be a good plan to use yarder with wire rope in transportation of timber in the mountains of the southern part of Chile, which have seven slopes. As to this problem, some opinions shall be mentioned in the next chapter.

When timber or lumber is transported by motor truck, some types of crane should be used to increase the efficiency of loading.

Anyhow, we are surprised at seeing too small load on a truck. In general, Japanese truck loads up 1.3 cubic meters of wood per

ton of its loading capacity on an average. The transportation cost of wood is a very important factor for wood industry, for products of wood industries have generally and comparatively heavy weight and large dimension.

III. Wood Technology

We have heard and read on the resource of wood in Chile. The useful woods in Chile were already introduced in 1923 on the Journal of Japanese Forestry Society.

But, the introduction was written only from the academic standpoint, for the resources of woods had been rich in Japan and a very small quantity of timber was imported at that time from such foreign countries as Canada, U.S.A., U.S.S.R. and Southeast Asian countries.

Today a great quantity of timber and lumber, has been imported mainly from the Far East Asia for plywood and from North America and U.S.S.R. for building material and raw material of pulp and paper, as Japan does not provide with enough the forest resource. Now, the monetary value of imported wood ranks third in Japan and wood is one of the most important materials imported from foreign countries.

Seeing with our own eyes, Chile is very rich in forest resource. We should say the resource is too rich to develop wood industry in Chile. Only a hungry wolf can get meat by making efforts.

Before now, truly remarkable progress had not been seen in Japan. It has only begun from the time, when the resource of wood began to be wanted and the demand of wood exceeded the supply.

The wood technology and practical technique have made considerable progress in the last ten years both in chemical and physical utilization of wood. In pulp and paper industries, hardwoods of many species have been used for many years, because conifers are wanting and expensive in Japan. The cost of needle leaved trees is twice higher than that of broad leaved trees, and Japanese pulp and paper mills have to use broad

leaved trees. There were many troubles by using many species, but we have taken away these troubles by intensive research and hard efforts.

We have been seeing the remarkable progress being simultaneously made in Japan in every field of wood industries, such as plywood, particleboard, fiberboard, lumber core plywood, and so on. 40 daylights hot press in plywood plants tells us how amazingly the progress has been being made now.

We may divide forests into two parts in Chile. One is the district with Insignis Pine and the other, that of the virgin forests. The former also includes Eucalyptus and improved poplar. Therefore, we must investigate the utilization of resource of wood in Chile from the points above mentioned.

In northern district, Insignis Pine district, pulp and paper mills and sawmills seem to have no problems to be solved, for the species of timber are limited and the timber can be gathered from very near forest. The products of pulp and paper are very good for less efforts. The less efforts may be able to solve a problem even when it is found in factory, and it is suggested that some research and tests be taken to solve these problems.

In the southern part of Chile, the resource of wood is very rich. But the resource is being mostly destroyed without any profitable utilization though much resources remain in unexpected virgin forests. We believe Chile has very good hardwood forests which will lead Chile to one of the greatest timber countries in the world in the future. There are very few forests to produce large timber in the world, from which we can make lumber with very fine grain and attractive color for annual

rings. In the countries of the Northern Hemisphere the diameter of a tree is rather small, and in the tropics woods generally have no good grain for annual rings.

The Chilean virgin forest is one of the most precious at present and in future as well. In the near future its value will be fully realized.

It is hard to understand why wood resource in virgin forests is not utilized so much. In Hokkaido Prefecture, the northernmost island of Japan, there are many species of hard wood, and we have exported sawn lumber (mainly 1" thickness) to Europe for many years and plywood to U.S.A. (16,000,000 m² per year). The timber is hardwood.

In general there are many species in virgin forest of hardwood, and its mechanical and chemical properties are much varied. To begin with, we have to study the properties of woods. In Japan about 400 students have been sent out from the Japanese universities (departments of forestry or forest products) to wood industry. The Japanese Government has established the Government Forest Experiment Station in Tokyo. The station has chemical and wood technology divisions for research on wood utilization. The Wood Technology Division consists of three sections; wood physics, improved wood and woodcutting.

On the other hand, almost every prefecture has its own institute for wood utilization. Hokkaido Prefecture has established a special research institute by itself. The Institute is very rare in the world. It possesses both laboratories and test plants for sawmill, drying, plywood, lumber core plywood, particleboard, fiberboard, flooring and furniture. The plants are producing in semi-economical scale. The

staff members often change their works so that they may engage in both practical work and research work. They are always studying practical problems on wood utilization from scientific and practical standing points. The institute, therefore, has been obtaining very useful results for wood working factories and has sent many experienced engineers to companies of wood industry.

