REPORT OF
PRELIMINARY SURVEY FOR
FORESTRY DEVELOPMENT IN GUATEMALA

1979

JAPAN INTERNATIONAL COOPERATION AGENCY

Forword

In response to the request of the Government of Guatemala, the Government of Japan has decided to undertake a survey on the forest development and timber utilization of Guatemala in order to promote modernization of its foresty industry and management, and entrusted the Japan International Cooperation Agency (JICA) with the survey work.

More than half the land area of Guatemala is covered with forests, which are important for the conservation of national land, build-up of water resources, and for the economic development of the country.

The Japan International Cooperation Agency dispatched to Guatemala a preliminary survey team headed by Mr. Takeshi Kano to conduct the survey. A report has been formulated by them.

I hope this report will offer a useful guidance for those who are engaged in forest development.

I wish to express my deep appreciation to the officials concerned of the National Forest Institute (INAFOR) and many other organizations concerned of Guatemal a for their close cooperation extended to the Survey Team.

January, 1980

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency

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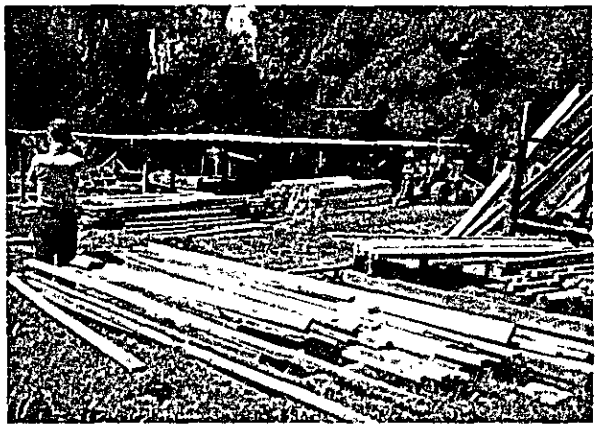
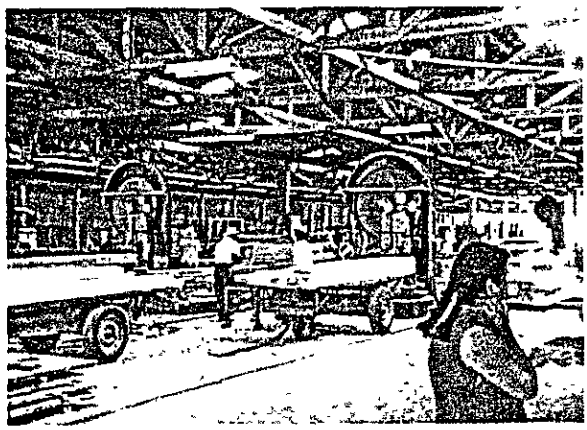
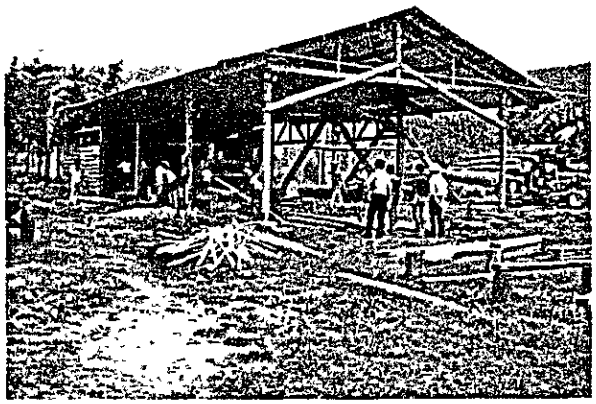


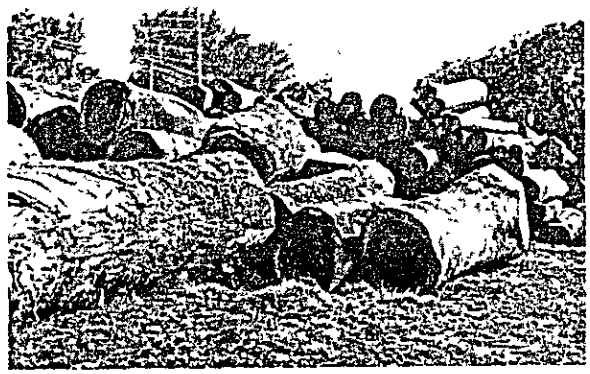
Sawmill of Cooperative Association (Installed by cooperation of INAFOR)



Large sawmill (in Guatemala City)



San Jeronimo sawmill (FAO cooperation)



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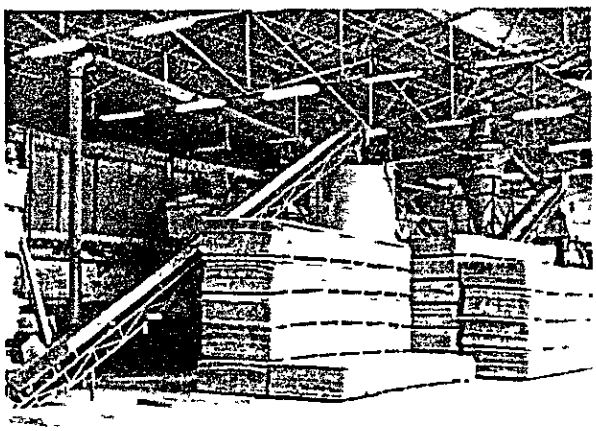
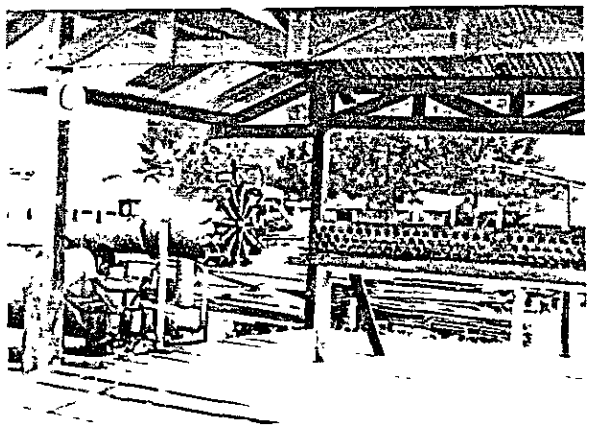
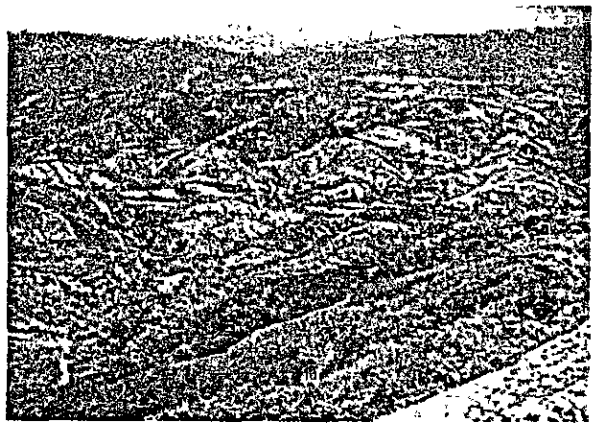


Particle board plant

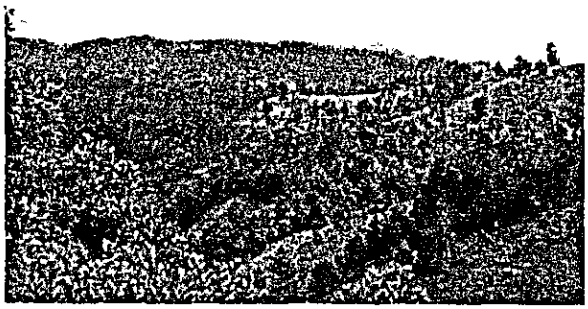


Wood preservative injector

Tropical rain forest in Peten State

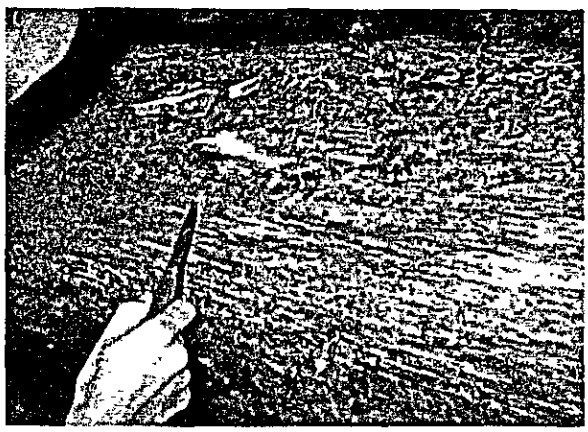


Dry forest land at the middle part of Guatemala



Damage by pine bark beetles (Totonicapan)

Damage by pine bark beetles (Several years elapsed)



Timber damaged by pine bark beetles

Pine not seedlings (INAFOR Nursery)

Chapter I: Outline of Survey

1. Object of Survey and Circumstances

The Republic of Guatemala has a national land area of 109,000 square kilometers and a population of about 6,000,000. The country is mountainous with forests covering more than 60 percent of the land area.

The forests in Guatemala are located, for the greater part, on mountainous district except the Peten area in the northeastern part and the southeastern coastal area along the Pacific and form a natural forest zone of several tens species of pines. In this mountainous area, a number of poor village people are living on meager farm land with pine trees as fuel and pasturage in pine forests. For improvement of the living of such village inhabitants, the Government of Guatemala contemplated use of the abundant natural pine forests and requested, through the Instituto Nacional Forestol (INAFOR) assuming the responsibility of forestry administration of Guatemala, the technical and financial supports of our country for construction of a small pulp plant with a capacity of 40,000 to 100,000 m^3 a year and for promotion of the timber processing industries.

To comply with the request, the Government of Japan decided to dispatch, through the Japan International Cooperation Agency, a Development Cooperation Preliminary Survey Team to Guatemala to investigate the possibility of cooperation through private enterprises of Japan for the requested construction of pulp plant or development of timber processing industries.

The survey team conducted the survey for the purpose of confirming the particulars of the cooperation requested by Guatemala, investigating the present circumstances of forests and forestry as well as social and

economic conditions as the background of the cooperation and examining the possibility of cooperation through civilian sectors.

The composition and itinerary of the survey team are given below.

2. Composition of Survey Team

Head	Takeshi KANO	Director, Wood Utilization Dept., Forestry and Forest Products Research Institute, Ministry of Agriculture, Forestry and Fisheries.
Cooperation Planning	Koichiro OTSUKI	Senior Official, Development Cooperation Div., Economic Cooperation Bureau, Ministry of Agriculture, Forestry and Fisheries.
Forestry Economy	Isao TAKAHASHI	Vice Director, Operation Div., Forestry Agency, Ministry of Agriculture, Forestry and Fisheries.
Wood Processing and Marketing	Yasunori YONEDA	Section Chief, Forest Products Div., Forestry Agency, Ministry of Agriculture, Forestry and Fisheries.
Coordinator	Nobumitsu MIYAZAKI	Vice Head, Forestry Development Cooperation Div., JICA

3. Itinerary

No.	Month	Day	Journey	Description
1	Oct.	3 (Tue)	Tokyo - New York	Movement.
2		4 (Wed)	New York - Guatemala	"
3		5 (Thu)	Guatemala City - Stay	Courtesy visit to Embassy and arrangement.
4		6 (Fri)	"	Instituto Nacional Forestol (INAFOR).
5		7 (Sat)	"	Data collection.
6		8 (Sun)	"	
7		9 (Mon)	"	Consultation with INAFOR.

