

REPORT  
ON  
THE SURVEY FOR THE DEVELOPMENT PLAN  
OF THE FOREST RESOURCES IN BOLIVIA

1965

FOREST RESEARCH AND PLANNING  
UNIT  
TOKYO, JAPAN

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## P r e f a c e

The Government of Japan, in response to a request from Bolivian Government, entrusted to the Overseas Technical Cooperation Agency (OTCA) the task of conducting a preliminary survey in Bolivia 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 Bolivia organized a four-member team of experts and dispatched it to Bolivia on January 12, 1965 for about 20 days on-the-spot survey under the leadership of Mr. H. Imai, Staff Member of Sanyo Pulp Company.

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.

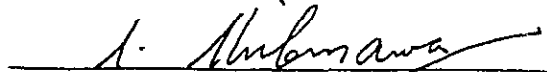
It is my sincere hope that this report will prove to be useful in the field of the Development Plan of the Forest Resources in Bolivia and will also help to foster closer technical ties and better understanding between Bolivia and Japan.

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 Bolivian 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.

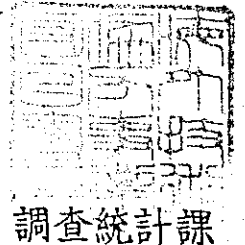
April, 1965

Shinichi Shibusawa

Director General



Overseas Technical Cooperation Agency



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## I. Introduction

Bolivia is full of forest resources throughout the country, which are one of the most important national resources, together with its mineral resources. In relation to their exploitation, however, it is not too much to say that only the export and other specific woods are lumbered at the present stage. In order to develop these forest resources most effectively and increase their contribution to the national economy, therefore, many problems remain unsettled.

In connection with the above, Bolivian Government requested our Government to dispatch a survey team in 1964 to make a fundamental survey of the possibilities of the development of wood utilizing industries in its country, because our country is technically on a high level not only in the paper and pulp manufacturing industries but also in general wood utilizing industries, and has practical experience and skill in utilizing the broad-leaved trees.

In reply to the above request, Japanese Government has decided to dispatch a survey team of the following members:

### *Organization of the survey team*

Team head (in charge of general affairs and the market researches), Hiroshi

Imai

Team member (in charge of forest), Yutaka Takahashi

Team member (in charge of lumbering, furniture, plywood and other wood manufacturing industries), Jun Hirasawa

Team member (in charge of the paper and pulp manufacturing industries),

Ichiro Tsubokawa

The above four team members conducted their survey activities in Bolivia for 19 days from 14 Jan. to 1, Feb. 1965. Their schedule for survey was prepared in consultation with the officials concerned of Bolivian Agriculture Ministry and Development Corporation, etc.

We hereby express our hearty thanks to Director of the Forest Bureau of Agriculture Ministry, Prieto Chacum and other Government officials concerned who were so friendly as to co-operate with our team in survey works, and Mr. S. Mojica, Agriculture Ministry, and Mr. G. Bejarano, member of the Development Corporation, who accompanied our Survey Team.

Our Survey Team is sure that the wood utilizing industries would be shortly fostered, and their products would come into the world market, because Bolivia is abundant in bulky forest resources of excellent woods. In this connection, we esteem it a great honor that our Survey Team could make a forest survey of Bolivia for the first time. At the same, we hope that this report should be useful for the economic development of Bolivia.

## II. Forest Resources

### 1. General Condition

Forests in Bolivia are widely distributed over the Bolivian plateau occupying one-third of the territory, mountain areas on the east slope of the Andes, and the northern and eastern plains.

In the La Paz and Cochabamba districts, 3,000 -- 2,000 m, above the sea level, however, there are found much bushes. Forests, where useful woods grow, are found forming jungles in the areas, less than 1,500 m above the sea level. In the South-eastern regions adjacent to Chile and Argentine, there are partly found timber forests, which, however, seem to be small topographically.

The air photo-survey has disclosed that the big forests along the Piray River north-east of Sta Cruz is especially extensive, and that the reserve of Mara and other useful woods is considerable in quantities. The forest survey of this district is, however, under way in co-operation with the FAO.

#### a) Forest area (refer to the attached table)

According to the data in Bolivia, the forest area is approx. 44,889,000 ha., about

41% of the national land area (approx. 109,858,000 ha.). At present, however, it is estimated that approx. 15% of the forest area, approx. 6,700,000 ha. could be exploited. Most of the forests are made of broad-leaved trees, but little virgin forests of needle-leaved trees are found.

b) Reserve of the forests, and the forest phase

As for the total reserve of forests, Agriculture Ministry of the country has since Jan. 1964 made a survey in co-operation with the forest experts dispatched by the FAO. As more than one year is reportedly further required to obtain the total estimate of the reserve, however, the total reserve of forests of the country is unknown.

In this connection, our survey team has tried to estimate the total reserve on the basis of data on the area shown in the attached diagram showing the survey limits, and the aerial observations.

In this country, trees are growing in the areas ranging from the highlands, approx. 4,000 m above sea level to the Tarija district, approx. less than 200 m above sea level adjacent to Paraguay. In the areas, more than 3,000 m high, however, natural bushes are partly growing. On the outskirts of La Paz City, the imported trees (mostly the needle-leaf trees) and the plant Eucariptus trees are growing.

In the areas, 2,000 m high, many thick bushes are found. Their timber reserve is estimated at less than 100 m<sup>3</sup>/ha. Therefore, major forests concentrates upon the areas ranging from the region approx. 1,000 m high to the lowland.

In the Sta Cruz area (450 -- 500 m above sea level), to which priority was given by our Survey Team in its survey work, the timber reserve seems to be approx. 200 -- 250 m<sup>3</sup>/ha.

But the quantity of the trees, which can be cut down and utilized as the useful wood, seems to be only 7 -- 8 pcs. per ha.

As mentioned above, the forest reserve of the country is at the stage of survey. When our Survey Team tried to estimate roughly the forest reserve on the basis of existing data and others in the country, it was estimated that the total reserve



of the above exploitable forests is approx. 1,200,000,000 m<sup>3</sup> -- 1,350,000,000 m<sup>3</sup>, and that of them, the reserve of the trees, which could be utilized, is approx. 260,000,000 -- 320,000,000 m<sup>3</sup>.

But the above useful trees show those which are utilized in the near-by area.

With the development and advance of paper, pulp and other wood utilizing industries in future, the sort of useful trees would increase greatly.

As for the forest phase many small-diameter trees of less than 50 cm breast diameter are found in the areas along the rivers, and the lowlands. In the areas, 700 -- 1,000 m. high, there are large-diameter trees.

In the damp grounds or in the marsh areas, mean-while, more coconut trees are mixed into the forests. On the other hand, useful trees of large diameter are found in the heart more than 300 -- 500 m off the river basin.

Anyway, the mixing ratio of the useful trees remarkably varies with the regions.

There is also a considerable difference among them in the number of useful trees per ha. Therefore, the realities are inconceivable from the partial survey of forest phase.

When we inferred forest phase and sort of the growing trees from the aerial forest observations by means of two Cessna planes, it seemed that there are 20 -- 30 useful trees such as the Mara, Cedro, Ochoo, Tarra, etc. per ha.

Above all, in some districts, the Mara, which is made most of by the Bolivian authorities, forms a thick forest. It is, therefore, desirable that these districts shall be developed as early as possible.

c) Sort of the useful trees

Mara (*Swietenia Macrophylla*)

This wood is brown-colored, used for the furniture, and besides exported as the boardings materials.

It grows in various places, especially in the Beni Chapare area.

Cedro (*Cedrela Oderata*, *Cedrela Fossilis*)

This wood is light brown, similar to the Japanese cedar, and used for the furniture and building material.

Amarillo (*Ocrosia Alternifolia*)

This wood is yellow, hard and used for the house building works.

It grows in various places.

Cuchi (*Astronium Urundenva*)

This wood is dark brown, hard and used for the building and piling works.

Sangre De Toro (*Virola Solivianenesis*)

This wood is yellow brown, and used as the plywood material.