Only the institute of this type can develop new type of utilization of wood in economical scale, when many species must be used as raw materials.

In Japan, for example, Buna (*Fagus crenata* Blume) was not used about twenty years ago. However, as its stock was very large in Japanese forests, the Ministry of Agriculture began to study the possibility of its use in co-operation with Government Forest Experiment Station and Japanese universities, and built some sawing and drying factories in several districts and succeeded in a few years in finding out the way of its use, mainly in furniture manufacturing and flooring industries. Now, Buna is one of the most important wood species in Japan.

Then, some suggestions on wood technology in Chile will be mentioned in the following chapter.

1. Sawmill

There are many sawmills in various scales all over Chile. In the districts where Insignis Pine and Eucalyptus are planted, the species are only two and raw material can be gathered from near forests with very low cost whenever wanted. In Japan, the transporting distance from forest to mill is about 200 kilometers on

the average and the price of coniferous wood for sawmill is from 30 to 40 U.S. dollars per cubic meter. In Chile, however, the price of the timber as raw material in sawmill is about 3 U.S. dollars. The price is calculated on the exchange rate of 3 Escudo to 1 U.S. dollar. Japanese price is very expensive and, what is worse is that the quality of timber is not so good as in Chile with the exceptions of Sugi (*Chryptomeria japonica* D. Don) and Hinoki (*Chamaecyparis obtusa* Sieb et Ducc.).

In Chile, we saw very good sawmills in European style which have fram saws and edger with double circular saws. The efficiency of sawmill is very high and the products are very fine in quality. In these sawmills we have no words to say. But we could not see so many good sawmills as expected. Most of them have only circular saw driven by a small steam engine. The fuel of the engine is the waste of sawmill, which is produced by the edger. The horse power of steam engine ranges from 6 to 16, and it is too small to drive a large circular saw or band saw with adequate speed to saw timber accurately.

It is necessary to have sufficient horse power to raise up productivity and to produce sawn lumber with very small labor.

In Chile, these small sawmills are mobile and transfered to a forest which is clearly cut. When the woods are consumed, the machines are carried to the next forest. This system of sawmill should be given up so that the higher level of sawing technique might be acquired. It is possible, as the main markets of sawn pine lumbers are in Santiago and most of them are sent to the city.

First of all, sawmill should be built in a city or in a town, where we can get sufficient power to operate sawing machines, and can train workers in both sawing and teeth setting. The owner of sawmill shall be able to have chance to control its management at any time. If necessary, proper machines can be set, which can run for long time in a good condition. At first they might seem to cost high, but the depreciation of them shall be done in a relatively shorter time by their high productivity. Only proper machine can maintain high productivity. Of course, the sawn lumber by it has accurate dimension. To develop the market of sawn lumber, its dimension should be standardized. In other words, the tolerance is smaller, the door of market shall be opened wider. We have seen the lumber planks, transported to a furniture manufacturing factory, was planed with planer just before artificial drying in order to make the thickness roughly in uniform. The plank, of course, was planed again after drying. Such a fact cannot be seen in the countries which have wood technology on an ordinary level, for the yield of sawn board is reduced and more labor shall be necessary in a factory on a lower level.

The sawn board above mentioned was not soft wood but hard wood. The same might be true of soft wood.

We should like to say again that first of all a sawmill must be set in a fixed place to arrange more excellent machines and to have good workingmen.

In this case, we must transport timber as raw material from forest to a mill. But in the central part of Chile where Insignis

Pine is planted, the forest is very near from city or town, and the transportation of wood is not difficult at all.

In the southern part of Chile, we saw a very fine virgin forest of hard wood. The forest has many different species, but the species are not so many as in the tropical forest, but almost similar to those in the Northern part of Japan. We can find out occasionally pure forest of some species in Japan. It is not so difficult to gather a proper quantity of the wood of the same species in some place. It is very desirable condition for wood industry.

We, however, cannot use only one species all the year round, except for a few species.