8	Oct.	10 (Tue)	Guatemala City - Huehuetenango	San Juan de Argueta Agricultural Cooperative Association; Totonicapan city forest pine bark beetle damage survey.
9		11 (Wed)	Huehuetenango	San Juan Ixcoy Forest Association, pine bark beetle damage survey.
10		12 (Thu)	Huehuetenango - Quezaltenango	Malacatancito Forest Association forest road survey.
11		13 (Fri)	Quezaltenango - Guatemala City	Port of Champerico Los Cerritos Paper Plant survey.
12		14 (Sat)	Guatemala City - Stay	Data arrangement.
13		15 (Sun)	"	
14		16 (Mon)	Guatemala City - San Jerónimo	San Jerónimo national forest survey.
15		17 (Tue)	Guatemala City - Stay	Particle board plant (TABLEX) and furniture plant (SIMCO) survey.
16		18 (Wed)	"	Sawmill and San Carlos University survey.
17		19 (Thu)	"	Interim report.
18		20 (Fri)	Guatemala City - Peten	Peten Department forest inspection.
19		21 (Sat)	"	Data arrangement, report to Embassy.
20		22 (Sun)	"	"
21		23 (Mon)	Guatemala City - Los Angeles	Movement.
22		24 (Tue)	Los Angeles	
23		25 (Wed)	Tokyo	Back to Japan.

Chapter II: Guatemala Forestry Promotion Program

1. Guatemala's Requests

The following items are explained as the matters for which Guatemala was expecting of the Japanese survey.

(1) In these years, the coniferous forests located in the northwestern part of Guatemala were suffering from noticeable generation of pine bark beetles, and the damage extended over an area of 125,000 hectares.

(2) In such forest zone in the northwestern part of Guatemala, many native people are living, and the forests are significant for conservation of the environment, while they provide daily necessities such as firewood and building materials for the people.

(3) Although the extent of damage by pine bark beetles is varying from place to place, the damage is destructive in some places, resulting in loss of precious resources, and is thus becoming a social problem. So the control of the insects is now an urgent problem for the nation as a whole.

(4) As a method of controlling the pine bark beetles, there is the so-called sanitary cutting to cut down infected trees and carry them out from the forest, and in fact, this controlling method is employed in some areas.

(5) The work to cut down and dispose the infected trees is a most adequate one for the people living in the forest zone, and such control measure was examined jointly by FAO and INAFOR as a task to be carried out by cooperative associations formed by local inhabitants.

(6) Under such policy, there were three cooperative associations established in and after 1972, and with the financial aid from Sweden, construction of sawmills and forest roads was expedited. Thus, the cooperative associations contributed greatly toward improvement of the living standard of local inhabitants. Therefore, INAFOR is intending to expand and expedite the work in this direction.

(7) For processing of injured trees, it will be required to increase the number of sawmills and establish new pulp plants.

(8) Japan has the modernized industries and is one of the advanced countries in the world so far as the technology is concerned and is particularly experienced in the construction of small pulp plants. Guatemala is expecting financial and technical aids from Japan in the aspect of constructing pulp plants and expanding sawmills.

In addition to the foregoing, it was stated that Guatemala would like to ask the cooperation of the Japanese survey team with respect to the comprehensive countermeasure including control of the insects and prevention of the damage and, specifically, the plan for use of damaged trees in the pine damaged area in the northwestern part of Guatemala.

2. Damage by, and Control of, Pine Bark Beetles

Pine bark beetles causing damage in Guatemala are said to be propagated from Mexico in early 1900. According to the data, in 1936 when General Jorgevio was the President, he ordered to investigate the cause of the damage. But, presently, the cause of the damage is not clarified yet exactly, and it is generally understood that the pine bark beetles attack the pine trees having the weak vigor due to various causes, and damage them.

As the causes of weakening of the vigor of pine forests, the following are considered, and they are described in detail in the appended data.

(a) Weakening of tree bodies by a forest fire.

(b) Excessive pasturage.

(c) Weakening of tree bodies by parasitic fungi.

(d) Weakening of the vigor of tree by overcrowding.

(e) Weakening of the vigor of tree due to poor and bad soil conditions.

As the pine bark beetles attacking the pine forests having the weak vigor, the following insects are reported:

Dendroctonus	adjunctus,
	valens,
	frontalis,
	aztecus, and
	parallelocollis;
Ips	calligraphus,
	mexicanus, and
	integers;
Curphobius	cupressi;
Phloeosinus	s.p.;
Xyleborus	s.p.;
Hylocurus	s.p.; and
Tomolips	s.p.

Among these, the five specied in the Dendroctonus genus are reported to be the ones most generally observed.

The Dendroctonus species are the insects shaped like cylinder with a length of 3-10 mm. Usually, they attack weakened trees, but they breed very rapidly into a large population and, in some instance, attack healthy trees or, more particularly, closed overripened forests.

Adults copulate in the barks, and the female creates passages and deposits eggs on both sides of the main passage. The eggs hatch in about 4 to 9 days. As it grows, a larva forms a chamber in the bark and pupates there. The life of adult is 10 to 32 days, and 7 or more generations emerge in a year. The number of generations varies with the environmental factors, and the damage is greater where the temperature is milder and the relative humidity is lower. It is reported that the atmospheric temperature of 20-22^{o}C and actual humidity of 50-60% are the most suited for breeding.

When attacked by insects, trees begin to secrete resin. But, if the insects break into through the bark, the flow of sap is impeded and begin to be weakened and finally wither.

The flying distance of the insects in the Dendrocutonus genus is reported to be about 10-12 m, and the control method employed presently is to cut down injured trees, strip the bark and burn the bark and branches, while the logs are carried out from the forest. When damaged trees are not usable as lumber, the larvae are exterminated by burning the bark at the site. In the case of a damaged forest section, the trees in an area of about 15 m width around the damaged place are fell down as a preventive zone to prevent flying of adults insects, while the larvae in the damaged area are to be killed.

INAFOR considers that this control method is not in the stage of study (spending time on study is no longer allowed) but of execution and is going to perform cutting, barking and burning of damaged trees.

Among the 9 species of principal coniferous trees in Guatemala, Pinus Rudis is the most vulnerable to the damage of pine bark beetles in that it has smaller resin content in the tree body and is thus less resistive to the pine bark beetles. On the other hand, Oocarpa is scarcely damaged so that it is taken as the species with greater resin content and higher resistance. Pinus Tenifolia is considered to be less damageable. From such points, Pinus Oocarpa and Pinus Tenifolia which are highly resistive to pine bark beetles are chosen as species suitable for reforestation of the damaged site.

In Japan, it was confirmed that the withering of pine teees by pine bark beetles was the damage by nematodes propagated by Japanese pine sawyer, and it was proved to be effective to spray a chemical at the time of adult feeding of the sawyer. Thus, with a legislative measure taken, the control is now in the stage of execution.

According to the data (appended) reported by INAFOR, the cause of damage to pine trees in Guatemala is not considered to be the same with that of in our country so that the control method will of course differ. Nevertheless, cooperation of the experts in control of the pine bark beetles from our country is desired as countermeasures in Guatemala. Further, training in the control measures and techniques of our country is considered to be useful. Thus, by dispatching the experts from each other, it is expected that the control in Guatemala will make a progress.

Particularly, with respect to the 15 m width of the sanitary cutting taken at present, it is doubtful if such width is enough for prevention of the propagation of damage, and this will require study by the experts.

3. Use of Damaged Trees by Processing

(1) Use of Damaged Trees

Use by processing of damaged trees caused by pine bark beetles as described by INAFOR has two aspects.

One is to exterminate adults, larvae and eggs of pine bark beetles which are present under the bark by felling, debarking and burning as a control measure for the damaged trees, and carry them out of the affected area for utilization in various applications. This is thus intended for an intensive use of damaged trees for effective use of the precious resources.

The other is that INAFOR considers the work of preventing damage and processing the damaged trees to be a pertinent one for the cooperative association formed by the local inhabitants. So the improvement in the value added by processing of the timber will bring interests to the members of the cooperative association and then serve for improvement of the living standard of local inhabitants.

These two aspects have essentially different objects from the enterprise activities which intend for profit making. They are, in character, the activities to be performed on the national standpoint. For the production of pulp, however, a private enterprise is operating a paper mill in Guatemala presently with the material pulp purchased from U.S.A. (at 410 dollars/ton at the plant in the case of coniferous pulp). Thus,

the pulp produced in Guatemala as paper material will have to compete with such pulp price. Therefore, where the domestic production of pulp is considered from the national point of view, INAFOR should take adequate measures in the process of production - tree cutting, transport of the material, chip production, pulp production and pulp transport - so that the produced pulp would be competitive internationally in the price at the paper mill.

Further, depending on the output, it will be necessary to study not only the domestic demand but the export to the Middle American countries.

(2) Use as Pulp Resources

According to the INAFOR data, the damaged area of coniferous forests in the northwestern part of Guatemala is estimated at about 120,000 hectares. If the volume of forest wood in this damaged area is assumed to be 100 m^3/ha, the total volume of forest trees to be investigated in the damaged area is estimated at about 12,000,000 m^3.

Such forest wood is important as living materials such as firewood and lumbering so that the material to be furnished as pulp material will of course be the part of these trees.

However, the paper demand in Guatemala is estimated at about 15 kg per capita per year so that the total demand of paper in Guatemala with a population of 4,500,000 is assumed to be not more than about 100,000 tons even if the future increase of demand is included. In Guatemala, about one half of the above-mentioned amount is imported as products presently, and the quantity of purchased pulp is estimated to be about 50,000 tons.

This about 50,000 tons of imported pulp is equivalent to about 100,000 m^3 of the material timber which is only about 1% of the forest wood in the area affected by pine bark beetles. Then, if a plant of a daily output of 200 tons is constructed in the damaged area (200 tons x 250 days or about 50,000 tons a year), the domestic demand of pulp can be accommodated.

Further, if the domestic supply of paper is aimed at, the quantity of pulp to be supplied is 2 times of the above-mentioned quantity or 100,000 tons so with the scale of production of pulp set at 400 tons a day, a yield of about 100,000 tons (400 tons x 250 days) is provided.

With the pulp production set at 100,000 tons a year, the resources required for such production correspond to only about 2% of the damaged area.

For such requirement of material wood, constant supply will be sufficient only by the sanitary cutting of damaged trees. But, it will be important to investigate the resources in detail through survey of, for example, standing timber and determine the suitable scale of the pulp plant.

From what is requested by Guatemala, the plant production is considered for improvement of the living standard of the local inhabitants rather than enterprising economy, and in this respect, it is desirable to proceed in a direction to construct a number of small plants closely related to the respective areas. That is, it is desirable, for example, not to construct a plant with daily output of 200 tons at one place but to construct a smaller plant with daily output of 50 tons in 4 areas.

The problem is what extent of sanitary cutting is required of the damaged forests for preventing further damage, and with respect to this

point, a more detailed survey will be required.

If it is found that an unexpectedly great amount of sanitary cutting is required, the material will hardly be consumed only by the lumbering and domestic demand of pulp, and it will be required to consider the export of chips, etc. to foreign countries.