Copaibo (*Copahera Officinalis*)

This wood is used as the plywood material

Nogal (*Fuglans Australis*)

This wood is a material similar to the walnut, which is used as the furniture and timber, and exported as the plywood material.

Ochoo (*Hura Crepitans*)

This wood is light yellow, and used as the house-building and wood-working material. When its sap is brought into contact with the man's skin, he is poisoned. When the sap comes into the eyes, he would sometimes lose his sight.

Tarara (*Midos permus Pedicilatum*)

This wood is brown, and used as the building material.

Verdolago (*Podocarpus Angustifolia*)

This wood is yellow-brown, hard, and used as the furniture and building materials.

Cacha O Quebracho Blanco (*Astronium Urundeuva*)

This wood is dark gray and brown, hard, and used as the building material.

Jichituriqui (*Asisposderma Polunesurum*)

This wood is yellow, and used as the building material.

Soto O Guebracho Colorads (*Schinopais Splendens*)

This wood is hard, used as the railroad tie, and exported overseas.

Aliso (*Alnus Josullona*)

This is used as the splint of match.

Alamo (*Ropulas Alba*)

This wood is used as the splint of match.

Negrillo-Laurel Negro (*Ocotea sp.*)

This wood is brown, and used as the building and erection material.

Quina Quina (*Myroxlon Percifeaum*)

This wood is a hard material like the teak, which is used for the vehicle making.

Pino De Monte (*Podocarpus sp.*)

This wood is a wood belonging to the yacca, which is used as the building material.

Table of the Forest Areas in Terms of Bovinces in Bolivia

<u>Name of the province</u>	<u>Total area (Km<sup>2</sup>)</u>	<u>Forest area (Km<sup>2</sup>)%</u>	
Pando	63,827	63,000	98.7
Santa Cruz	370,621	216,240	58.3
Cochabamba	55,631	26,700	48.0
Beni	213,564	72,650	34.0
Tarija	37,623	12,500	33.2
Chuguisaca	51,524	16,900	32.8
La Paz	133,985	40,400	30.2
Potosi	118,218	500	0.4
Oruro	53,588	-	0
Total:	1,098,581	448.890	41.0

d) Species of the trees which could be used as the paper and pulp materials

Trees in virgin forests in this country have not so far been any physical and chemical test to be utilized for making the pulp.

According to the visual observation made by our Survey Team on the site, the followings could be used as the pulp materials:

### Balsa (Ochroma Lagopus)

This wood seems to be equal to the "Mitsumata" in Japan, which is used for making the Japanese paper.

### Ambaibo - Cético (Cecropia)

This tree is called the "ant tree". Its wood seems to belong to the "Paulownia". The above "Ambaibo" is a vernacular word. The scientific term is unknown.

The above two sorts of trees account for approx. 4 -- 9% of the virgin forest.

Their growth is also rapid.

On the other hand, many reforested areas are especially covered thickly with Balsa trees. In addition to the above, there are found the Cuta (Myrsina Marqinata), Bibosi (Ficus, 39), etc. Above all, the Cuta belongs to the Myrsinaceae. As the number of its species is so large, test must be given to find which can be used for making the pulp.

### e) Wood cutting work

#### i) Wood cutting method

Wood cutting work is conducted chiefly in dry season (from May to September) in general, contract system is employed.

Cutting tools are axe and hatchet. Not only in cutting the wood but also in logging, axes and hatchets are used, but no chain-saw is used.

In carrying out the wood, man power or cart is mostly used. Some leading cutters have carried the wood to the truck road by means of tractors.

These lumbered logs are carried to the sawing mill or river. On the river, rafts are made, and carried to the specified harbor.

#### ii) Expenses for the lumbering work

In relation to the expenses for the lumbering work, contract system is chiefly employed. But its details and the calculation method varies with each region.

In the Sta Cruz area, for instance, the lumbering work costs U.S.\$2.08/m<sup>3</sup>

in total including the expenses (U.S.\$ 0.83/m<sup>3</sup> per 100 m) for finding one Mara tree, opening the way for wood cutting and cutting down it, those (U.S.\$ 0.42/m<sup>3</sup>) for logging, and those (U.S.\$ 0.83/m<sup>3</sup> per 100m) for transit.

When the Cedro, Ochoo, Tarara, Cuchi, etc. are cut, the above cost reduces by 5 -- 10%, When other trees are lumbered, the cost seems to be further reduced.

iii) Disposal of the trees by the Government, and the cost of wood.

Trees are sold by the Government in the following way: Purchaser specifies the desired area according to the map, makes an application for the number of trees to be cut per ha., receives the Government license, and starts the lumbering work.

The cost for trees paid to the Government varies slightly with the region and the species of trees. But it is approx. U.S.\$ 0.43 per m<sup>3</sup> of the wood product.

If it is then assumed that the sawing yield's 50%, therefore, the charge for trees paid to the Government would be approx. U.S.\$ 0.22/m<sup>3</sup>.

f) Freight

Truck of 5 -- 10-ton capacity is mostly used. Freight is considerably dependent upon the road condition. Several instances shall be given hereunder:

U.S.\$ 7.06/m<sup>3</sup> ..... San Juan - Sta Cruz, 160 Km.

(The section, approx. 50 Km. long is paved)

U.S.\$ 8.94/m<sup>3</sup> ..... Caranavi - La Paz, 160 Km.

(Height difference; approx. 4,000 m., no pavement, skilled driving technique is required)

U.S.\$ 21.19/m<sup>3</sup> ..... Cochabamba - La Paz, 600 Km.

(Partly paved, road condition - non- pavement B)

Note: "Non-pavement B" is regarded as a road, in which the level and the portion of more than 10° up-grade occupy less than 20 % of the total length.

When the wood is exported in the Sta Cruz area, it takes the following routes:

- |     |                         |         |                |         |
|-----|-------------------------|---------|----------------|---------|
| (1) | Sta Cruz - Cochabamba   | Truck   | approx. U.S.\$ | 16.67/t |
|     | Cochabamba - Charana    | Railway | approx. U.S.\$ | 15.14/t |
|     | Charana - Arica (Chile) | "       | approx. U.S.\$ | 7.22/t  |
|     |                         |         | approx. U.S.\$ | 39.03/t |

The planed Mara wood costs approx. U.S.\$55.56 per m<sup>3</sup>. If the above freight is added to this cost, therefore, it would cost approx. U.S.\$97.22.

As the F.O.B. price, Arica is over U.S.\$111.11 the above cost could pay.

- |     |                                   |         |                |         |
|-----|-----------------------------------|---------|----------------|---------|
| (2) | Sta Cruz - Corumba                | Railway | approx. U.S.\$ | 13.56/t |
|     | Corumba - Santos                  | "       | approx. U.S.\$ | 8.42/t  |
|     | Acuiba - Buenos Aires (Argentine) |         | unknown        |         |

In case of the routes mentioned in the above items, (2) and (3), the transit distance becomes so long that the ratio of the freight to the wood cost is greatly increased. If the wood products are exported to Brazil and Argentine, or by way thereof, therefore, it would be necessary, that the Bolivian Government should negotiate with the above two governments about the reduction of transit duty and railway freight.

g) Wood cost

The wood cost in Bolivia is represented by the quotation of the Mara wood, Though the cost is different among regions, the log, 2.7m. long costs approx. U.S.\$ 15.00 -- 15.56/m<sup>3</sup> in the Sta Cruz area.

Cedro wood is 3 -- 5% cheaper than the Mara, while other wood is almost 5 -- 10% cheaper than the Mara. No wood price in terms of the species of trees is found in this country.

h) Reforestation

Reforestation is scarcely found in this country except the Eucaliptus, Eucaliptus trees are growing around the residences, on stock farms and along the roads throughout the areas ranging from La Paz, 3,700 m. high to Sta Cruz, 480 m high.

In the eastern district 100 Km off Cochabamba, meanwhile, a plantation, approx. 10 ha. is observed. It seems to be the largest afforestation of this kind in this country. In this connection, it is reported that the Government has a program for the afforestation of Eucaliptus, 20,000 ha. wide in the Cochabamba area, which shall be put into practice in near future.