When compared the price of hard wood in Chile with that in Japan, the price in Japan is about 50 U.S. dollars per cubic meter on an average at the yard of sawmill, but the price of lumber for plywood is more expensive as mentioned afterwards. The price in Japan is far more expensive than in Chile, even when the price is about 10 U.S. dollars in Puerto Montt. We cannot understand why wood industry, for example, sawmill which is the most simple and fundamental industry, is not well developed in Puerto Montt. It is right to say that the market of sawn hard wood lumber is too narrow to establish many saw mills. But we shall be able to have some foreign markets in the world. Europe and North America are wanting hard wood with fine grain and beautiful natural color for furniture.

We know the most difficult problem is the transportation of products from Chile to the markets. We, no doubt, cannot use

local shipping line, as it costs too much. For example, Japanese transports lauan wood from Borneo Island by exclusive ship. The cost is less than that of transportation from there to Singapore Port by a local ship. We must have exclusive ship for wood transportation in the district where shipping is very few. On the relationship of Japan and Chile, the cost of wood transportation from Tokyo to Seattle in west coast of U.S.A. is 25 U.S. dollars, but it is 58 U.S. dollars per 1000 B.M. from Valparaiso to Tokyo by ordinary ship. The cost shall be more expensive in southern part of Chile. The problem of transportation of wood and its products should be solved with further investigation.

When the problem is solved, I believe Puerto Montt will be one of the best place for hardwood industries. Sawmill, plywood and lumber core plywood have their potentialities in there. Puerto Montt is an ice-free port, and has very good fore-and back-grounds where the resource of hardwood is very rich. There we can gather good shape lumbers with fine grain and color in proper quantity whenever demanded. The transportation of lumber from forest to factories will be done easily, for railroad or truck on the land in background and raft or ship on the sea in foreground might be used. The coast of the sea in foreground is very deep and the forest is adjacent to the coast. What is better is the fact that Puerto Montt has proper population for wood industries and weather is very fine all the year round.

We can expect many wood industries in Puerto Montt, for Japan has been importing raw timber from foreign nations by an exclusive

ship. The imported timber is used not only for pulp and paper, but also for such the other wood industries as plywood and furniture.

Puerto Aisen is also a very good place for wood industries. Near the city, we can find out other good resources of wood in virgin forests.

In southern part of Chile we did not see sawmills on a large scale. The conditions of sawmills are quite the same in central Insignis Pine districts, using circular saw driven by small steam engine. The products of sawmill, then, have only low quality in dimension and sawn surface. We would like to guggest again that the products in low quality can not open the mouth of its market. The market of wood products is narrow in Chile, but we can find out foreign markets in the world, for Chilean wood is very good in properties. But it must be dried artificially before exporting and have precise dimensions.

In order to produce sawn products of precise dimensions with less tolerance, sawing technique on a high level is required, and a band saw with strong machine body must be set. The factories must be established in cities or towns and must be fixed there. Only in these factories we can train workingmen in sawing and teeth setting, and get sufficient power for sawing. Sawing of hard wood needs higher technique than that of soft wood, for the product of hardwood is generally more expensive in a wood market. In this case, of course, raw timber needs to be transported from forest to factory. The transportation of timber will not be so serious problem in sawmill management in Chile.

First of all, the sawmill should be established in city or town and should be fixed there and use band saw with strong body and bed. The machine can produce sawn lumber in high quality and can enlarge its market in both Chile and the world.

2. Drying

When wood is used adequately, it should be dried previously. There is no good market for wood not dried artificially. The reason is understood from a practical viewpoint, and the explanation of it is omitted here.

In Chile, we did not see many wood drying kilns, and it is a very poor thing judging from the standpoint of wood technology. When wood is artificially dried, its equilibrium moisture content is less than naturally seasoned wood. It means less shrinkage during the use. The warp, checks in wood surface, gaps of joint, and so on are caused by changes of moisture content of wood, and these defects make the market narrow.

The drying technique of soft wood is easier than that of hard wood, and there shall be no problem as to Insignis Pine wood. High temperature shall be required to dry it in a short time.

What we must pay attention is how to dry hard wood without any drying defects. There are many useful species in southern virgin forest, and each species should be dried the best suited way according to its nature. The distinctive properties by artificial drying are very different from one another. It shall be evident in Northofagus wood, imaging from the case of Fagus wood in Japan.

Fagus wood is one of the most difficult species to dry.

First of all, the distinctive properties of artificial drying should be tested by routine method in laboratory. It is not difficult and shall be easily done only if the people who are handling and has connection with wood wish so. The practical condition of kiln drying should be determined on each species with reference to the results in laboratory in order to make no drying defects.