4. Activities of Cooperative Associations

As a specific method for control of pine bark beetles, INAFOR has employed, with cooperation of FAO, a new system which is very unique and has a social significance. That is participation of the inhabitants of regional society to the control and is carried out now. This system has its concept to form organizations of the regional inhabitants as the members such as forest unions or cooperative associations to perform the cutting and carriage of damaged trees, lumbering and sale of the products and reforestation of the cut site. Thus it aims to secure the labor force and, at the same time, create the places of work for the local inhabitants to increase the income and improve the living standard.

This project to support the union or association activities was already started in the form of adding a forestry division to the agricultural cooperative association which has a history of about 10 years at San Juan de Argueta in Solola as of 1975. Next, it was carried out in the form of creating a lumbering cooperative association at San Juan Ixcoy in Huehuetenango in 1977, thus raising the lumbering industry in this area and having the local people engage in the lumbering. These two associations had lumbering machines and equipment furnished from Sweden, and the works are making a smooth progress. In addition to the foregoing, INAFOR has some specific plans for rearing the associations, and it is going to

organize 10 associations as a target in the near future.

Thus reared association seems to have a significance not only as a measure for control of pine bark beetles but as a nucleus for promotion of the forestry in the central highland area in the West, and the Survey Team evaluates this concept highly, as commented in the Interim Report.

However, in order for this kind project to be carried out smoothly, financial measures (long term, low interest rate equipment fund, short term operating fund, etc.), securing the required technical level (forestry technology in general from formulation of forest plan to cutting, carrying out and forestation, processing and sale techniques of forestry products, etc.), leadership of the manager of association and the will of the members to participate and cooperate, are indispensable. It will be necessary to note that the operation of the association will have a number of difficult problems ahead.

(1) San Juan de Argueta Cooperative Association

This association is located in Solola. It was formed in 1966 with a view to improve the living standard and the educational and cultural level of the members. Initially, the members numbered 27, but they increased to 154 as of 1978. Qualification for participation is to pay 50 Quetzales (dollars) in two years, and there is no other requirement. The association was concerned mainly with the production of wheat for sales and purchase of living necessities. But it purchased a forest of 345 hectares with a long term, low interest loan given from the Agricultural Development Bank in 1967 and had an experience in the management of forestry such as a production of the materials for use of the members. On account of this, the association was first chosen as an object of the forest union rearing

project when INAFOR started the project with cooperation of FAO.

The lumber mill of the association was established in 1976 with donation of the equipment (a circular saw and small tractors and trucks) amounting to 54,000 dollars in total. For the material wood, the association use the trees cut systematically in the forest owned in common, and the monthly output of lumber is about 60,000 Pies tablares (about 142 m^3; 1 m^3 = 424 Pies tablares). The lumber products are sold as building materials in the area in one part and are directed for use by the members on the other. Cutting of the forest is made systematically with permission of INAFOR under the Forest Law and is carried out mainly by selective cutting. Plantation has started since 1977. They produce 15,000 seedlings (Pinus Oocarpa) and about 6,000 trees in 1978. Wages of the workers engaged in forestry works are: 2 Quetzales (dollars) a day for chain saw man and workers in the lumber mill; and 1.4 Quetzales (dollars) a day for workers in plantation and seedling field as in the case of workers engaged in wheat production.

The lumber work of the association is carried out smoothly and is yeilding a profit of about 20%. As the reasons, there may be cited that the association had an experience of performing the activities as agricultural and livelihood cooperative association for about 10 years successively under the distinguished leadership of the manager, that it had the lumber equipment furnished without cost, that it had the demand for its products in the proximity of the area and could sell the product at appropriate prices and that it had adequate technical guidance given from INAFOR.

(2) San Juan Ixcoy Cooperative Association

This association is located in Huehuetenango in the northwestern part of the Central Highland. It was established in 1976 and is formed by 50 members. The qualification for participation is only to pay 60 Quetzales (dollars) in 2 years as in the case of the cooperative association at San Juen de Argueta. As the national park site of 3,400 hectares at an altitude of 3,300 m (forest located close to San Juan Ixcoy Village, owned by the village initially and transferred to national land) was attacked by pine bark beetles, the association started its activities to process the damaged trees and afforest the cut area, with lumber equipment furnished by INAFOR. While the lumber equipment is comprised of only a unit of circular saw and a small truck, the association is sawing timber at a rate of about 4 m^3 a day (about 80 m^3 a month) and selling the products as building materials in the area at about 42 Quetzales (dollars) per m^3. For afforestation of the cut area, seedlings (Cypres Comun, Pino Candilio, etc.) cultured in its seedling farm (about 0.5 hectare) are planted since 1977. In 1977, 15,000 seedlings are planted and 20,000 seedlings in 1978.

As a problem in the operation, the association had no truck furnished for transportation of timber so that it had to use such truck on a rental basis. In this respect, it has some problem in the cost, but except this, the operation seems to be carried out smoothly. To the sawmill are assigned 28 members, and to forest cutting and plantation 6 members, and their daily wages are: manager, 3 dollars; clerical and lumber workers, 2 dollars; and others, 1.5 dollars. The members are engaged mainly in agriculture, but they are farming on holidays and after the association work is finished. Thus it seems that there is no problem. Formerly, they had to go to other place to work. But, now that the sawmill is founded,

they are satisfied with as they are able to get stable cash income at the site.

This association may be taken as a typical case of embodiment of the INAFOR policy to secure labor force as a control measure of pine bark beetles and, at the same time, provide a field of work and open the way of cash income for the local inhabitants.

(3) Dianode las Flores Cooperative Association

This association is located in Mala Village in the proximity of Malacatancito. It was formed in 1977 and has started its activities, but the formal establishment is still in the stage of application for approval. The association is composed of 42 members, and they are respectively an owner of 15-20 hectares of forest. The association was organized for the purpose of joint management of the forests owned by the members, cutting the trees systematically and thus supplying material timber for lumbering and, at the same time, operating a sawmill (of a capacity of 4,000 Pies tablares or about 9.4 m^3 a day). For such purpose, construction of forest roads is required, first of all, as the basis of forestry production, and it was started in 1977 as a project of the association.

INAFOR seems to take up the association as one under the "forest road construction project" and, upon completion, as one to be supported under the "lumber project." Thus, in 1977, it granted a subsidy of 158,000 Quetzales (dollars) for construction of forest roads. However, the cost of forest road construction increased much more than initially estimated, and now the roads are completed only about one half of the plan. As for the fund for construction of the remaining half of forest roads and that for construction of the sawmill, there is no prospect of raising them, and

the success of the activities of this association is depending on this fund raising.

As stated above, the fund, technology and leadership are indispensable for smooth execution of the association activities. Thus, for this association, it is urgently desired to establish a fund raising plan and place the association activities in orbit.

5. Technical Cooperative Relationship of INAFOR with Overseas

In order to strengthen its activities, INAFOR is receiving technical aids, etc. from foreign countries. Principal programs are listed below.

(a) Pensativo River Watershed Management Project

This is a watershed management program formulation project which has been carried out by the support of Australian experts since 1976.

(b) Northwestern Highland Forestry Development Project

This is a project to create a demonstration forest of INAFOR in the northwestern highland area, and afforestation and soil conservation are being carried out with cooperation of the American Peace Corps.

(c) Forest Division Reinforcing Program

This is a project which has been carried out with the support of FAO as a part of the United Nations Development Program (UNDP) since 1972. The activities extended over a wide range, including enactment of Forest Law, establishment of the organization of INAFOR, creation of San Jerónimo model forest, start of the forest union activities, survey of forest accumulation, etc. Further, for improving the level of engineers, training in foreign countries was made.

(d) Others

In addition to the foregoing, INAFOR is in the following cooperative relationship:

- o Prospected support for securing seeds from West Germany;
- o Dispatch of trainees to Chile scheduled with aid from UNDP; and
- o Survey of forest resources with aid of IDB.

For the development of forestry in the Central American countries including Guatemala, the Inter-America Development Bank (IDB) has the following concept.

(a) At the 1977 general meeting, IDB expressed its intent through President Mena that it was considering the development of resources as one of the important fields for which the loan would be made.

(b) As a specific project, it would take up the development of forest resources in Olancho, Honduras, and would make a loan of total 84,500,000 dollars in 1977, while the Government of the Republic of Finland would extend a technical cooperation for execution of the project. Under this technical cooperation, the Finland Government would conduct a feasibility study including the study of the total cost of Olancho Project and market survey for establishment of pulp and paper plants for Corporacion Forestal Industrial de Olancho (CORFINO) of Honduras without cost to Hinduras.

(c) For the development of forestry in Guatemala, IDB expressed its intent that it would be prepared for a gratuitous aid of 600,000 dollars and a loan in a scale of 15,000,000 to 20,000,000 dollars. The loan is a very soft one with repayment in 30 years including a period of 10 years of

deferment (with the interest rate at 1% for the first 10 years and 2% for the remaining 20 years).

(d) Notwithstanding the foregoing intention of IDB, the Government of the Republic of Guatemala has not yet presented a specific project to IDB.

6. Direction of Promotion of Timber Processing Industries

For promotion of the timber processing industries in Guatemala and export of the products, there are a number of problems to be resolved. They are, for example,

i. Reinforcement of the infrastructures of timber processing industry;

ii. Improvement of the timber processing techniques;

iii. Provision of stable collection system of materials and stable shipment system of products;

iv. Presence of a potential domestic demand in Guatemala; and

v. Market researches of the countries for export.

At the present stage, it is considered to be appropriate to take measures for promotion of the industry with a view to improve the industrial infrastructures designed for a considerable amount of domestic demand and to supply the fundamental materials for improvement of the living standard of the people. Thus, in this report, the measures for promotion of the timber processing industry will be described with the domestic demand in Guatemala taken as a basis and in reference to the pulp, chip and lumber industries which are deeply related to the currently impending problem or use of damaged trees by pine bark beetles.

(1) Pulp Industry

As stated in the foregoing, Guatemala is dependent entirely on import for supply of pulp.

Thus, in establishing a plan of constructing a pulp plant in Guatemala, what become problems are the following points.

i. Establishment of more specific plans for promotion of paper and pulp industries in Guatemala.

ii. Conditions for location of pulp plant - Material oriented or consumption oriented.

iii. Choice of species for pulpwood.

iv. Provision of a stable supply system of wood chips and material timber.

v. Provision of a stable supply system of pulp products.

vi. Choice of an adequate pulping method for final paper products and material species.

vii. Securing water resources which are related deeply to pluping.

viii. Securing labor force.

For the pulpwood, occupia and other pines are abundant in quantity and are, therefore, considered to be appropriate. But, from the points of view stated in (i) and (v) above, broadleaf timber will also be required. However, the broadleaf resources comprise a variety of species as are seen in Peten so that they have problems in gathering and pulping.

The pulping method will have to be determined in consideration of the kind of paper and board used in Guatemala and the condition of use of pulp by the paper factories operated presently. At present, however, unbleached kraft paper (UKP) seems to be adequate, but it will be necessary to consider grand pulp (GP).

For construction of a pulp plant and its management, generous government supports will be required in that the paper and pulp production in the world is under severe conditions as stated below. Otherwise, the pulp plant will not be able to operate satisfactorily.

a. With respect to the pulp production in the world, there is a great international difference in the enterprises, and due to the technical innovation, etc., the international competition is intensifying.

b. The scale of management per pulp plant in the world is not less than 100,000 tons/year, and a small scale pulp plant results in high cost.