As seen in various countries including Japan, young trees are nursed in the order of mud kneading, boring, seeding, germination and transplantation. In 4 -- 6 months thereafter, they are sold to the people, and planted.

Planting intervals are approx. 2m. As for the trees which are found mostly rapidly grown, their height has become 23 m. in 15 years, and their breast diameter approx. 62 cm.

These Eucaliptus trees are used for the electric light posts, cases and fire-wood.

Though other species of trees, for instance, Mara, Alamo, Pino, etc. are planted, their number is very small. Most of them are planted on trial in the public laboratories, nurseries, or in the settlements.

### III. Paper and Pulp Industry

#### 1) Present Condition

Bolivia has imported the newsprint, wrapping paper, printing paper, toilet paper and all other kinds of paper from European countries. The homemade paper is only the cardboard, which is, however, poor in quality and besides cannot satisfy the domestic demand.

As occasion demands, the imported paper has been processed, and sold to meet the various requirements.

As the domestic market is very small, and the paper is one-sidedly imported, no overseas market is possible so long as the paper is concerned. Therefore, a large number or large-scale of paper mills is not required. In La Paz, there is found only one paper mill of the La Papelera. S.A., where small quantities of

cardboard are manufactured, and the imported paper is processed to satisfy most of the domestic paper demand.

The above Company has branch offices in cities with the population of more than 20,000, and sold the paper directly to the consumers. But the cardboard production is a sacrifice, and the main force of the company activities is concentrated upon the process and sale of imported paper.

Thus the paper and pulp industry of the country represented by the above company is not a manufacturing industry but rather paper processing industry.

- 2) Demand and Supply of the paper, and its Market-Demand and supply of the paper in Bolivia are as shown in the following Table. Paper consumption per head of the people is the lowest in the countries of South America. It seems to be mostly attributable to the racial constitution of the country. The natives, "Indios" hold the greater part of the population. Most of these natives are illiterate. Except some people, they make their social living, being isolated from the whites and half-blooded. In this connection, the chief reason for small paper consumption can be found in the facts that the natives live independently of the paper consumption, and the industrial level of the country is still too low to increase the demand for industrial paper.

Paper and cardboard consumption per head in the countries of South America

(unit : lbs)

(in 1962)

Argentina	69.5	Columbia	28.0
Venezuela	63.8	Peru	17.3
Uruguay	41.0	Ecuador	8.5
Chile	36.0	Paraguay	4.9
Brazil	22.1	Bolivia	3.8

Annual paper consumption in Bolivia is as shown in the following Table. All the papers but some cardboards are imported chiefly from Sweden, Finland, Chile, etc.



Annual paper consumption in terms of its sort (unit : ton)

<u>Year</u>	<u>Newsprint</u>	<u>Printing and writing paper</u>	<u>Other paper and cardboard</u>	<u>Total</u>
1957	1,600	883	1,652	4,135
1958	1,700	1,000	1,700	4,400
1959	1,800	1,000	1,800	4,600
1960	2,100	1,480	1,040	4,620

Note: The above is based upon the data of the FAO

Details of the imported paper assorted in terms of sorts in 1961 are as shown hereunder. It is only the printing paper (3,675 tons) including the newsprint, which was most consumed in that year.

<u>Sort of the paper</u>	<u>Quantity (Kg.)</u>	<u>Amount (US\$)</u>
Wall paper	10,402	8,390
Wrapping paper	302,000	85,308
Writing paper	252,912	211,262
Sensitive paper	13,997	37,373
Carbon and blotting paper	12,685	14,248
Printing paper (including the newsprint)	3,675,729	686,011
Sand paper and paper towel	117,263	11,911
Rice paper	51,926	39,818
Laminated paper	18,672	4,890
Cardboard	111,740	29,969
Total:	4,463,126	1,129,180

Note: The above data is based upon the "Boletin Estadistico (1963) issued by the Statistical Bureau of Finance Ministry, Bolivia.

On the other hand, paper consumption trend in Latin America as a whole as shown in the following Table:

<u>Item</u>	<u>Year</u>	<u>Newsprint</u>	<u>Printing and writing paper</u>	<u>Other paper and cardboard</u>	<u>Total</u>
Mean Consumption in Latin America	1957	30%	19%	51%	100%
	1958	28%	20%	52%	100%
	1959	27%	19%	54%	100%
	1960	29%	18%	53%	100%
-----					
Bolivia	1957	39%	21%	40%	100%
	1958	38%	24%	38%	100%
	1959	39%	22%	39%	100%
	1960	45%	32%	23%	100%

While the mean consumption ratio of the "other paper and cardboard" in Latin America is yearly over 50%, the consumption ratio of the above items in Bolivia is no more than 40% annually, even if the low consumption in 1960 is excluded. This can be attributable to the low demand of cardboard, wrapping paper and other industrial-use paper in this country due to the fact that the industrial activities of the country are not yet vigorous. At the same time, we expect that with the advance of its development programs, the paper demand in Bolivia would increase most in the field of industrial-use paper, and gradually approach the consumption level of the whole South America.

In addition, we estimate the future paper demand in the whole Latin America and Bolivia as follows : (unit : 1,000 tons)

	<u>1955 -- 1957 (Mean value)</u>	<u>1965</u>	<u>1975</u>
Latin America	1,965	3,501	6,659
Bolivia	5	8	13

#### IV Wood Processing Industry

##### 1. General Condition

Wood processing industry in Bolivia is so inactive at present that it could not make rapid advance in near future.

The first reason therefor is that little wood is used for the house-building, and the dwelling use such as the interior construction, etc., and therefore the wood demand for the building application is very small.

The above situation is true not only to Bolivia but also to the countries in South America in general. As the people have since the rule of Spain followed the old building system, the exterior of most houses is made of stone, or brick, or brick-worked and mortar-finished, while the interior is mostly plaster-finished. As the construction material, wood is used for the rafter or some beam. As for the interior finish work, wood is used only for the window, window frame, door, and the flooring block.

It can be concluded that there is no custom to use the plywood, hard board and other wooden board for the house-building.

Not only that modern buildings in major cities such as La Paz, Sta Cruz and Cochabamba, and the above-mentioned buildings of Spanish style account for only approx. 14 -- 16% of the total building area of the country. On the other hand, most of the farmers, indios and the inhabitants of lower class have made simple dwellings of kneaded and block-like hardened soil and clay. There is, therefore, little room for the wood to encroach upon the building material field.

In relation to the furniture and the interior finish work, too, only a limited number of the propertied classes have purchased their furniture and utensils, because the living standard of general people is very low. Meanwhile, only a very small number of the people, who live in the above clay-block dwellings, seems to have the furniture (note 1), which was purchased from the dealers.

Note: The furniture possessed by the residents of the clay-block houses is mostly limited to the wooden beds, dining table, chairs and shelves. When we inquired the procurement of the inhabitants, most of them replied that these articles were home-made, or bought at second-hand, or bought long ago. In this connection, there is likely little promise of large latent demand for the wooden furniture and utensils among the inhabitants living in clay-block dwellings, who account for approx. 50% of the population of the country.

In addition, approx. 60% of the middle-class people living in the urban areas of the country seem to live in rented houses. Meanwhile, rented houses and rooms equipped with the furniture seem to be small in number. Especially, as the rent is higher as compared with the income of the people, their purchasing power for the furniture and utensils seems to be low.

From the above, it is conceivable that the demand of the people for furniture would not rapidly increase, and that the high-grade furniture would be made chiefly for some upper classes, and tables, chairs, shelves, etc. would be made for the government, companies and schools as occasion demands. Such being the case, we consider that the wood manufacturing industry of this country should give the export priority to the domestic demand. At present, however, much cannot be expected from the export from a viewpoint of manufacturing technique and transit situation. In this connection, possible measures shall be described hereinafter.