When wood is dried with proper moisture content, the market shall be extended and the price of wood will be possibly controlled according to the amount of storage in warehouse.

The proper moisture content should be 10 per cent on an ordinary market, but 7 - 8 per cent shall be better in the districts with very low relative humidity in the open air.

When the sawn lumber is exported, it must be dried without exception.

Only artificial drying of wood can establish a new market and extend the present market.

In Japan, Buna (*Fagus crenata* Blume) has been able to cultivate a good market after the drying method of it was developed as already mentioned. It is a very important fact especially when new species of wood begins to be put on a market.

We have seen many small scale furniture makers in Santiago. They are manufacturing very fine furniture in European style. They should use portable drying kiln. Its capacity is very small and is not expensive. The waste of planer in the factory, might be used for fuel when its capacity is only from 1.5 cubic meter to 3 cubic

meter. No boiler man is needed and it can be operated only in daytime. The dry kiln chamber is so small and the velocity of hot air is so sufficient that the variety of moisture content in dried lumbers is very small.

In Japan, small scale furniture makers are using more than 2,000 kilns of this style in their factories, and they can use the wood, knowing its moisture content.

3. Plywood and Other Improved Wood

In Chile, plywood industry is not so well developed. The capacity of plywood depends upon the shape and properties of lumber used in the factory.

The species now being used is mainly Araucaria. We will not discuss Araucaria plywood question for we have heard the resource of Araucaria is rapidly wanting in the virgin forest of Chile.

We should state on new plywood whose potentiality is large in Chile. It is hardwood plywood and its raw material is hardwood produced in the southern part of Chile.

In Hokkaido Prefecture, the northernmost island of Japan, there are many species of hardwood. We are producing hardwood plywood using them and exporting it to U.S.A. (16,000,000 m² per year) as mentioned already.

About five years ago, we manufactured plywood with the same species wood; The face, back and core veneer were made from the same species. At that time the production was very small, as we could not develop it, and were controlled to manufacture veneer with

rotary lath.

Now, we are using lauan core veneer, which is imported from the Far East Asian countries. We have been maintaining high productivity by using lauan lumber. In this case, of course, only face and back veneer are made of some domestic species woods which U.S.A. markets welcome highly. The production by a workingman per month has attained ten thousand square feet per month (but the production in lauan plywood factory is sixty or seventy thousand square feet per workingman per month with thirty or forty daylight hot press).

This is very interesting fact for Chile. If we find out some proper species for core veneer, we can make mass production of hardwood plywood in Chile. The species for core veneer may be either softwood or hardwood. But its resources must be rich and easily gathered in proper quantity all the year round. When we cannot find proper softwood for core veneer, we may use hardwood which can be got in low cost and has proper diameter, fitting to make core veneer.

When we use slicer for surface veneer of hardwood, we can manufacture very high class plywood.

We believe the Chilean hardwood plywood can find a new market not only in U.S.A., but also in Latin America.

There is no anxiety on the resources of wood which fit for surface and back veneers.

As a reference, the proportion of lumber and transportation cost to the production cost in Japan shall be shown in the next. These figures are obtained in hardwood plywood factory in Hokkaido Prefecture, the northernmost island of Japan, where forest is much

alike the Chilean one in character. The percentage of lumber cost is 56 per cent and that of transportation of products to their markets is about 10 per cent. The products are mainly exported to North America. In Hokkaido the cost of lumber is very expensive, but in Chile very cheap.

Then, we think the cost of lumber shall be able to make up that of transportation by some means even when the plywood is exported to far markets.

On the other hand, we can consider lumber core plywood, too. The wood of Insignis Pine will be better for lumber core. It has better properties for being sawn to strips by gang rip saw, and being dried in dry kiln. The lumber core machine is not so expensive. The surface veneer, of course, is made of proper hardwood produced in the virgin forest. The lumber core plywood veneered with hardwood has been opening up very good foreign and domestic markets and been used in large quantities in ordinary furniture and sound furniture industries all over the world.

But the lumber core plywood has to compete with particleboard on the market. And the economic conditions should be carefully investigated in Chile. Generally speaking, particleboard has more competing power than lumber core plywood.

4. Particleboard

We visited a new particleboard plant in Valdivia.