Further, the pulpwood required for pulp plants now operated in Guatemala is about 100,000 m^3 or 30,000 to 50,000 tons in terms of pulp, and the problems involved in supplying such quantity with damaged trees by pine bark beetles will be described later.

(2) Chip Production

Wood chips are usable as a material for fiber board, chip board or paper and pulp, and the chip production is one of the effective methods for utilization of timber resources including processing of trees damaged by pine bark beetles. However, from the trend of import of pulp from America, use of the wood chips in Guatemala is considered to be limited to chip board plants.

In producing wood chips, the following should be noted as important points.

i. Clarification of the industries on the demand side in that the wood chip manufacturing is an industry to supply materials to the paper and pulp industries.

ii. Choice of the material species, etc. in relation to "i" above.

iii. Development of the material, wood supply system etc. for stable production of wood chips.

iv. Development of the wood chip stable supply system.

While the existing paper mills are being operated under the system of importing all of the pulp required, only the chip board plants are operated with material timber collected from the area in the vicinity of Guatemala City. Thus, unless paper and pulp or fiber board and chip board industries are newly installed for promotion of the wood chip industry, development of the wood chip industry is not expectable.

Further, if it is intended to produce chips not only for domestic use but for foreign markets, advancement of the wood chips to new international markets will be very difficult in terms of the international situation surrounging the production of wood chips as stated below.

a. In the international market, the wood chips as material of pulp and paper are in a trend of excessive production.

b. In the international trade, a system of stable supply of chips of uniform quality and in large lots is required.

From the foregoing, promotion of the wood chip industry involves big problems, but promotion of industry should be considered, as part of the development of forestry industry, with the chip board, which has already started its production, as a nucleus.

(3) Lumber Industry

For effective use of the pine bark beetle damaged trees, etc., lumbering is the most effective although it involves problems in carriage, etc. of the damaged trees. As regarding to lumbering, it is considered that satisfactory activities have already been carried out.

For promotion of the lumber industry, there is a plan established by INAFOR with cooperation of FAO, and the survey team considers this direction to be adequate in principle.

The survey team is also in cognizance of the fact that the construction of the lumber plant has greatly served for improvement of the living standard of people in mountainous villages through offering the place of work for the rural inhabitants, and the activities of INAFOR are expectable in the future.

However, in constructing a lumber plant for processing of pine bark beetle damaged trees, etc., the following points should be taken into consideration.

(1) The existing sawmills have a sufficient allowance in the lumbering capacity so that their production system should first be improved.

(2) Now that the timber processing engineers are shortcoming, it is imperative to train engineers.

(3) To raise the demand for timber, development of a series of policies from afforestation to timber processing is required.

(4) The lumber plant will have a difficulty in future management if it depends only on the processing of damaged trees. Here, it is required to establish a forest plan to permit long range supply of material wood and a market developing system for sales of the products, and the scale of operation should be determined accordingly.

(5) Due consideration should be given to harmony, etc. with the use of firewood by the village people which occupies a great part of timber consumption.

Chapter III: Possibility of Cooperation through Private Enterprises

The requests of INAFOR for the survey this time may be summarized as follows, as stated above.

1. Pine bark beetle damage control.

2. Sanitary cutting, carriage and processing of damaged trees.

3. Construction of lumber mill and pulp plant for processing of damaged trees.

4. Management of lumber mill and pulp plant by cooperative association of local inhabitants.

5. Improvement of the living standard of the inhabitants by rearing the cooperative associations of the local inhabitants.

Among these, what INAFOR expected particularly of the Japanese side was the financial as well as technical support for construction of the lumber mill and pulp plant.

The total area of the damaged forest is estimated at 12,000,000m^2, and cutting of only several percent of the above-mentioned area is considered to be enough to meet the domestic consumption of lumber and pulp in Guatemala.

However, depending on the speed of attack of pine bark beetles and the quantity of cutting for the sake of preventing damage, the policy to be taken is subject to be changed, and for establishing such policy, a more detailed survey will be required.

If the request of INAFOR are taken as they are, the pulp plant and lumber mill to be constructed are of very small scale so that the scope of cooperation permitted for the Japanese private enterprises is limited. However, as the quantity of sanitary cutting increases, it will be considerably difficult to use up the cut trees only in Guatemal a or Central American countries. Thus, there arises a necessity of studying the export of chips to foreign countries.

Should the export be made, the chip production and export are expected to be of considerably large scale, and then the cooperation of private enterprises from Japan will become necessary.

In the present survey, we were unable to make any conclusion because of the time limit.

It is hoped that more adequate measures will be established through surveys of the resources, damaged trees, cutting plan for control of damage, etc. at the site of damage.

Chapter IV: Necessity of G-G Cooperation

As reported up to the preceding paragraph, the role of forests in improvement of the living standard of the people in the mountainous area except Peten in Guatemela is very important. Particularly, the present situation, which a number of pine forests being attacked by pine bark beetles and pressed for immediate sanitary cutting, has brought up close relationship between the forest andthe local inhabitants in some aspects.

One of such aspects is the emergence of the place of work through cutting and utilization of the trees attacked by pine bark beetles, while another is the devastation of the living place upon extinction of the forest after cutting.

As a means to solve these two contradictory phenomena, INAFOR is going to promote, under the advice of FAO, etc., a project to rear and reinforce the forest unions for the purpose of accelerating adequate control of forests through organization of the people in the mountainous area, and this has been stated in the foregoing. And it is also true that such fostering and strengthening of forest unions will become a key for cooperation through Japanese private enterprises concerning the promotion of timber processing industries in Guatemala in the future.

Fostering and strengthening of the forest unions first started with sanitary cutting of trees damages by pine bark beetles, and it stressed on the conservation of resources by forestation successively. For expansion and intensification of these policies, there will be required: (1) Exact grasping of the forest condition, timber accumulation and the condition of generation of damage caused by pine bark beetles; (2) Establishing a cutting plan for damage control; (3) Establishing a forest control and

management plan; (4) Preparation of forest survey books and maps as basic data for formulation of the plans; (5) Formulating a forest road improvement plan; (6) Formulating a forestation plan; and (7) Planning a lumber mill, chip plant and pulp plant for procdssing of damaged trees.

With respect to (1) generation of the damage of pine bark beetles must first be examined ecologically, and if the technical cooperation of the researchers of Japan is obtainable, its effect seems to be remarkable. It will also be effective to conduct a comprehensive survey of the forests damaged by pine bark beetles with technical cooperation of Japan. The survey may include, for example, looking into the main factors causing damage by preparing an accurate standard map of forest through survey in use of aerial photos (or, more specifically, infrared photos), plotting the damaged forests on the map and examining the environmental location in use of the procedure of multi-variable analysis. Further, along such survey, it will be possible and is considered to be effective to advance the techinical cooperation concerning the formulation of the forest plan specified in (2) and the transfer of the procedure of formulation.

For (3), a system of forest plan having a long history is settled in Japan, and there are a number of engineers who will be able to offer advices on the administrative support or systems for supervisor training, etc. If the techinical cooperation of such engineers is obtained, INAFOR will have its administrative measures intensified much more. In order for (4), (5), (6) and (7) to be executed, introduction of various forms of financial cooperation is expected in addition to the technical cooperation because of the enormous amount of fund required and versatality of the characters of support funds. In this respect, introduction of the development support fund through international organizations along with

that through various systems of Japan is considered to be indispensable. For Japan, thus, it will be imperative to consider the technical cooperation concerning a feasibility study for formation of a project on such investment of the international organizations.

If such technical cooperations are furnished to the Instituto Nacional Forestal of Guatemala, the step toward promotion of the forestry and improvement of the welfare of the people in mountainous villages in Guatemala will start steadily. But, what is to be considered here is the decisive shortage of forestry engineers who receive such technical cooperations in Guatemala. For training of forestry engineers, study in the forestry departments of the foreign universities in Chile, Honduras, etc. and learning at the Forestry School, Huehuetenango Division, San Carlos University, started only shortly ago, are available in Guatemala presently, and engineers capable of instructing at the site are scarcely found. Thus, the supports of the international organizations extended to the forestry education and training division is considered to be one of the technical cooperations Guatemala is looking forward to.

Anyway, it is desirable to start the cooperation for education and training of the forestry engineers of Guatemala such as, for example, acceptance of trainees and dispatch of experts concerning the control of pine bark beetles and also creation of a forest union support system as technical cooreration of our country.

Reference 1 Informe Preliminar Sobre Desarrollo Forestal en la Republica de Guatemala

Honorable Señor
Jorge Spiegler No.
Gerente del Instituto Nacional Forestal
INAFOR
Su Despacho

Honorable Senor Spiegler:

Tengo el gran honor de poder presentar a usted este informe preliminar que elaboro la Misión Japonesa de Estudio Básico para el Desarrollo Forestal de J.I.C.A., de acuerdo a las investigaciones realizadas en el pais del 4 al 23 de octubre en curso.

El propósito de esta Misión ha sido el de efectuar estudios de factibilidad e intercambio de opiniones con las autoridades forestales del pais sobre los temas submencionados relacionados con la solicitud de cooperación que por via Diplomática el INAFOR hiciera a nuestr pais para fomentar las industrias de procesamiento de maderas:

A) Intercambio de opiniones sobre los proyectos de fomento de la industria de procesamiento de madera en Guatemala.

B) Recabar informaciones sobre las condisiones de los bosques y la politica forestal de Guatemala que constituyen la base para la elaboración de dichos proyectos.

C) Examen e intercambio de opiniones sobre la posibilidad de cooperación técnica y financiera por empresas privadas japonesas para el fomento de la industria de procesamiento de la madera.

La Misión Japonesa ha intercambiado puntos de vista con usted y otras contrapartes de INAFOR desde el 5 de octubre último y llegó a establecer que los temas concretos de interés que INAFOR expuso son los siguientes:

a. Es problema imperativo la protección y la eliminación de aquellos bosques de pino dañados por el gorgojo, el cual se está extendiendo por toda la región nor-occidental de Guatemala.
(Huehuetenango, Totonicapán, Quiché, Sololá, San Marcos, etc.)

b. Es un tema de suma importancia para la seguridad económica de su pais proteger los recursos forestales de los daños del gorgojo que a la vez constituye un serio problema de órden social pués ello implica la pérdidad de importantes materiales que podrian ser utilizados en la construcción de viviendas.

c. Seria de un positivo efecto talar los arboles dañados y utilizarlos, ya sea para leña o como materiales para la construcción de viviendas, reforestar la parte del bosque mutilado y precesar los arboles talados como una de las medidas de protectión ontra el gorgojo.

d. En las regiones que han sido dañadas por la invasión del gorgojo vive un número considerable de habitantes, los cuales por falta de trabajo se ven obligados a desplazarse a la costa en busca de un medio de ganarse la vida. Seria muy productivo, la formación de cooperativas para la tala y aserramiento de las daderas daña das y la reforestación asi muchas oportunidades de empleo.

e. La idea de cooperativización, después de estudios conuntos por FAO e INAFOR al ser puesta en práctica dió por resultado la formación de tres cooperativas a partir de 1977 con la asistencia financiera de Suecia.

f. Por tanto, para empliar esta idea, INAFOR expresó el deseo de contar con la cooperación técnica y financiera del Japón para la instalación de fábricas de pulpa y aserraderos.