In short, we can conclude that the rapid advance of wood processing industry is hopeless from the following two reasons : Little wood is used for the house-building work in this country, and the demand for the furniture and utensils is very small because of the low living standard of the general people.

## 2. Sawing Industry

### i) Present status

Each collecting and distributing point of the wood materials is dotted with one or two sawmills. As the survey data on the number, scale and the capacity of sawmills are not made available to us, the whole aspect of the sawing industry in Bolivia is unknown. Therefore, its current status shall be hereunder described in reference to the observations of our Survey Team on the sawmills in various places of the country.

(1) Caranavi district (refer to the map) : In this area, the phase of virgin forests is so excellent that the useful trees seem to be growing at the rate of 20 -- 30 pieces per ha. Above all, trees of excellent quality such as the Cedro, Tarara, Amarillo, Laurel, etc., whose breast diameter is more than 80 cm., are large in number. As the Mara in virgin forests, which could be easily carried out, were mostly cut down, they remain uncut at the rate of no more than 1 -- 3 trees per ha. in the areas 30 -- 40 Km. off the Caranavi district.

Scale of the sawmills is as follows: 1 mill equipped with 1 circular saw (150 cm, dia., thick blade, 5 m/m, sawing width including the setting, approx. 10 m/m) and 1 mill equipped with 2 circular saws. These two sawmills are both using the gasoline engines for driving.

The sawing capacity was said to be 3,900 m per month. Considering the circular saw capacity, the number of workmen, the quantity of wood piled in workshops, the sawing capacity per month seems to be 280 m<sup>3</sup> per month.

Sawing cost is 0.04 peso per pie. The monthly income of sawing operator is U.S.\$ 66.67 -- 75.00 and that of his assistant U.S.\$ 44.44 -- 50.00.

Note: 1 pie is equivalent to 810 cm<sup>3</sup> Most of the sawed products are the planks, 2 inch thick, while the boards, less than 1 inch thick are rarely found. All the products are sawed along the veins of wood with 3.75, 4 or 5 m of length. The elongation of the planks is approx. 5%. Planks, which

were cracked 4 m long, cannot be brought to ordinary market, and their cost is also reduced by 10 -- 20%.

Quality of the products is dependent upon the skill of sawyers, As for the plank, even 2 inch thick, there is a difference, approx.  $\pm 3\%$  in thickness, and an unevenness in sawing. Thus the sawing technique would be lower than that of middle grade.

Sawed products are trucked to La Paz across Yungas, 4,680 m high.

- 2) On the outskirts of Sta Cruz, there are five sawmills, which have more than one circular saw, 150 cm $\phi$  respectively.

As we could not find any sawmill equipped with an automatic-feed-lug band saw, we inquired of the persons concerned. But they replied that the situation is unknown.

In all these sawmills, carts are used for carrying the products. When some unsawed portion remains on the upper section of log, approx, 70cm $\phi$ , wedge is driven into the "sawing allowance" portion to crack the log (refer to the Photo.)

Sawing capacity is so low, and seems to be about 1/3 of that in Japan.

Kind of the sawed wood is 4 -- 6. In some sawmill, there were found approx, 10 pieces of the Mara, 1.3 m diameter each.

The total production of a sawmill (equipped with a circular saw, 150cm $\phi$ ) in the Caranavi district was said to be 180m<sup>3</sup>/day. From the sawing technique and working efficiency it is conceivable that the total production is approx. 100 m<sup>3</sup>/day (in terms of the plank, 2 inch)

- 3) In the Cochabamba and Sta Cruz areas (refer to the map), too, most of the sawmills are so small-scaled as to be equipped with only circular saw (thick blade saw, 150 cm $\phi$ ) respectively. Some sawmills, which also make the boards and planks, are equipped with 3 -- 4 circular saws (30 cm $\phi$ ) each. The planks are used for the packing cases of food stuffs. No sheet for the building application is sawed.

ii) Prospect, and the measures for promoting the sawing industry.

- 1) As the wood resources are abundant, the sawing process itself is rough. For instance, even the plank, 2 inch thick has such an unevenness as approx.  $2 - 2 \frac{3}{6}$  in sawing work. Therefore, technical training is required for the sawyers. In this connection, it would be necessary to specify the proper standard for the sawing work.
- 2) In relation to the wood cutting, it is wasteful that the wood of A grade, which could be brought on the international market, is sawed along the cross grain. In this connection, the straight-grain sawing, which could express the fine grains of the heart of the trees, especially the Trompillo, Urundey, etc, should be more studied.
- 3) In this country, no band saw was found. The official concerned also said that there is no band saw machine. We, therefore, hope that under the financial aid of the Government, one band saw equipped with an automatic feed unit, 48 inch long should be purchased to serve the improvement of sawing technique of this country.
- 4) The wood resources of this country have the possibility of making their appearance on the world market, when the wood will run short on a world-wide scale. From now, therefore, sawing technique should be studied against the possible wood shortage in the world, even if the researches are small-scale.

### 3. Plywood Industry

#### i) Present condition

In Cochabamba, there is a plywood workshop called the "Imbol" Plywood Company, Ltd.", where the veneers are purchased from Sta Cruz, and bonded into the plywoods.

Considering the capacity of hot press, the daily production of the workshop seems to be 250-300 sheets of the standard plywood, 5 m/m  $\times$  1,200m/m  $\times$  2,200 m/m.

Facilities :

- (1) Casein mixer 1
- (2) Casein spreader 1
- (3) Hot press 1 (b-stage system, 200 tons)
- (4) Double saw 1 (saw for sizing the plywood)
- (5) Sander 1 (drum sander, 250 m/m $\phi$ )

Sort of the plywood

Plywoods, 5 m/m, 10 m/m and 20 m/m thick are custom-made.

Materials

As mentioned above, the veneers are made of Ochoo, Cedro, Copaibo, Cabun, etc., which are cut in the forests around the Sta Cruz area. These rotary veneers of proper size (approx. 10% larger than the finished size, 1,200 m/m  $\times$  2,200 m/m), which had been delivered, are assorted in accordance with the order, and bonded together.

Bonding agent

Soybean casein made in Mexico is used.

Product

Plywood product is equivalent to that of 3rd grade. From a viewpoint of the surface finish, qualitative beauty, adhesive property, etc., the products are used for the back board of the furniture, the bottom of drawers, the outer board of packing cases, etc.

ii) Other plywood

In case the plywood is used for the surface materials (including the surface materials for the table top and shelves), small quantity of U.S.-made overlay plywood is imported. Price:

Plywood, 5 m/m  $\times$  1,200 m/m  $\times$  2,200 m/m size is quoted at approx.

U.S.\$ 4 (shipment price at the factory). According to the material,

there seems to be a difference of 5 -- 15% in quotation.

iii) Possibilities, and the measures for promoting the plywood industry.

1) As mentioned above, the demand for the plywood for the building use



is very small. The domestic demand for plywood is therefore, satisfied by the present domestic production, and the import of small quantity of specific plywood. In all countries of the world, however, there is a trend of the large-diameter (breast diameter, more than 1 m/m) trees for the plywood making decreasing year by year in their production. It is, accordingly, desirable that such trees of excellent quality as the "Mara", "Cedra", "Tarara", "Trompillo", etc., which are suitable for making the plywood, should not recklessly be cut, but on the basis of a longrange plan so as to be preserved as far as possible.

- 2) The wood of most excellent quality in Bolivia is the "Mara". It is estimated that the "Mara" trees are growing at the rate of over 10 per ha. in the Rio Grande area extending over 20,000 ha. 80 Km north of Sta Cruz. As it is considered that this area could be easily developed, we recommend that the ministry of Agriculture and Forestry of the country should make a large-scale survey of the useful trees such as the "Mara", etc, in the above area, and subsequently a plywood plant should be established on the outskirts of Sta Cruz. In this connection, a standard plan for the plywood plant has been attached to the end of this report.

#### 4. Furniture Making Industry

##### i) Present condition

As outlined in the above, the domestic demand for the furniture in the country is so small that the furniture manufacturing company "BATK" in La Paz city seems to have supplied most of the furniture of over medium-grade in this city.