In general, particleboard industry should be undertaken in a country with less wood resource. When the industry is undertaken in a country rich in wood, it can not expand its activity, because ordinary particleboards have almost the same properties as natural wood though some of them have been improved. The use of particleboard is mainly for the core material in improved wood. In other words, particleboard should be dressed with other materials (veneer, plastics or paper), even when it is used for building. But we must often use it as building material without dressing. In this case, the density (specific gravity) should be higher and thickness of surface chip (flake) very thin. That is because the surface of particleboard has a tendency to become rough when it is exposed in the high humid air or is used for a long time in low humidity even if it is coated with paint. The hot-pressed surface chip swells by absorption of moisture. The swelled chip catches dust in the air, and the surface of board becomes dirty.

On the mechanical properties, particleboard is not so good as natural hardwood. For examples, the Young's modulus of particleboard is about one tenth of natural wood, the impact resistance and the creep limit are especially low; and particleboard needs to be dressed with some other materials when its specific gravity is ordinary or lower and the resin content used as binder is not much. But it is not advisable to use too much binder in order to increase the strength of particleboard.

We envy a particleboard plant in Chile, for the plant is using only Insignis Pine as raw material. In Japan, we have to use more than forty species of wood at the same time. When the board is made with many species of wood, it is very difficult to control the thickness of the particleboard just hot-pressed. In hot-pressing, the resistance of compressive deformation, relaxation of stress, absolute water content (g) $\sqrt{\text{not moisture content (\%)}}$, moisture content, passing out of vapour from board, and so on are different by each species. These factors influence the thickness of board when it just finished hot-pressing. These influences become more evident when many species are used as raw material. The thickness of particleboard must be controlled by sanding. We must sand off about 1 - 1.5 mm on both faces when twenty or forty species are used as raw material. It is nonsense from economical point of view to grind off 1 - 1.5 mm the surfaces of board, but it must be done to put on the market and the industry in Japan cannot survive without having a good market.

We, therefore, envy the particleboard industry in Chile.

But, Chilean particleboard industry has a very short history and has not yet obtained a good market like Japan of ten years ago. It is very difficult to find out the easy way to secure good market, competing with natural sawn lumber in a country rich in wood resources. In Japan the wanting of wood resource has brought the good market for particleboard.

The production shall have to be enlarged by expanding with hard efforts its market in future. At that stage, the narrowest path in

production shall be confined in hot-press, for other paths can run on the parallel. In hot-press, we can attain our purpose to increase the production by, both using high temperature of hot plate and adding more hardener to synthetic resin as binder. But too high temperature of hot plate causes decrease of board thickness by previous stress relaxation and damage to chips (flakes) in outer layer of particleboard, especially when softwood is used as raw material. As a result, bending strength and tensile strength perpendicular to surface decrease considerably. We, then, should use more hardener for synthetic resin by spraying separately or controlling catalyzer (for example NH_4OH for hardener NH_4Cl in urea resin).

The dressing method depends upon the circumstance of the country. The methods in other countries are merely helpful for reference. The demand of market decides the method of dressing, and wood technology should follow it as far as possible. In Japan, particleboard is often dressed with 0.3 mm veneers in minimum without cross bands. It has been demanded by user and the technique of dressing has been succeeded in this with intensive research and practical tests. This technique has been able to reduce the cost of dressed particleboard. In Europe we cannot see such a technique of dressing with very thin veneers. The dressed particleboard in low cost shall suit for mass productive furniture, which in near future should be manufactured for both domestic and exporting demands.

The dressing materials may be patterned paper or plastics, but in Chile we are able to use veneer of hardwood which has fine grain and color. In Japan, we are exporting the particleboard dressed with hardwood veneer, but its quantity is small. And in Chile it shall be good business as well as lumber core plywood dressed with hardwood veneer.

The transportation of the products, of course, should be carefully considered from economic standpoint.

5. Fiberboard

We are very sorry that we had no good chance to see any fiberboard plant in Chile, but we saw the products put on the market in Santiago. The properties of it was good, it can be judged by the surface of sawn end section.

The raw material of fiberboard shall be Insignis Pine, and the troubles shall be very few in the factory. The wood of Insignis Pine shall be used from now on because of its very low cost in Chile. And, the troubles shall be few, too, in the future. In Japan, we are using hardwood and softwood mixing. The power consumption of softwood is larger than that of hardwood in defibrater and the properties of hardwood fiberboard are rather better than that of softwood board.

Resulting from this experience, it has potentiality to use low quality hardwood as raw material for fiberboard, especially for hardboard. The softwood as raw material for insulation board is rather better from the standpoints of forming of wet mat and

properties of the board.