De acuerdo a las ideas arriba mencionadas y con base a la solicitud de INAFOR, la Misión realizó su investigación in situ seguń el itinerario siguiente:

19 de octubre	Actividades de Aserramiento de maderas y reforestacion que lleva a cabo la Cooperativa de San Juan Argueta.
11 de octubre	Visita al área de San Juan Ixcoy dañada por el gorgojo y observación de las actividades de la Cooperativa local que utiliza los árboles dañados procesando su madera.
12 de octubre	Contacto con el Centro Universitario de Nor-occidente de la Universidad de San Carlos, en Huehuetenango; y observación del camino forestal que construye la cooperativa de Malacatansito y el bosque de pino.
13 de octubre	Visida al Puerto Champerico y fábrica de papel situada en Los Cerritos.
14 de octubre	Observaciones sobre el Bosque Nacional en San Jerónimo (Bajo el cuidad de INAFOR)
17 de octubre	Aserraderos de la ciudad de Guatemala.

1. Resultados de la Investigacion

La opinión de la Misiń sobre la plaga del gorgojo y las medidas a tomar, después de los estudios in situyconsulta con INAFOR, es la siguiente:

1. Situación de los daños producidos por el gorgojo

   a. Se presume que el gorgojo llegó de México a principios del anõ 1900 ye produjo estragos en varias oportunidades, pero la plaga actual ha causado serios daños en un área más extensa.

   b. El daño causado por la plaga en San Juan Ixcoy es desvastador y el bosque está casitotalmente destruido y árboles que áun tienen hojas verdes están siendo carcomidos en su mayoria.

   c. La plaga se ha extendido más cada año y si no se tomasen medidas drásticas e integrales para combatirla se estima que podria llegar a ser un problema continental.

2. Medidas que se han tomado en contra del goriojo:

   a. En los últimos dos o tres años se empezó a tomar varias medidas en algunas áreas, pero en la mayor parte de las áreas deñadas no se ha tomado ninguna medida lo cual ha causado la expansión de la plaga.

   b. Actualmente se están talando los árboles secos o próximos a morir como una medida contra la expansión de la plaga del gorgojo.

   c. Aún no se ha determinado cual es el mecanismo por el cual el gorgojo mata los árboles y por qué se ha extendido tan rápido.

   Por tanto, como aún no se sabe si son acertadas las medidas tomadas es necesario proceder a estudiar en forma inmediata el problema para elaborar una fórmula adecuada.

3. Situación actual de la utilización de los árboles dañados:

   a. Los árboles dañados están siendo utilizados como madera aserrada y como combustible doméstico.

   b. Los aserraderos fueron instalados con asistencia de FAO y el Gobierno de Suecia y son administrados por cooperativas locales, lo cual contribuye a que los habitantes locales tengan dinero en efectivo, reduciendo asi la necesidad de emigrar fuera de la región y aumentando el bienestar de los mismos.

   c. En la actualidad solamente hay dos aserraderos administrados por cooperativas: San Juan Ixcoy y San Juan de Argueta, las cuales son insuficientes para procesar todos los árboles dañados en muchas áreas. Por tanto, es necesario instalar más aserraderos a pequeña escala.

   d. Sobre los mpetodos de la tala de árboles dañados, sistemas de recolección de los mismos, instalación y técnica en el manejo de la maquinaria, existen algunas dudas. Deberá mejorarse la capacitación de los operarios de tal manera que puedan trabajar segura y eficientemente.

4. La regeneración de los terrenos después de la tala:

   a. En las áreas dañadas es necesaria la tala selectiva de los árboles dañados. Pero la técnica actual de regeneración es insufienciente. Deberá desarrollarse la técnica en este campo.

   b. Habrá que reforzar las actividades de reforestación de las cooperativas en vista de la necesidad de perpetuar la vida de las cooperativas y de conservar y fomentar los recursos forestales.

5. Centro Universitario de Nor-occìdente de la Universidad de San Carlos, en Huehuetenango.

Recientemente se ha iniciado la educación y el estudio en el campo de la silvicultura. Recién en 1976, dió principio su actividad, de manera que en la actualidad deja mucho que desear para mejorar el sistema educativo en general, tales como encontrar instalaciones adecuadas para la educación, como el uso de materiales de enseñanza. Especialmente en la administración estatal de la silvicultura hay falta de expertos en el ramo. Es una necesidad imperiosa crear y entrenar especialistas en silvicultura.

6. Bosque Nacional de San Jerónimo:

En el Bosque Nacional de San Jerónimo administrado directamente por INAFOR, se observa que los bosques son muy bien cuidados, lo cual demuestra que INAFOR está haciendo grandes esfuerzos en la conducción de la politica forestal del pais. En los aserraderos a su cargo, se reconoce también su papel pionero como por ejemplo con la instalación de un secandero y equipos de preservación. Felictamos a INAFOR por la excelente labor que realiza en este bosque nacional. Hacemos votos porque en el futuro se mejore aún más los logros administrativos en dicho bosque teniendo en cuenta la misión de constituirse en un ejemplo para otras iniciativas.

7. Aserraderos en la Ciudad de Guatemala:

Después de visitar las fábricas de plachas de madera compactada, de muebles, aserraderos y de mosaicos de madera, concluimos que las industrias madereras en Guatemala está produciendo lo suficiente para satisfacer la demanda pero que para el mejor desarrollo de las mismas existen algunos problemas por resolver, tales como el suministro

estable y continuo de materias primas, mejora de las instalaciones y maquinaria, introducción de técnicas modernas, etc.

II. Posibles Areas de Cooperacion Japonesa

Para la protección de los bosques y el desarrollo de la silvicultura en Guatemala, la Misión considera recomendable estudiar las siguientes posibles áreas como objeto de la cooperación japonesa:

1. En los últimos años en Japón también se han observado graves daños causados por el gorgojo, y sólo muy recientemente se ha establecido que tales daños a los pinos no son causados por la acción directa del gorgojo sino por nematodos cuyo agente transmisor en el gorgojo. Opinamos que en Guatemala son my visibles los daños cusados por el gorgojo pero que todavia no se ha establecido plenamente el mecanismo por el cual los árboles atacados por esta plaga son destruidos total o parcialmente. En esta campo si es el deseo del Bierno de Guatemala, el Japón con sus propias experiencias podria cooperar eficazmente con el Gobierno de Guatemala enviando especialista o aceptando técnicos guatemaltecos para su entrenamiento en el Japón.

2. Opinamos que, la labor conjunta que INAFOR y FAO están realizando para promover la creación de cooperativas para la tala y procesamiento de árboles deñados y posterior reforestación tiene efecto muy positivo para elevar el bienestar rural y, por consiguiente, es muy deseable su futuro desarrollo.

   En el Japón, tambien para el fomento de la vida rural y de la reforestación desde hace mucho tiempo se ha incentivado el movimiento cooparativista, dotando al Japón de una large experiencia en el mojoramiento institucional y de formación de lideres. La Administración de

cooperativas forestales conlleva problemas bastante dificles y necesita apoyo decidido del Bobierno central. Si el Gobierno de Guatemala desea la cooperación de Japón en este campo en las formas de envio de técnicos japoneses o aceptación de becarios guatemaltecos para el entrenamiento en Japón, tal asistancia seria muy útil.

3. Es de desear que las cooperativas que contribuyen a reducir los efectos de la plaga del gorgojo y al mismo tiempo aumentar el bienestar rural, siga desarrolládose en el futuro en forma adecuada y satisfactoria. Para lograr ésto, será nècesario utilizar los recursos forestales en forma planificada. Seria muy recomendable que INAFOR ayude a los sectores interesados a levantar mapas básicos forestales, mapas de tipos forestales, catastros forestales, etc. Si el Gobierno de Guatemala lo solicita, el Gobierno de Japón podria estudiar la posibilidad de cooperar con INAFOR en dichos campos para efectuar el inventario forestal.

4. Es de suponer que en algunas circunstancias no podremos depender únicamente de las cooperativas para la eliminación del gorgojo o proctección de los recursos forestales de los daños producidos por el mismo. En este caso, será necesario recabar las informaciones en forma inmediate y exacta respecto de daños particulares de una región. Para eso el inventario forestal será gran utilidad.

5. Con respecto a la instalación de una industria maderera a gran escala o de una fábrica de pulpa que reauiere constante y voluminoso suministro de materias primas, antes de llegar a una conclusión necesitaremos analizar en forma integral ciertos aspectos importantes como sigue:

   1) Incidencias negativas sobre el fomento a las cooperativas que actualmente se están impulsando (Empresas de fuerte capital).

2) Posibilidad de suministro estable y continuado de materias primas después de la tala de árboles dañados por la plaga.

3) En el caso de la fábrica de pulpa, investigación de costos comparativos de pulpas nacionales e importadas.

4) Politica de explotación forestal en el Petén.

Finalmente quiero expresar mi sincero agradecimiento a los señores de INAFOR por haber prestado su gentil atención y proporcionado vallosa documentación a nuestra Misión para la realización de nuestras labores. Analizaremos estos documentos más detenidamente después de nuestro regreso a fin de que en su oportunidad podamos presentar un más detallado informe final.

Guatemala goza de abundantes recurosos forestales y un ambiente natural de suma hermosura, tiene, además muchos importantes vestigios de la cultura maya, siendo por ello primordial la explotación del ambiente natural tomando en cuenta la protección de los recursos forestales. En cuanto a este aspecto, Guatemala tiene mucha semejanza con las condiciones naturales de los bosques japoneses.

Si llegare a concretarse la solicitud guatemalteca, nosotros informaremos al Gobierno y a otras instituciones relacionadas de Japón para promover la cooperación al más amplio nivel posible.

Espero que las labores de nuestra Misión hayan contribuido, no sólo a la compresión mútua y a una incipiente pero solida amistad con los señores expertos en silvicultura, sino también a fomentar las relaciones de cooperacion entre Guatemala y Japón.

Reitero a usted mi sincero agradecimiento y aprovecho la oportunidad para suscribirme.

Muy atentamente,

Takeshi Kano
Jefe de la Misión Japonesa de
Investigación Forestal
(Misión de Investigación Preliminar
para el Desarrollo Forestal de la
República de Guatemala)

Reference 2 Present Condition of Timber Processing Industries in Japan

1. Pulp Industry

Pulp production of the pulp industry in 1977 is 9,437,000 tons as shown in Table 1, ranking the third following America and Canada in the world. But, the recent productive activity of the pulp industry is hovering low because of increasing import of the pulp products.

There are 74 pulp producing factories, and the total employees are 15,000 as shown in Table 2.

Materials are supplied about 10% of pulpwood and about 90% of chips. About 40% of the chips are dependent on import as shown in Table 4, and the dependency on import chips is intensifying in these years.

Table 1 Paper and Pulp Production (Unit: 1000t)

Year	Paper and Board	Pulp
1973	15,975	10,123
1974	15,646	10,040
1975	13,601	8,630
1976	15,394	9,518
1977	15,702	9,437

"Statistical Annual Report of Paper and Pulp"
Ministry of International Trade and Industry

2. Paper Industry

Production of paper and board by the paper industry in 1977 is 15,702,000 tons, as shown in Table 1, ranking the second following America in the world. Recent productive activity of the paper industry is hovering very low, particularly in the division of board, owing to stagnant domestic demand but is making a recovery generally.