- |                                   |   |
|-----------------------------------|---|
| 1) Band saw machine, 24"          | 1 |
| 2) Circular saw machine, 16"      | 1 |
| 3) Hand feed planing machine, 16" | 1 |

- |                             |   |
|-----------------------------|---|
| 4) Surfacing machine        | 1 |
| 5) Hollow chiseling machine | 1 |
| 6) Belt sander machine      | 1 |

#### Sort of the furniture

The Company has made the following furniture of over medium-grade to order : Book case, cabinet, dining and reception tables, common, half-pedestal and school desks, sideboard, dressing chest, bed, screen, arm and easy chair, sofa, chest of drawers, etc.

The products make no great difference from the medium-grade articles sold in general furniture stores in Japan in their technical standard, But their cost is so high, about 2-2.5 times as high as that of those of the same kind made in Japan.

Style of the furniture made in this plant is relatively new, and mostly of U.S. design.

#### Materials

As for the materials, the Mara, Cedro, Ochoo and Guatambou are used mostly. Plywood is imported from Brazil and Finland.

#### Constitution of the cost

The greatest reason for the above high cost of furniture is that cabinet makers are so tardy in making the articles. For instance, it seems to take 3 -- 3.5 times of the working time than that in Japan for them to complete one pedestal desk of general type. Even if the workmanship is almost the same, the making cost and the subsequent indirect cost become higher. As mentioned, consequently, the sales price of the furniture seems to become approx. 2 -- 2.5 times as much as that in Japan.

#### ii) Other wood processing industry

Several wood processing workshops (with 10 -- 20 workmen each) are found in La Paz, Sta Cruz and Cochabamba respectively. As their production is chiefly dependent on the order, however, they make not only the furniture of medium

grade but also the window frames of residences.

Tools for the wood work used in these workshop are those made in U.S.A., Germany, Norway, Finland etc. Most of them were made in the 1950's.

#### Flooring industry

In Cochabamba City, there is a furniture, fixture and flooring manufacturing plant called the "Carpinteria Pesce Y Cia" equipped with one unit of flooring machine, whose producing capacity is approx. 200 m<sup>2</sup> per day. We were, however, told that there is no demand much enough to run the unit for 12 -- 16 days per month.

In short, we can conclude that the demand for the flooring is no more than 3,000 m<sup>2</sup> per month. As for the material, the Mara is used. The standard conforms to the U.S. standard scale.

### iii) Possibilities, and the measures for promoting the wood processing industry

#### 1) Furniture

In many cases, the furniture, room fixture, industrial art objects, etc. are regarded as the luxuries of a sort in this country. Their demand would not increase until the living standard of the people reaches a certain level. From the present living standard of the general public of this country, therefore, it is inconceivable that the domestic demand would increase greatly within several years to come.

Considering the present technical standard and cost, meanwhile, it is also hopeless that the furniture could be exported to the adjacent countries such as Brazil, Argentine, Chile, Peru, etc.

If there is any possibility of the wooden products being exported under the present condition, it would be possible that contract would be made with a specific maker in the adjacent country to export the half-finished and highly-worked products.

In this connection, it is desirable to make researches into the effective application of the wood materials. For instance, the Mara and Cedro should be used for the folding chairs and tables, while the Cacha like the Teak produced in the South Seas, the Trompillo of beautiful and fine grains, etc. should be used for the standardized frames, doors, etc.

Even if these semi-finished products are to be exported, artificial dryer unit is inevitably required. At present when the above Carpintena Pescey Cia, Cochabamba is equipped with only one unit of artificial boiler type dryer of practical output, approx. 8 m<sup>3</sup>, it is desirable that the Government should build a wood drying chamber (whose actual output is approx. 10 m<sup>3</sup>) in a public organ to make researches into the effective production of artificially dried wood, chiefly the above-mentioned.

#### 5. Other Timber Manufacturing Industry

It the utilization of Verdolaga, Trompillo, Cuchi, etc, for the salad bowls, kitchen plate and others is considered, and further researches are made into their drying, adhesion and other processes, these exported wooden products could compete with those of the countries in U.S. and Europe in quality. As Japan is ahead of these countries in the wood processing technique, meanwhile, it would be possible that the Bolivian Government should dispatch the operators to Japan to train them.

### V Observations Based upon the Survey Records

#### 1. General Observation

The great dependence of the national economy of Bolivia upon the export of mineral products, chiefly the tin ore indicates that Bolivia is a typical primary-product-making country in order to find a way out of this situation and industrialize the country, it would be inevitable to promote the mineral industry more greatly, and make efforts to increase the export of minerals

to obtain the foreign funds. In this connection, it would be natural that in parallel with the above efforts, the Government has worked out a 10-year national industrialization program to expand the facilities of fundamental industries other than the mining industry. In this connection, the Government has made a practical plan for 1965 -- 66, which laid stress upon the following urgent problems:

- ) Survey of the forest resources - promotion of the export of useful wood materials.
- ) Achievement of the self-supply of agricultural products.

The prime consideration with the above problems is the present forest developing system. According to this system, no more than 2 -- 3 growing useful trees are cut per ha., and the remaining trees are burnt to bring the land under cultivation in most cases. From a viewpoint of the effective use of wood, such a step seems to be quite unreasonable.

As the abundant forest resources of this country are evidently the important national resources second to the mineral ones, the effective development and utilization of these forest resources could greatly contribute to the national economy of Bolivia in future. In this connection, it is desirable to take the following steps to exploit and utilize the forest resources:

- ) Promotion of the afforestation

In accordance with the requirements of wood processing industries, useful trees shall be chosen, and the reforestation shall be given as previously planned. Above all, the needle-leaved trees shall be afforested.

- ) Researches into the multiple-use of wood for the applications other than the export of useful wood.
  - o Increase of the wood use for the house building.
  - o Utilization of the waste in sawmills.

- o Enhancement of the process grade of wooden products, and the researches into their qualitative improvement.
- o Researches into the pulping process.
- ) Researches into the development of the related industries.
  - o Researches into the pulping process of bagasse in sugar manufactures.
  - o Aid to the electrolytic industry using the rock salt produced in the south-western area.
- ) In order to put the above measures into practice, the establishment of national research laboratories, the introduction of technique from the advanced countries, etc. should be taken into consideration. In embarking in undertakings, it would be necessary to take various protective measures, for instance, the enterprise shall be generally managed by the Government for some time.

## 2. Development of the Forest Resources

This country is abundant in the reserve of forest resources. The most effective exploitation of these valuable national resources for improving the national economy would be therefore one of the important policies of the Government.

As one of these policies, "Establishment of the wood industry complex" is outlined in another item, it shall be hereinafter described how the coming forest policy is:

### 1) Policy for increasing the production of the wood to be exported.

Such timbers as the Mara, Cedro, Laurel, etc. produced in this country rank among the wood products of excellent quality of the world.

Above all, the Mara is expected to become one of the important useful wood materials on the world market within the coming ten years, because there is a trend of the production of excellent wood materials decreasing year by year in South-East Asia.

In connection with the above, survey of the distribution and reserve of the

Mara should be made in relation to each area, as the Mara's are growing over a wide range of areas.

2) Regional exploitation of virgin forests (exploitation in the Sta Cruz area)

It is impossible to exploit the widely distributed forest resources on a wide scale.

In the first place, it is feasible to work out an exploitation program in the Sta Cruz area, where a considerably large number of the Mara and other useful trees are growing.

Practical example of the program:

Of the virgin forests within a radius of less than 100 Km from Sta Cruz city, an area, 50,000 ha., where trees of excellent quality are well grown, shall be specified. In order to develop this specified area, drag roads and motor-ways shall be built, all the trees be machinecut, useful woods be utilized for the export and the domestic use, trees for the pulp use be sent to the pulp plant (refer to another item of the complex of wood utilizing industry), and the trees of lower quality and miscellaneous trees shall be made into firewood, or burnt on the cutting site.