We, anyhow, must defibrate raw wood chips to have proper proportion of fiber bundle, single fiber and fine. The proportion of those three is one of the most important factors to effect the properties of fiberboard. The fiber bundle acts as frame, single fiber as muscle and fine as filler in forming of wet sheet. The proportion of them decides the freeness of raw material (raw pulp) and condition of hot pressing, and in its turn influences the final properties of fiberboard. A good fiberboard cannot be produced without paying attention to this proper proportion of raw pulp in forming line.

The kinds of fiberboard are classified as follows; hardboard, semi-hardboard and insulation board. There is a problem as to which shall be mainly produced. In fiberboard industry the capacity of production, if a plant should be rather great from economic points, but the market is small in Chile. Some products, then, should be exported to the other Latin American countries with low exporting and importing taxes. The supply of fiberboard is over the demand all over the world with the exception in Asian countries. Then, in Chile the production capacity of fiberboard should be carefully decided, considering the competition with North European countries in Latin America.

In a domestic market, the fiberboard is mainly used for building. In this case, the technique of dressing on the surface of board with other materials and painting of it should be considered to maintain or enlarge the market. In a certain sense the price of

fiberboard can be raised up by this technique. In Japan the price of hardboard (its thickness is 3.5 mm) is about one thirtyth of U.S. dollars per square feet. But this price may be expected to become 17/360 U.S. dollars by printing some pattern at the same factories. It is economically very important in competition with other companies or foreign countries.

Finally, we would like to mention on dry process (air felting process) of fiberboard. In Japan, there are four plants of dry process. The manufacturing conditions are very difficult and have not yet been perfected at present in the world. The machines used for are expensive and the main problem in a factory is how to control the moisture content of raw pulp just before hot pressing, for the moisture content of raw pulp is one of the most important conditions to decide the properties of board. On the contrary, the manufacturing technique of wet process has been already satisfactorily established.

However, the property of board manufactured by dry process for printing is better than by wet process. In addition to it, dry process does not use so much water as wet process and is economical in heat consumption.

Attention should be paid when the dry process (air felting) of hardboard is introduced to Chile.

6. Flooring

In Chile, flooring industry has a very high potentiality by using wood resources in the virgin forest in the southern part of the country.

As timber in virgin forest has a large diameter, flooring with long strips can be made easily. But parquet and mosaic parquet flooring should be produced at the same time. The large timber shall be able to raise up the yield of the production.

At a present time, wood flooring industry is competitive, for examples, plastics, hardboard and combined flooring with them, but the flooring made of natural solid wood is still liked by many people for its elegance and other good properties for flooring all over the world. This phenomena shall continue permanently.

When flooring with long strips is manufactured, it is profitable to use large timber in length and diameter. As for reference, the yield of raw strips for the flooring obtained at Hokkaido Forest Products Research Institute in Japan (explained in the preface of this report), shall be written in following table.

From this table we shall know that Chilean wood of virgin forest is profitable for flooring.

Timber

Species	Length of lumber (cm)	Diameter (of lumber) (cm)					
		16-18	20-24	26-30	32-38	40-46	Ave.
Oak (Quercus)	< 50	—	6.8	6.3	5.7	7.2	6.3
	> 52	—	20.2	21.5	21.9	26.1	22.0
	Total	—	27.0	27.8	27.6	33.3	28.3
Maple (Acer)	< 50	11.2	7.1	6.3	6.4	—	6.7
	> 50	8.0	16.4	18.5	19.0	—	17.7
	Total	19.2	23.5	24.8	25.4	—	24.4

Notes: Thickness of strips: 2.2 cm., Width: 9.6, 8.2, 7.0 cm in main products, 5.0, 4.0, 3.0 cm in by-products and length: > 32 cm 2 kinds, > 52 in only C grade.

Parquet and mosaic parquet flooring may have good domestic and foreign markets and to raise up the yield of production as Japan does.

Flooring with long strips depends upon the technique of sawing and drying in high level of technique in order to give the products accurate dimension without reducing the yield. In the case of parquet and mosaic parquet flooring, the high level technique is necessary. The reason is the same in long strip flooring. For this purpose, stationary sawmills, not mobile, should be established in a city or in a town as already mentioned in sawmill section, and artificial drying of green lumber should be taken as a fundamental condition.

7. Handicraft

Wood handicraft is a very good industry in a country where labor price is very low and women workers are abundant.