There are about 1,100 factories producing paper and board including large and small factories. But, the small factories with a daily output less than 200t constitute about 90% of the whole. Employees working in the paper and board factories are 64,000 in total, as shown in Table 2.

Demands for paper and board in 1977 (except private use) were 14,755,000 tons, broken down to 37% for cultural use such as for newspaper, printing and writing, 57% for industrial use such as packing paper and board and 6% for household use such as tissue paper.

In addition, per capita consumption of paper and board in Japan is 134.5 kg (1976), and this consumption is ranked ninth in the world.

The material pulp is increasingly dependent on the import, and the dependency on the import pulp including DP (dissolved pulp) in 1977 was 11%.

The equipment investment of the paper and pulp industries in 1977 was 156.7 thousand million yen which were low as the preceding year. Under such situation, the investment on paper and board equipment amounted to about 80 thousand million yen or about 2 times that in the preceding year, but the investment on pulp sector, pollution control and maintenance decreased remarkably.

Table 2 Employees at Paper and Pulp Plants (Unit: 100 Persons)

Year	Paper	Board	Pulp	Total
1973	509	219	174	902
1974	498	218	171	887
1975	477	205	168	850
1976	468	193	160	821
1977	451	184	154	789

"Paper and Pulp Statistics"
Ministry of International Trade and Industry

Table 3 Equipment Investments of Paper and Pulp Industries
(Unit: Hundred Million Yen)

Year / Classification	1970	1971	1972	1973	1974	1975	1976	1977
Pulp	414	365	241	268	446	506	537	370
Paper & board	768	562	552	699	769	695	404	809
Pollution control	85	235	201	380	522	437	270	164
Maintenance	194	211	233	377	401	311	286	224
Total	1,464	1,373	1,227	1,724	2,138	1,949	1,497	1,567

"Paper and Pulp Statistics"
Ministry of International Trade and Industry

3. Present Condition of Chip Industry

In Japan, the chip industry was first established in 1950's and developed as a division for supply of materials to the paper, pulp and fiber board industries.

However, the management activities of the chip industry in these years are rather restrained and are tending to move in a direction toward reduction of the production owing to the sluggish paper and pulp industries which are the main areas of demands, and owing to increasing import of chips and pulp.

In 1977, the chip plants numbered 7049 as shown in Table 5, and about 90% of them were operated alongside the lumber mills, etc. Generally, the management is of minor scale as shown in Table 6, and plants of less than 10 workers constitute more than 90% of the whole plants.

The chip production in 1977 was 15,930,000 m^3, with chips of the coniferous trees at 34% and those of the broadleaf trees at 66%, as shown in Table 7. The proportion of outputs by materials is: raw material, 52%; plant residue, 46%; and forest residue, 2%. Specifically, the chips of coniferous trees are dependent largely on the plant residue, and the chips of broadleaf trees on the raw material.

Table 4 Domestic and Foreign Supplies of Pulpwood and Chips

(Unit: 1000 m^3)

Year	Total	Pulpwood			Chip		
		Total	Domestic	Foreign	Total	Domestic	Foreign
1973	37,381	4,379	3,712	667	28,002	17,446	10,556
1974	35,521	5,012	3,781	1,231	30,509	17,680	12,820
1975	28,787	3,251	2,673	578	25,536	14,324	11,212
1976	31,961	3,257	2,856	401	28,704	15,826	12,878
1977	31,981	2,844	2,521	323	29,137	15,581	13,556

"Paper and Pulp Statistics"
Ministry of International Trade and Industry

Table 5 Number of Chip Plants

Year	Total	Joint Operation		Independent	Workers
		Sawing	Veneer and flooring production		
1973	7,650	6,624	102	924	25,004
1974	7,693	6,698	117	878	23,697
1975	7,319	6,383	97	839	21,372
1976	7,176	6,267	97	812	20,672
1977	7,049	6,157	81	811	-

"Paper and Pulp Statistics"
Ministry of International Trade and Industry

Table 6 Number of Chip Plants by Scale of Employees

Total	Total	4 or less	5-9	10-19	20 or more
	7,049	6,008	572	383	86
Joint operation	6,238	5,792	282	110	34
Sawing	6,157	5,726	275	106	30
Veneer & flooring production	81	66	7	4	4
No joint operation	811	216	270	273	52

"Chip Statistics"
Ministry of Agriculture, Forestry and Fisheries

Table 7 Chip Production by Material, Tree Species and Management Form (1977)

(Unit: 1000 m^3)

Classification	Total	Raw material (Material timber)	Plant residue	Forest residue
Total	15,928	8,239	7,251	438
Species				
Coniferous trees	5,490	725	4,728	37
Broadleaf trees	10,438	7,514	2,523	401
Management form				
Joint operation				
Sawing	9,271	3,374	5,646	251
Veneer & flooring production	552	24	528	-
No joint operation	6,105	4,841	1,077	187

"Chip Statistics"
Ministry of Agriculture, Forestry and Fisheries

4. Present Condition of Lumber Industry

The lumber industry in Japan is producing lumber products for building of dwelling houses. In 1977, it consumed 53,870,000 m^3 of material timber and produced 38,180,000 m^3 of lumber products, as shown in Table 8. The material timber is comprised, by kind, of domestic timber 38%, North American timber 28%, South Sea timber 14% and miscellaneous 6%. By application, it is comprised of 77% for building, 8% for packing, 8% for furniture and fixtures, 3% for construction and 4% for miscellaneous use. The greater part of the material for building is applied to housing using the conventional wall frame construction method.

Domestic production of the lumber followed a way of increase up to 1973. Thereafter, however, with sharp decrease of the demand, it moved at a low level up to now.

There are 23,136 lumber plants as of 1977, and they are distributed over the whole country. Classified by the lumbering power output, the lumber plants less than 75Kw account for 78%, those of 75-150Kw for 14% and those above 150 Kw for 8%.

The lumber products are of high weight of material cost and low value of addition. That is, the material timber is priced high, giving a small margin to the product price. Thus, in production of the lumber, it is particularly important to improve the value added as well as the yield through an appropriate choice of dressing method. From such situation, saw mills are, for the greater part, band saws, and relatively thin saws are used.

With the stagnation of demand in and after 1974, excessive capacity

of production is tinted deeply throughout the country, so structural improvement including development of the demand and higher level of processing, and stabilization of material supply are listed as pressing problems for the industry.

Table 8 Outline of Lumber Industry

Year	Number of Plants	Number of Employees	Supply of Round Wood (1000 m^3)			Lumber Production		Import of Lumber Products (1000 m^3)	Lumbering Power Output	
			Domestic Timber	Foreign Timber	Total	Quantity (1000 m^3)	Percentage to Previous Year		1000 Kw	Percentage to Previous Year
1970	24,546	254,343	27,362	30,690	58,082	42,127	101%	3,011	1,126	107%
1971	24,199	244,560	26,325	31,503	57,828	41,806	99	2,129	1,158	103
1972	23,930	245,956	26,433	34,723	61,156	43,664	104	2,422	1,216	105
1973	24,018	243,181	26,102	37,601	63,703	45,038	103	3,679	1,324	109
1974	24,016	232,732	22,388	34,059	56,447	40,510	90	3,637	1,388	105
1975	23,630	221,356	20,961	31,416	52,377	37,362	92	2,612	1,418	102
1976	23,482	215,921	21,378	33,669	55,047	39,315	105	3,301	1,462	103
1977	23,136	207,492	20,526	33,345	53,871	38,273	97	3,586	1,479	101

Reference 3 Pine Bark Beetle Damage and Control in Japan

1. Circumstance and Present Condition of Damage by Pine Bark Beetles

From old times, the pine is said to be the best of all trees and is a very familiar tree for the Japanese for the evergreen of the tree means immortality and long life pledging perpetuity. Further, the "white sand and green pine" present a splendid scenery, and the wording is well said to be a synonym representing the beautiful scene in Japan. Growing along the front line of the Japanese islands and under severe environmental conditions, the pine trees are silently protecting the people's livelihood and farm land from disasters.

Not a small number of these pine forests were developed by our predecessors through a large amount of expense and labor and as the result of assiduous efforts and works over long years.

However, the pine forests extending from Okinawa in the south to Miyagi in the north were attacked by the so-called pine bark beetles in these years. Pine trees begin to wither suddenly from summer to autumn, presenting a scene of untimely red leaves. The damage is thus related to the environment and is posing a serious social problem.

According to the record, damage by the pine bark beetles occurred first in 1905 in the pine trees in Nagasaki. Subsequently, there was a report of about 3,000 pine trees withering in a year in the vicinity of Ashiya Cho, Fukuoka.

Further, in 1913, pine bark beetles occurred in the privately owned pine

forests near Nagasaki. The Prefectural Government exerted efforts for control of them with an order issued, and they were terminated in about 2-3 years.

From 1914 to 1921, the beetles developed in Hyogo. Consequently, the old trees in the remains of Akaho Castle and in the lines of trees in the Hachiman Shrine in the present Aioi City were destroyed.

In 1925, they occurred again, after some period of cessation, in Nagasaki or, more specifically, around Sasebo City, but the site was a military land, precluding thorough control. Thus, they spreaded over the whole area of the prefecture until about 1935 to 1937.

In 1928, they occurred in the Akashi Castle, Hyogo, and the old trees withered and continued to wither every year thereafter.