In the area where all the trees are thus cut, such export trees as the Mara, Cedro, etc., and needle-leaved trees shall be planted immediately. If so, the production of newsprint would be possible.

If the forests in the Sta Cruz area are exploited on the basis of a 5 -- 10 year program in such a way as mentioned, the virgin forest, approx. 150,000 ha. could be easily exploited.

If we estimate the wood quantity accruing from the exploitation of the forest, 50,000 ha. in the Sta Cruz area, the followings could be effectively utilized:

Mara : 270,000 m<sup>3</sup>

Cedro and other useful wood : 1,200,000 m<sup>3</sup>

Pulp wood : approx. 3,600,000 m<sup>3</sup>

### 3) Establishment of forestry experiment station

Though the country is abundant in forest resources, its research laboratories and organs are small in scale and number.

In this connection, it is desirable to establish the facilities, in which the botanical classification of the domestic trees, chemical and physical tests and the pulping test can be given even on a small scale.

In parallel with the above forest exploitation program, the establishment of research organs shall be immediately examined. As one of the steps to promote the research activities, the expansion of such existing research organs as San Simon College in Cochabamba, and the public botanical research laboratory in the Ciyane district is feasible.

### 3. Development of Pulp and Paper Making Industry

It is technically very difficult to make paper pulp, by using only the domestic-produced wood of this country. As there are the following favorable conditions, however, there is a possibility of the paper pulp industry becoming a primary industry of this country some day:

- 1) Soil is fertile, and the climate is suitable for the growth of woods.
- 2) Rivers are large in number and their flow is rich so that the industrial water can be obtained much enough.
- 3) As such minerals as the lime, sulfur, rock salt, etc. are much in production, the chemicals for the pulp manufacture can be easily self-supplied.

In Japan, the needle-leaved trees run short, and the broad-leaved trees has since the middle of the 1950's been used for making the pulp.

At present, more broad-leaved trees are used than the needle-leaved.

As the forests of this country are covered with broad-leaved trees, the technical problem on the making of paper and pulp is considerably similar to that in case of Japan. Therefore, by the application of the present paper making technique, however difficulties may be, there are possibilities of the broad-leaved tree utilizing paper and pulp industry being promoted.



In this country, there are not only the rich virgin forest resources but also much bagasse, many plantations of eucalyptus and mahogany, which can be used for making the pulp. From a technical viewpoint, we have observed the problematic points of the possible establishment of paper and pulp industry including the industries using the above materials as follows:

[ Materials ]

In making the pulp in this country, (a) Virgin forests, (b) Bagasse discharged from the sugar plants, (c) Eucalyptus and mahogany produced in the plantations, (d) Waste paper and cotton rags can be used.

(1) Virgin forests

Broad-leaved trees growing in virgin forests of this country can be used for making the pulp by means of chemical pulp manufacturing process.

From some data, we could conclude the fitness of forests for the paper pulp as follows:

In forests, the tree (A) containing extremely short fiber (less than 1 mm on the average) is larger than the tree (B) containing longer fiber (approx 2mm) in number. In the reserve, however, the latter (B) is for more than the former (A). Though the (B) can be chemically pulped, it cannot be made into the newsprint and strong wrapping paper, unless it is mixed with the needle-leaved tree pulp, because the (B) pulp is inferior in strength. But the (B) could be made into the general writing and printing paper. On the other hand, the (B) cannot be pulped in the ground pulp process. In utilizing the primeval forests for making the pulp, therefore, it is desirable to make the pulp of the same blend as that of the forests. If this system is employed, it is economically favorable, and the labor can be saved by reason of the followings: (1) If large quantities of the wood of a definite species are to be collected, more cost and labor are required for the collection, because its

distribution per unit area of the forest is very small. (2) Utility of the cut area would be higher when the trees of forest are all cut than partially cut down. Thus it can be more easily utilized for the reforestation and farming. (3) Produced pulp is qualitatively so uniform as not to disturb the paper manufacture. As the tree containing the longer fiber is overwhelmingly larger in quantity, the pulp is qualitatively not affected by the tree containing the short fiber.

In utilizing the primeval forests, however, it is desirable that the following sorts of trees should be previously removed.

(a) Tree containing the resistant organic matter against the decomposition effect of acid and alkali, which cannot be easily pulped (b) Hard tree, which could accelerate the abrasion of chipping machine, etc. These trees would qualitatively affect the pulp and worsen the economy of its manufacture.

The above has been learned by our experimental intuition, when we compared the apparent feature of various kinds of wood. In planning the building of plant in practice, therefore, it is necessary to examine the plan on the basis of the detailed data collected.

## (2) Eucalyptus and mahogany

The government of this country is keenly interested in the afforestation of eucalyptus and mahogany, which are the promising trees for making the pulp in this country.

According to the experimental data in Japan, the eucalyptus contains 25.07% of lignin and 57.62% of cellulose (which has 68.86% of  $\alpha$ , 0.70% of  $\beta$  and 31.0% of  $r$ ), while the mahogany contains 64.3% of fiber, 19.2% of pith gland, and 16.5% of conduit. In the paper factories in Argentine, not only the pine tree but also the eucalyptus are used. The eucalyptus is a promising material, and its afforestation has been already started in this country, too. Therefore,

this wood can be easily utilized for the paper and pulp industry.

In combination with the utilization of primeval forests, the eucalyptus plantation should be effectively utilized as planned.

(3) Bagasse

In this country, the sugar manufacturing industry is so active that large quantities of bagasse are discharged. At present, however, they are used as the fuel for the steam and power generators in these sugar factories.

Bagasse, which contains the fiber, approx. 1.5 -- 2.5 mm. long, can be made into the pulp of excellent quality. Not only that, it is more easily made available than the wood material. If its refining grade is enhanced, and the yield is reduced, paper of good quality can be made therefrom. If any paper of lower than midium grade is to be made, it can be made, even if the above yield is not so much reduced. It is generally said that the yield is 30 -- 40 %. As the bagasse is easily pulped and treated, it should be utilized for the paper and pulp production as far as possible.

(4) Waste paper

It is important to work out a plan of collecting the waste paper, and using it as the paper material again. Waste paper is an important material for the cardboard, and inexpensive for making the low-grade paper. In this connection, efforts should be made to collect and utilize the waste paper. Chiefly in big cities, measures should be examined to collect this material, which can be utilized again.

{ Secondary materials }

The chemicals required for making the pulp can be mostly self-supplied easily, when the minerals mined in this country are utilized. Chlorine and caustic soda can be electrolytically self-made from the rock salt. As the lime and sulfur are produced, and the soda ash is

manufactured, there is no problem, if the SP (Sulfite Pulp) or semi-chemical process is employed. Bleaching powder can be also self-supplied. In case the Kraft pulp process and  $\text{ClO}_2$  bleaching process most effective for the broad-leaved trees are employed, the required chemicals must be imported from overseas.

The organic agents necessary for the paper material preparing process shall be almost imported from overseas : Color, dyestuff, surface-active agent and sizing agent, etc.

{ Water for industrial use }

This country has many rivers rich in water.

If these rivers are utilized, plenty of the water for industrial use can be obtained.

Though the water of these rivers are muddy, it can be easily purified at present when the water cleaning technique is advanced.

In relation to the contamination of the rivers with the drainage from the plants, there is no danger of the lower courses being polluted, because the rivers are rich in water. In this connection, fishery and farming could be left out of consideration.

If no small branch is chosen, but the main course of river in a lower area is used in building the plant, there is no difficulty in the water supply as well as in the treatment of waste water.

{ Plant building site }

In choosing the plant building site, it is ideal that the following fundamental requirements would be satisfied : (1) Raw materials shall be easily collected. (2) Plenty of water of excellent quality shall be obtained. (3) Waste water shall be easily treated. (4) Labor shall be easily made available. (5) Building site is so close to the consuming area that the products can be easily

shipped there, etc.

It is practical that as mentioned in the above item, raw material, the paper and pulp industry should not only utilize the primeval forests but also rather positively utilize the plantation and bagasse, and that the industry should be promoted, by utilizing these three factors as planned. If so, it is unnecessary to build the plant in the depth of primeval forest, where there are no good communications to, and the living environment is bad.