The production of handicraft is easily imagined in Chile. There are many species which have specific gravity from high to low and fine color from dark to light, and we can easily get wood which has proper hardness and good properties for cutting.

On furniture manufacturing industry of European style, we need not to say many words, for the furniture is excellent. But the green lumber should be artificially dried to develop its utilization for furniture. The furniture in classical style is so elegant that we cannot neglect drying process of its green lumber in dry kiln.

We can imagine furnitures in modern style knocked down for mass production, by which we can reduce the transportation cost of furniture to a domestic or foreign market and enlarge the market. The knock down furniture manufacturing industry, indeed, needs high level wood technology in sawing lumber, drying, cutting and planning.

As other wood handicraft, wood milling shall be imagined. The products by milling shall be legs of desk and chair, knob or grip, other parts of furnitures, and so on. Raw lumber shall be gathered according to its properties needed. Chilean virgin forest shall have potentiality to produce the timber needed in proper quantity.

The scale of this industry cannot be large and should not be so. It is better to be small. Many factories must be established here and there in a small scale. It is rather better for gathering raw material and other conditions.

In this case too, the green lumber should be dried artificially before milling. The quantity of dried wood needed as raw material is very small, and some portable lumber dryer should be used as above mentioned in drying section of this report.

The market of milling products shall not be good in Chile for the time being and the rapid development cannot be expected in the near future, for the demand depends upon other industries.

The foreign market, however, has been opened for any country especially in North America when the products have precession in dimension and moisture content control.

The semi-finished products, raw parts of furniture, shall have possibility to be exported to foreign markets and Chile has the ability to do it. In this case, the designs of parts shall be sent from importing countries.

The production by handicraft can reduce cost of transportation. The cost of transportation is one of the most important problems in wood industry in Chile.

The troubles in a country which has good wood resources are less than in poor country on wood. There are many possibilities in the future that people can produce any wood products by research and efforts but the research or tests on the wood technology should be started at once in Chile.

IV. Pulp and Paper Industry

1. Preface

Following is the gist of our findings, together with a few comments, which we think will be of interest to the Chilean Government authorities concerned.

2. Summary of the findings of the Survey Team

It shows a potentiality of developing a most progressive pulp and paper industry in South America with its vast plantations of Insignis pine in the area around Concepcion.

The country's pulp and paper industry has already attained to a pretty high level. Particularly, the quality of Insignis pine as the raw material of pulp and paper and the localities of the plantation areas near pulp and paper mills are so good that it is hard comparably to find favorable conditions in Japan.

It was noted that both the Government and the people had vigorous interest for the promotion of pulp and paper industry.

Insignis pine plantation around Concepcion, however, is only 350,000 ha. in area and leaves little surplus after supplying pulpwood for the existing and planned mills.

Measures have to be taken to augment the plantation. Regarding the establishment of pulp and paper mills in the area, Japan is in a position to be able to contribute a great deal by exporting modern and efficient pulp mills and by according assistance of pulp and paper manufacturing technology. However, in so doing, it is important for Japan to make aggressive efforts in order to give

informations and let the people of Chile familiarize with the conditions of the Japanese pulp and paper industry. The virgin hardwood forests in the South are mostly undeveloped, but the species found there are good enough to be utilized as pulpwood.

There are relatively unmixed forests (pure stands). They are very promising secondary resources to be utilized for the pulp and paper industry of Chile. As for the location of mill site, the area is naturally inferior to the plantation area, and the conditions are in no way unfavorable. In view of the fact that the utilization of the virgin broad leaved wood forests, if realized, will affect a great deal on the development of both the Chilean economy and the pulp and paper industries of the Latin American countries, efforts should be made for the establishment of pulp and paper mills utilizing hardwood by conducting more detailed investigations.

3. Recommendations for the Chilean pulp and paper industry

There are, in fact, many things to be praised for the current conditions of the Chilean pulp and paper industry. Problems to be pointed out and recommendations to be made concerning the industry are very few.

To be praised, in particular, are the fine softwood forests in the Central South districts, the modern pulp and paper mills have been already established there, and the vigorous exports which are being made after fully supplying domestic requirements. Furthermore, there is a permanent office of the United Nations Pulp and Paper Advisory Group of Latin America at Santiago, which published

a report entitled "Chile Potential Pulp and Paper Exporter" in 1957. There is also the Instituto Forestal which is working for the industrial utilization of forest resources.