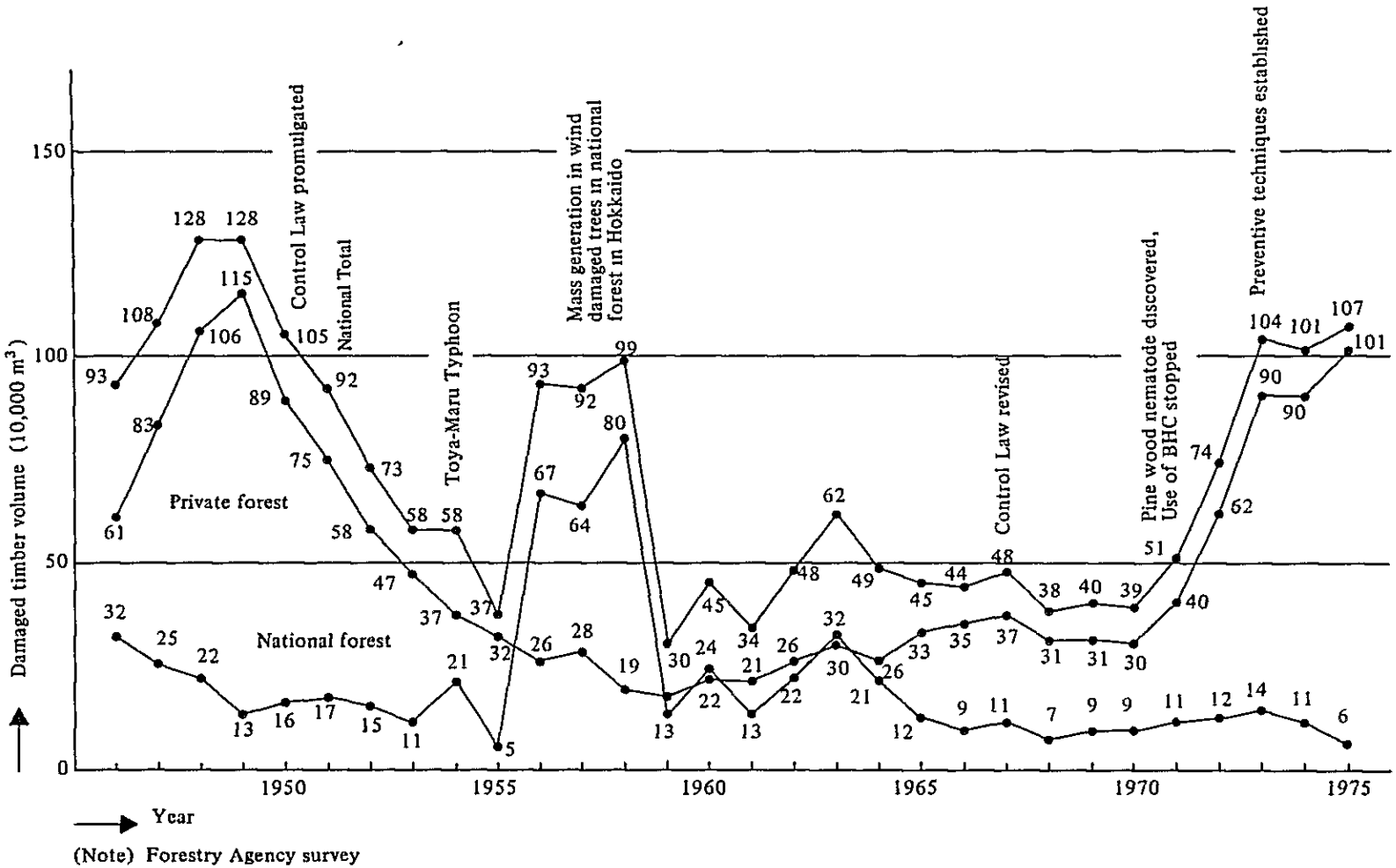
In 1933 to 1936, they occurred in the municipal forest of Aioi, Hyogo, spreaded along the coast of the Seto Inland Sea and intruded from Hyogo into the eastern part of Okayama.

The volume of timber damaged by pine bark beetles in 15 years of from 1932 to 1946 amounted to about 3,700,000 m^3 or damage of 250,000 m^3 a year, and the damage was particularly heavy in Hyogo, Nagasaki, Okayama and Miyazaki.

Now seeing the damage after the War, there were three peaks of occurrence, and now is the fourth peak (Fig. 1). The first peak occurred in 1947 to 1950, with damage exceeding 1,000,000 m^3 every year, and the cause is considered to be the extensive forest denudation due to excessive and indiscriminate cutting of forests during and after the War.

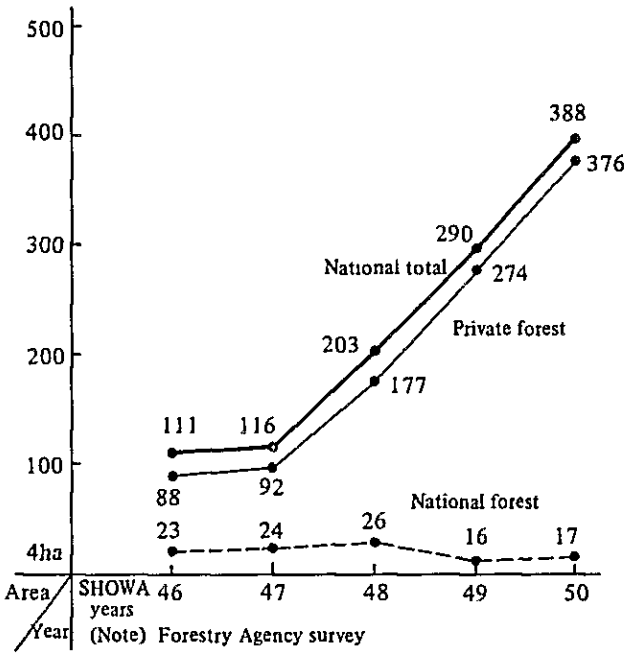
The second peak occurred in 1956 to 1958, and the damage during these three years was 900,000 m^3 or more a year. The damage is due mainly to a mass of pine bark beetles developed in Hokkaido, since a number of fallen trees by the wind of the typhoon assaulted Hokkaido in 1954 provided a good field for breeding of the insects.

Fig. 1 Damage by Pine Bark Beetles after the War (Timber Volume



(Note) Forestry Agency survey

Fig. 2 Area of Damage by Pine Bark Beetles



The damage decreased to 300,000 m^3 in 1959 and continued to be on the same level until 1961. But, in 1962, it began to increase third time to 620,000 m^3 in 1963, representing the third peak. In terms of the volume, the damage at this, which was at about 500,000 m^3 time was not much different from those at the preceding two peaks. However it is characterized that the damaged trees numbered as many as 4 to 5 millions, and trees of smaller diameter were also damaged. That the pine was weakened greatly by abnormally high temperature and drying in summer in the preceding years and assault of the typhoon are considered to be the causes of such damage.

Thereafter, control works were carried out year after year, and control effects were observed more or less. But, in 1971, the damage showed an increasing trend at about 500,000 m^3 under the influence of typhoons, and in 1973, owing to abnormally high temperature and drying in spring and autumn, it increased explosively to more than 1,000,000 m^3 and continued to increase thereafter to 1,070,000 m^3 in 1975.

The area of damage is also expanding in a geometric ratio from 90,000 hectares in 1971 to 180,000 hectares in 1973 and to 370,000 hectares in 1975.

2. New System: Pine Bark Beetle Control Special Measures Law

For special measures for creation of a new system for planned control of pine bark beetles, a "Bill for Pine Bark Beetle Control Special Measures" was submitted to the 80th ordinary session of the Diet. It was approved at the session, and is represented briefly in the following.

(1) Purpose

The law is intended, in view of the anomalous damage occurring in the pine forests due to nematodes carried by pine bark beetles, to take measures

adapted to urgently and systematically promote special control required for protection of the important pine forests as forest resources, with due and adequate consideration given to the conservation of natural as well as living environment and thus contribute to conservation of the national land (Article 1).

(2) Definition

1. "Pine bark beetles" refers to those which carry nematodes withering the pine.

2. "Special control" refers to control by chemical to be made in use of aircraft for exterminating or preventing spread of the pine bark beetles (Article 2).

(3) Principle

1. The Minister of Agriculture, Forestry and Fisheries must determine a principle with respect to the standard, etc. of the pine forests of which the special control is to be made (referred to simply as "principles" in the following) so that the anomalous damage occurring in the pine forests due to nematodes carried by pine bark beetles will be terminated in five years of 1977 and thereafter.

2. When the Minister is going to determine the principle, he must consult with the chiefs of the administrative organizations concerned and, at the same time, refer it to the Central Forest Council and ask the opinions of the governors concerened (Article 3).

(4) Implementing Plan

1. The respective governors must determine, in accordance with the principle, an implementing plan comprising necessary matters for systematic

execution of the special control for each group of pine forests to be determined as a unit of control to include two or more pine forests conforming to the standard of the pine forests of which the special control specified in the principle is to be made (such group of pine forests being referred to as "pine forest group" in the following).

2. In determining an implementing plan, the respective governors must it refer to the prefectural forest council and ask the opinions of the mayors and village heads concerned and, at the same time, present it to the Minister for consultation (Article 4).

(5) Special Control to Be Performed in Lieu of Order

1. For the forest groups specified below, the governors may perform the special control in lieu of the order of control by chemicals according to the provisions of the Forest Pests and Diseases Control Law (referred to as "Control Law" in the following), if and when they recognize it particularly necessary to control the pine bark beetles and prevent their spreading, to such an extent as is required.

(a) Pine forest group of which a greater part is composed by pine forests specified as reserved forest or of high function for public interests.

(b) Pine forest group of which it is recognized that the damage occurring in the pine forests will expand greatly unless the special control is made urgently (except the pine forest group specified in (a)).

2. For the pine forest groups specified in paragraph 1 (limited to those having an area greater than that specified in the Government Ordinance),

the Minister may perform the special control in lieu of the order of control by chemicals according to the provisions of the Control Law, if and when he recognizes it necessary to control the pine bark beetles or prevent their spreading immediately and thoroughly and upon application of the governor concerned, to such an extent as is required.

3. For the special control to be performed by the Minister or the governor concerned as stated in paragraph 1 or 2 above, there shall be provided the stipulations concerning the announcement of the area and period of such special control and complaints of the owners of pine forests in the area of announcement.

4. Persons owning or managing a pine forest in the area in which the special control is executed as stated in paragraph 1 or 2 are not allowed to refuse the execution of the special control (Articles 5 through 7).

(6) Safe and Adequate Use of Chemicals, etc.

Persons performing the special control in the pine forest groups must insure safe and adequate use of chemicals and take necessary measures so that damage is not caused to the agriculture, fishery and other projects (Article 8).

(7) Miscellaneous

1. In ordering the control by chemicals in accordance with the provisions pertaining to the control of pine bark beetles in the Control Law, the Minister of Agriculture, Forestry and Fisheries or the governor must insure that the implementing plan is achieved.

2. The national organs administering the pine forests which are national forests must perform the control of pine bark beetles with

respect to such pine forests in accordance with the principle.

3. There shall be provided the stipulations of the plans of government subsidy, etc.

4. The Law is enforced from the day of promulgation and becomes ineffective as of 31 March 1982 (Articles 9 through 13 and Supplementary Provisions).

(8) Budgetary Appropriation for Execution of the New System (1977)

In order for the new system to be carried out smoothly, the following budgetary measures were taken in the budget for 1977.

1. Fiscal 1977 appropriation for control of pine bark beetles - ¥3,500,000,000 (221% of that in the previous year).

2. Main items

(a) Chemical spraying area: 90,400 hectares.

(b) Creation of special control projects operated by prefectural governments (with a subsidy of 2/3)for a total area of 42,500 hectares.

(c) Expansion of the proportion of the area of chemical spraying to be managed by the government: 20% (17% in the previous year), 18,100 hectares.

(d) Appropriation for prevention of hazards and damagee(new): ¥16,000,000.

(e) Investigation expense for confirmation of the safety of chamicals (new): ¥7,000,000.

(f) Investigation expense for commissioning formulation of control program (new): ¥28,000,000.

(g) Expense for formulation of execution plan (new): ¥2,000,000.

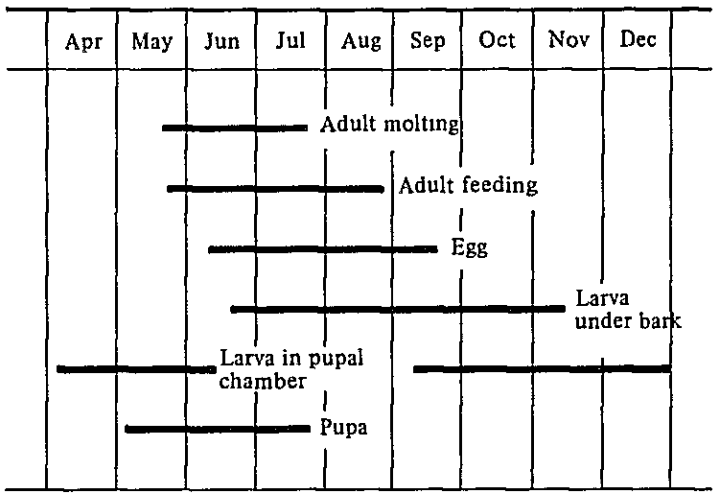
(h) Expense for conference for promotion of control (new): ¥3,000,000.