As it is not so difficult for the time being to procure the paper material much enough to meet the demand, it would be advisable to choose a district, which is easy of access, suitable for the plantation, rich in water, close to the forests, and has great possibilities of various industries developing.

In the concrete, the Sta Cruz area, and its outskirts would be most suitable.

{ Development program for the paper and pulp industry }

- (1) At the early stage, printing, writing, wrapping, blotting and toilet paper, etc. shall be manufactured. Such processed paper as the newsprint, laminate, etc. shall not be made.

The total production shall be 200 tons per month (on the basis of the basis of the actual consumption of those sorts in 1963)

- (2) Materials to be used shall be forest trees, chips of sawmills, planted eucalyptus, bagasse, waste paper and cotton rags.
- (3) As for the digesting method, sulfate process, neutral soda sulfite process and chemical ground pulping process shall be employed.

In practice, however, they are accompanied by the following unfavorable conditions : small-scale plant to match the 200-ton paper production mentioned in the above (1) would not be economically justified. When the plant is small-scaled, the facilities would be

partially omitted. In this connection, either of the followings steps should be taken : No sulfate process facility shall be built until the demand becomes much enough to justify the plant economically, but the pulp of high quality (including the needle-leaved trees, etc.) shall be imported and used. Or a facility of production capacity over the demand shall be built, and its operations shall be curtailed to control the production until the production can be balanced against the demand. In relation to the sulfate process pulp, it is somewhat difficult to build a plant of economical capacity, as the paper market is so small at the current stage in this country. But the pulp import would be also accompanied by various difficulties. If the promotion program for industry is considered, therefore, it would be better to build a plant at any cost.

When the bagasse is used, the Pomilio system is advisable so long as the chlorination process is concerned. For the time being, however, the easily controlled soda process shall be employed.

- (4) In bleaching the pulp, chlorine, caustic soda, and hypochlorite shall be self-made for the present.  $\text{ClO}_2$  process shall be employed at the future stage when the paper consumption becomes much enough to justify the building of a plant economically.
- (5) As for the paper manufacturing machine, two kinds of Fourdrinier and cylinder type shall be employed. Though the paper demand in this country is small, many kinds of the paper are required. It is, therefore, desirable that the paper making machine to be laid should be capable to manufacture many kinds of paper. The production capacity shall be a little over the present demand, and the number of the machine unit shall be limited so far as possible. As the paper making machines, unlike the pulp making

facilities, can be easily increased to meet the demand, one unit of each of both types shall be laid for the present.

[ Other measures to be taken for the paper and pulp industry ]

- (1) Industrial research laboratory shall be established to make collective investigation and researches into the paper and pulp. In the meantime, a paper making machine of daily production, 1 -- 2 tons on a pilot machine scale shall be laid to train the operators. Paper made by the above machine shall be brought on the market.
- (2) The actual import of cardboard from overseas is approx. 110 tons at present. Because of its small consumption, its manufacture is difficult. As the cardboard is larger than other paper in the growth of consumption, it is desirable that the easily made sort should be first manufactured. With the considerable increase in consumption, and the reserve of skill, it shall be home-made in due time in process of the development of the paper and pulp industry in this country.
- (3) At present, no newsprint can be made because there is no needle-leaved tree. As the newsprint is keenly needed, afforestation of needle-leaved trees shall be researched to pave the way for using them for the paper and pulp.

#### 4. Program for the Wood Utilizing Industries Complex

In the above general observation of forests, a consolidated exploitation program for the forests in the Sta Cruz area, and a plan for establishing a pulp plant of monthly production, approx. 200 tons are described.

In combination with these programs, a plan for establishing other wood utilizing industry is additionally feasible.

On the assumption that the wood, approx. 1,200 m<sup>3</sup> is required monthly to produce the pulp, approx. 200 tons per month as mentioned above, it is necessary

to consider other related industries.

In the meantime, an industry cannot be realized independently of others.

Even if a pulp plant is built, and operated to start its production, for example, proper routes or workshops supplying various chemicals, machine parts, materials and instruments are required for the effective run of the pulp plant.

But the above problem shall be left out of consideration, and only the establishment of sawing and related industries shall be described in this paragraph.

#### 1) Sawmills

As the domestic demand is small, the main objective of the establishment of sawmills is to make the export wood, and the half-finished wood products for export.

In connection with the above, the wood to be sawed would be chiefly the Mara, Cedro, Laurel, Tarara, Amarillo, Ochoo, etc. It is, therefore, desirable that the wood should be sawed lengthwise of the grains chiefly, and the residue should be used for the domestic demand.

##### A) Scale of the sawmill

###### Mechanical facilities per workshop

- a) 48" automatic-feed-equipped band saw 1 unit
- b) 1,220 m/m circular saw 1 unit
- c) 12" circular saw for chipping the lug 1 unit
- d) 24" -- 28" table band saw 1 unit

3 units of machines, and their accessories.

###### Sawing capacity

If it is assumed that the straight-grain cutting accounts for 1/2 of the sawing operation, and besides the above mechanical facilities, labor and social custom of the country, etc. are taken into consideration, the daily production, 15 -- 20 m<sup>3</sup> would be possible, and the raw wood, approx. 35 m<sup>3</sup> would be required for the above production.

It is, therefore, possible that the considerable quantities of the residue,



approx. 17 -- 18 m<sup>3</sup>, of the raw wood, from which the sawed products had been obtained, would be utilized for making the pulp. In this connection, it is necessary to further study whether the above useful wood can be utilized for manufacturing the pulp, or not.

#### Sawed products

The trees are generally logged into the wood, 3m, 4m and 5m long. As the small-wide wood, it is sawed into the product, 2" x 4" and its multiple long. It seems that the product, 2" x 4" would occupy the majority. The board would be generally 1" x 12" or 2" x 12", while others would be made to order.

As the circular saws of thick blade, which are used for sawing in this country, have coarsened the grains of sawed goods to reduce the commercial value of the products, and still the chips, 10 -- 20% (varies with the board thickness) have been discharged, even when the trees are sawed crosswise of flat grains, saws of thin blade shall be used as far as possible.

In the meantime, it is desirable that the sawing size standard should conform to the international standard, for instance, the standard size of 1" thick wood should be approx. 1" x 1/16". According to the international custom, the thick wood, less than 1" is placed out of transactions.

When the heart wood of Trompillo is cut lengthwise of grains to make the surface material, such face materials as the plywood, etc. can be made. If it is sawed into the thick board, 6 -- 12" wide, and exported as the noble wood, therefore, it could compete with the noble wood made in South-East Asia. On the otherhand, the Cacha wood bears a close resemblance to the Teak made in South Seas in appearance and specific gravity. Though its oil content seems to be smaller, the Cacha wood could compete with the Teak economically on the world market, because the reserve of Teak has decreased year by year,

and its cost has tended upwards yearly, as its cutting has been moved into the depth of forests.

It is, meanwhile, possible that the Tarara, Ajunade, Ochoo, Nagal, etc. would be sawed into square timber for the building and fixture use.

Considering the demand for square timber for the building application in the adjacent countries and U.S.A., the export of square timber would be difficult for the time being. Therefore, their sawing work for square timber should be so much as to meet the domestic demand.

The sawed thin board, less than 1/2" is not suitable for the export, because it would be often cracked and warped in transit, being affected by the change in climate and temperature. In addition, its domestic demand is so small that the thin boards of this kind are not generally used for the building, but only for the window frames and the in-and outlet doors. Such being the case, the sawing facilities for thin board can be considered secondarily.

## 2) Wood dry process

As for the wood drying, there are two sorts of processes: natural and artificial dryings. Most of the wood can be piled up for natural drying.

But the artificial dryer unit is required for the half-finished wood products.