Under these circumstances, it is indeed beyond our capacity to make recommendations for the Chilean pulp and paper industry after making a very brief visit there. However, the reporters would like to make few comments, which are more of our impressions in nature.

a) The quality of papers currently produced is not so good, considering the superior raw materials and producing facilities. This is partly due to insufficient experience in the technology, but it is considered to be caused by the fact that practically all the pulp and paper productions in the country have been monopolized by one company, leaving no room for inter-company competitions. Domestic demands are already supplied fully, and the products of new mills are totally shipped to foreign markets. However, paper consumption level in the country is still low, and there is still a considerable room for enlarging domestic market. It is through really severe competition among companies in the country for the improvement of the quality of products and the lowering of production costs that the Chilean pulp and paper production technology will be modernized and the living standard elevated. This principle applies, in our opinion, not only to the pulp and paper industry, but also to the Chilean industries in general which are being modernized.

b) Chilean pulp and paper products have not only to be improved in quality, but also to be diversified. We were surprised, when we wanted to buy some paper products at shops, to find out how

similar products were made so uniformly from similar paper. It is necessary for the all out development of Chilean pulp and paper industry to increase the number of grades of both pulp and paper products.

c) Prospects of producing chemical dissolving pulp are good

The only chemical dissolving pulp currently produced in Latin America is that of Brazil, which amounts to some 55,000 tons per year. In 1962, the requirements amounted to 111,000 tons, and the deficit of 56,000 tons had to be imported.

Dissolving pulp of fairly good quality has been produced from Chilean Insignis pine. There are good prospects of exporting dissolving pulp to such countries as Argentine, Brazil and Mexico after fully supplying the domestic requirements of Chile, which currently amount to 5,000 to 10,000 tons.

d) On industrial utilization of broad leaved wood according to the estimates of FAO, the total consumption of wood in 1965 for the production of paper including all the Latin American countries will be 3,800,000 cubic meters for coniferous wood and 1,300,000 cubic meters for broad leaved wood and 8,050,000 cubic meters and 4,000,000 cubic meters respectively in 1975. The ratio of coniferous wood and broad leaved wood is calculated to become 75:25 and 67:33 respectively in 1965 and 1975.

(FAO: Pulp and Paper Prospects in Latin America)

On this quantity, the plantation of Insignis pine in Central South is expected to supply 3,800,000 cubic meters. It must be stressed here that this source of softwood will play an extremely big role

for the pulp and paper industry in Latin America. Broad leaved wood however, is placed under an entirely different light.

Although the ratio of broad leaved wood utilization is bound to increase as mentioned above, no interest whatever is shown concerning the role to be played by broad leaved wood for the future Latin American pulp and paper industry.

When we consider such favorable conditions as excellent coniferous wood plantations, their superiority as the source of pulpwood and convenient location of plantations as mill sites, it is very reasonable that the Chilean pulp and paper industry has so far depended entirely on those plantations. However, there are vast virgin forests of broad leaved wood which occupy about 20,000,000 ha. of the Chilean land. Nearly all of the southern broad leaved wood forests are not yet developed. The Survey Team noted that there are relatively unmixed forests (pure stands) and that the properties of the wood found there are quite close to those currently used as pulpwood in Japan.

Broad leaved wood is at present widely used in many countries in the world by the pulp and paper industry. The broad leaved wood pulp is not at all inferior to the softwood pulp when used individually or mixed with the latter for making such papers for printing and writing. Moreover, addition of broad leaved wood pulp to coniferous wood pulp has many advantages; the sheet formation for example, is improved by this method. Dissolving pulp of good quality is also being successfully made from broad leaved wood.

These broad leaved wood forests should be developed, and an overall plan to produce lumber, plywood and fiberboard as well as pulp and paper utilizing them should be worked out by all means.

The localities of these forests are not as favorable as those of coniferous wood plantations at present for the establishment of wood industry. Practically no study has hitherto been made regarding the conditions of localities. From our very basic surveys, there is possibility of establishing such coordinated wood industries for the development of broad leaved wood utilization in the area around Puerto Montt. For this purpose, it is necessary to conduct more detailed investigations as to the wood collection, transportation facilities, supply of industrial water and power, and production costs.

At present, these valuable broad leaved wood resources are being lost by natural calamities and conversion of forests to cattle breeding ranches. It is indeed a pity. The government is urgently desired to work out plans for their development and utilization in real earnest as soon as possible.

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