In case of the Mara wood, 1" thick, approx. 32 -- 37 hours are required for the drying to approx. 15% of the moisture, when the standard wood dryer unit is used. In a drying chamber, approx. 100 m<sup>3</sup>, the artificially dried timber, approx. 56 -- 64 m<sup>3</sup> is obtained for two days.

As the high skill is required to obtain the properly dried wood without reducing its commercial value, however, it is desirable that a small-scale wood drying equipment should be first made to give a drying test to each sort of the wood.

Weather, temperature and humidity in this country are different between the rainy and dry seasons. In the Sta Cruz area, the number of days for drying

the Mara (1" thick, piled, moisture, 18 -- 20%) in Nov. -- Mar. is estimated at approx. 50, and that in Apr. -- Oct. at approx. 40.

As the piling of wood, the wood should be piled obliquely at the rate of approx. 9 -- 12 m<sup>3</sup> per unit. Assuming the piling surface is 4 m<sup>2</sup>, the wood, 1,200 -- 1,300 m<sup>3</sup> can be dried per ha. As the monthly dried wood production seems to be approx. 900 m<sup>3</sup> throughout the year on the average per ha., the area of artificial drying yard should be decided in accordance with the quantity of sawed products.

But 70 -- 80 days would be required to reduce the ultimate moisture to approx. 20% in case of Verdolaga, Cuchi, Urundry, Trompillo, etc.

### 3) Plywood and other wooden board

Even if a plywood making plant is built, over 50% of the product must be exported, because the domestic demand for plywood is very small.

Even a plywood plant on the min. scale would be in need of the equipments mentioned in the attached data.

Considering the plywood demand in the adjacent countries, and the transport capacity in this country at present, the export of plywood would be very difficult. The above equipments must be, therefore, carefully examined.

In addition, it would be unnecessary to make researches into the production of such wooden boards as the hard, soft and particle board, etc., because their production is in need of huge investments in facilities.

### 4) Flooring

As mentioned above, a wood manufacturing workshop in Cochabamba is equipped with one unit of flooring making machine, which has been operated for approx. 15 days monthly, because the domestic demand for flooring is very small at present. In this connection, the flooring production should aim at the export rather than the domestic demand. If such hard and fine-grain woods of excellent quality as the Trompillo, Urundry, Verdolaga, Cacha, etc. are then artificially dried, and made into the flooring materials, there would be great possibilities of their being exported, because these

woods are materials suitable for making the flooring.

In case of hard wood, however, the flooring making machine has a production capacity of 180 m<sup>2</sup>, when it is operated for 8 hours per day.

It is, therefore, naturally necessary that the production should be adjusted to the export demand.

#### 5) Conclusion

According to the synthetic program mentioned above, the forest resources only in a certain district (on the outskirts of Sta Cruz) shall be exploited, wood be cut as planned, pulp plant be built, and other related wood utilizing industries be promoted.

It would not be impossible to realize this consolidated development program under the financial and technical aid of foreign countries, judging from the present state of things in this country.

But the then most problematic point is the transport route for export, and the ratio of the freight to the export price.

If the products are to be exported from Sta Cruz to various countries, for example, the transit distance would become longer, and the freight car condition would not warrant optimism because of various bad conditions.

When the products go out of the country, the customs and transit duties would naturally come into question. It is, therefore, indispensable to the export from the country that the products should have scarcity values in the receiving country, and be the necessities (in case of the wood utilizing industry products), which could bear any freight expenses.

Transit routes from Sta Cruz to various places in foreign countries.

(1) Sta Cruz - Corumba (Brazil) - Sao Paulo, approx. 2,400 Km.

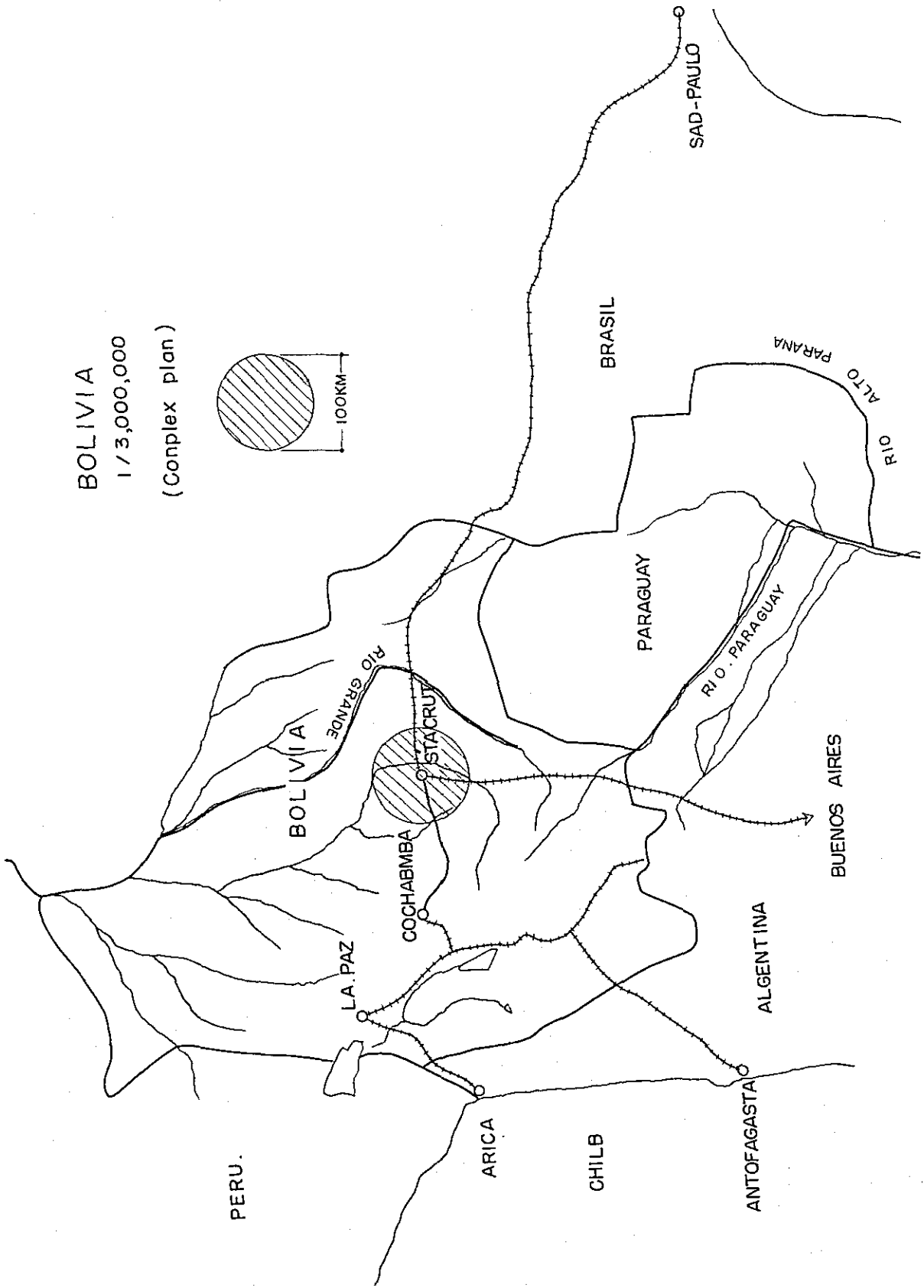
(Note, the railway condition, Corumba-Sao Paulo is said to be under the worst condition, though details are unknown)

(2) Sta Cruz - Yacuiba - Buenos Aires (Argentine), approx. 2,600 Km.

(3) Sta Cruz - Cochabamba - (truck) - Charaad - Arica (Chile), approx.

1,400 Km. (Note : Truck transportation for the route from Sta Cruz to Cochabamba)

Anyway, long-distance transportation is required for the export to foreign countries. In addition, the railway condition including the trucks, locomotives, freight cars is reportedly so bad that the goods would be naturally damaged in transit. In exporting the wood and related products from this country, therefore, it would be necessary to make efforts and take political considerations to overcome various disadvantages ranging over many fields.



LAYOUT OF PLYWOOD PLANT AND THE EQUIPMENTS THEREOF