3. Ecology of Japanese Pine Sawyer and Control Method

(1) Ecology of Japanese Pine Sawyer

Annual life cycle of the Japanese pine sawyer (called simply as "sawyer" in the following) is illustrated in Fig. 1, and the ecology of phasic development will be described in the following.

Fig. 1 Annual life cycle of Japanese pine sawyer



The sawyer in the phase of adult has a body length of 20-30mmm with antennas as long as 1.5 times the body length in the case of female or 2.5 times in the case of male. The male antenna is reddish brown in color, while the female antenna has grayish white spots, so that the male and female can be distinguished with ease by the antenna.

The time at which the adult comes out from a tree is verying from place to place and from year to year, but generally, it is earlier in the year of warm spring and in warmer district. Adults make active movement and immediately dispersion, then settle nearly at one place and bite bark to feed themselves*1 (photo 1). They feed largely on one to three years branches. The time when adults move most actively is from 20:00 to 05:00 o'clock. The insect is apparently nocturnal. Pine wood nematode (called simply as "nematode" below) getting out of the spiracle soon after coming out of the sawyer creeps mainly over the ventral surface and, across the bristles at the cremaste, comes to the bite of the adult sawyer feeding.

Sawyers copulate in the period of adult feeding, and in about 3 weeks after coming out, the female begins oviposition. During this period of about 3 weeks, the nematodes propagate in the tree. Then, the pine becomes a heteroresinous tree*2, thus providing conditions allowing

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*1 Adult feeding: Feeding action of adult.

*2 Heteroresinous tree: Soon after intrusion of nematodes, the pine loses resin suddenly. At such time, the pine is normal in appearance on the outside but is abnormal physiologically and is called the heteroresinous tree.

oviposition of the sawyer. Oviposition is made in such a manner as to produce a shallow scar in the bark, ınsert the ovıpositor in the white inner bark and deposit generally one egg (rarely two eggs) there. The number of eggs per sawyer ıs verying greatly but is assumed to be about 100 average.

The eggs are white and spindle-shaped (Photo 2). They hatch in 5-10 days into milky white larvae. The larvae feed first on the bast mainly and some on the surface of the rap wood. At such time, coarse wood dust is discharged from the holes on the surface of the bark. At the fourth instar, they become the larvae of the final instar (with a body length of about 40mm) and, boring a hole of flat oval form, pierce into the tree, then create a pupal chamber in the tree, stuff wood dust at the entry of the chamber and enter into winter sleep (Photo 3). It is about 1.5-2 months from hatching to piercing into the tree. Hibernated larvae pupate in the chamber and, after a period of pupa of 10-20 days, become adults. Then, forming a hole of about 10mm diameter in the bark, the adults escape into the outside in 1-10 days after emergence, (Phote 4).

Photo 1 Sawyer in adult feeding.

Photo 2 Eggs (shown with bark taken off).

Photo 3 Larva in pupal chamber.

Photo 4 Sawyer escaping upon emergence.

The nematodes propagated explosively in the tree over the period of from summer to autumn and gather around the pupal chamber around at the end of autumn. Thus, in the range of the thickness of 1-2mm around pupal chamber, the density of nematodes becomes extraordinarily high.

Then, the nematodes ride on the body of adult emerged in the pupal chamber and enter it through the spiracle into the trachea. As for the number of nematodes kept in the internal tracheal system of an adult sawyer, a maximum record of 236,000 is reported. But, not a small number of sawyers contain no sematode, and the average number is 2,000 to 20,000 verying from place to place and from year to year.

(2) Pine Withering Preventive Methods

Withering of pine caused by nematodes has a complex relationship of pine - Japanese pine sawyer - pine wood nematode so that for prevention of the withering, many methods are to be considered (Table 1).

Table 1 Methods of preventing pine withering.

Strengthening the resistance of pine forests	Breeding of resistive species	under study
	Forest land fertilizing, and injection of nutrients	Little effect
	Accelerating activities of natural enemies	under study
Decreasing density of sawyers	Exterminating larvae in withered trees	Effective and in practice
	Inducing escaped adults and killing them	Effective to a certain extent and in practice as auxiliary means
Decreasing density of nematodes	Exterminating nematodes in withered trees	Effective but hardly practicable
Preventing intrusion of nematodes into pine	Spraying for prevention of adult feeding of sawyer	Very effective and in practice
	Application of nematodicides to sound trees	Effective but difficult to apply over a wide area

Select and use resistive species to nematodes is one of the most desirable measures of control. Among the foreign origin pines, a strong resistance is noted in the Trada Pine which grows repidly on the warm land in the western part of Japan. As for the red and black pines of the Japanese origin, it is known that the red pine comprises more or less resistive individuals or strain. In the case of the black pine, a resistance is noted in Crossing F1 with Taeda Pine. In this way, the research works of the people concerned with breeding are continued energetically, but they are not yet able to cope with the present intensive withering immediately.

Application of fertilizers and injection of nutrients to the forest land in order to increase the resistance to the plaque of nematodes were tested, but it is known that they are scarcely effective. This is probably because the nematode disease is different from the other ordinary diseases of trees which are induced when the trees have weakened vigor. The concept of creating conditions which are favorable for natural enemies of the sawyer is a common knowledge in the field of forest entomology, and for furtherance of thic concept, many forest entomogists are engaged in research works to see what kinds of natural enemies are, in what ways they work and if it is possible to reinforce such work artificially.

Extermination by felling withered trees was carried out from old times and is still an important control method now. As a means of extermination, burning of withered trees is the most complete one but us hardly practicable because of the danger of a forest fire. It is now confirmed that spraying of insecticides is effective. Such method may be correct in principle but is, in fact, unpracticable in the case of a topographically

steep forest, and the shortage of manpower makes it difficult to carry out this method. Moreover, this method fails to give an appreciable effect unless it is applied over a wide area to exterminate the insect completely, since there is a possiblity of sawyers flying from the outside. Thus, in the case of a wide area of serious damage, satisfactory control only by this method is hardly expectable. Rather, the method exhibits its effect in an area where damage is going to occur.

Using the behavior of the escaped adults of sawyer gathering on fresh logs at the time of oviposition, it was attempted several times to distribute a number of poisonous bait logs having an insecticide sprayed thereon in a forest to lure and kill the insect. Also, a control method using a luring agent comprising extracts from pine log as a main component was tested repeatedly. However, either the bait log or the luring agent involves a problem of conflict with the standing trees in an area of intensive damage, and it is unable to reduce the density of sawyers strikingly by such method alone. Rather, they can be used effectively as a method of reducing or surveying the density in an area of minor damage.

For extermination of nematodes in withered trees, burning the withered trees is the perfect method as in the case of extermination of the sawyers but is not practicable actually. Spraying of an insecticide is technically practicable, but it requires an enormous amount of expense in order to kill all of the nematodes in the trees. Then, it is easier to control the sawyers or mediation of the nematodes.

A method of spraying a chemical onto the branches of pine in order to prevent adult feeding of sawyers is generally called the preventive spraying. This method was tested at various sites with respect to the kind of chemical, quantity, method, frequency and time of spraying,

and it proved to be invariably effective at the sites of intensive damage. The preventive spraying is made in two ways: ground spraying and aerial spraying. Adult feeding of the sawyer is made on 1-3 years old branches so that it is required for the chemical to be sprayed onto the top of the crown. In this respect, the ground spraying is disadvantageous in that it involves a greater loss of the chemical. On the other hand, it is advantageous in that it is applicable to a small area. Thus it can be used effectively for a small area of flatland forest with low trees or an independent tree in a park. However, for the purpose of spraying the chemical onto the tip ends of branches, the aerial spraying is the most suitable method.

Concerning the preventing method of the harm in the trees caused by nematodes intruding into the trees at the time of adlut feeding of the sawyers through infiltration and dispersion in the trees of a chemical which is effective on the nematodes by injection into the trunk or soil treatment, a number of tests were carried out in terms of the kind of chemical, quantity, method and time of application. As the result, some effective chemicals were found. Although this method is not applicable to a forest covering a large area, it involves little environmental pollution so that it is a promising control method for precious trees in a park or urban area.

As the presently practicable control methods among those described above, there amy be listed (1) extermination of the larvae of sawyer in the withered trees, (2) luring of sawyer adults, (3) preventive spraying for sawyer adults and (4) application of nematodicides to standing trees. The method (4) is applicable for independent trees, while the methods (2) and (3) are effective only for a area of slight damage and are an ancillary

measure in an area of intensive damage. Thus, it is concluded that the most effective method applicable to a large area of severe damage is, upon the technical point of view, the one listed as (3).

However, the last mentioned method is subject to the restriction in terms of the environmental pollutions so that it should be applied under a careful plan with due consideration made of the minimum quantity of chemical, minimum frequency of spraying and minimum area of application as well as optimum application time.

(3) Techniques of Control by Aerial Spraying

The first factor affecting the effect of chemical spraying is the time of spraying. Such time is determined upon two factors, viz. period during which nematodes come out from the adlut sawyers and effective period of the chemical. Coming of the nematodes begins about 10 days after the time of emergence of sawyers and continues for more than 2 months. Effective periods of the chemicals used presently are 1-1.5 months at best so that in order to expect a complete control effect, it is required to spray the chemical twice. The first spraying is preferably at the initial stage of emergence and escape of adult sawyers and the second one is immediately before the peak of emergence and escape. For the sake of safety, it is desirable to perform the first spraying rather earlier. On the other hand, new branches of pine continue to extend until June. Thus, the spraying at this time is too early, since there may be increasing new branches that have no chemical adhering. So considaration must be taken into account.

Emergence and escape of sawyers are dependent highly on the conditions of temperature and humidity. For investigation of the process of emergence

and escape, a method of periodical counting the adult sawyers coming out of withered timber kept in a net chamber is employed generally. This method is advantageous in that detailed data are obtainable but not in that the process of emergence and escape is different from that of under natural conditions. In general, (1) the process of escape in the net chamber tends to be delayed to that under the natural condition because of lower temperature and higher humidity, and (2) if the withered logs are piled on top of another, the lower ones are of low temperature and upper ones are of high temperature so that the process of escape as a whole tends to be longer than is under the natural condition. Therefore, if the investigation is made in a net chamber, it will be required (1) that the withered logs are to be placed in the net chamber immediately before the start of emergence and escape, (2) that the net is to be arranged that the sumshine condition in the net is kept as close to that under the natural condition as possible and (3) that the logs in the net are to be exposed to sunlight evenly.

From the data obtained by 3 years survey in Meguro-ku, Tokyo and Gamo-cho, Kagoshima, the emergence and escape start in late May both in Tokyo and Kagoshima, and the peak is in late June in Tokyo and in middle June in Kagoshima. From such data, the optimum time of spraying is at early or middle May and early or middle June in Kagoshima, and at middle or late May and middle or late June in Tokyo. However, the time of emergence and escape is varying from year to year, and it is known that such change is dependent mainly on the temperature in April-May of the year. Thus, hereafter, it is desired to form a system to shift the time of spray depending on the temperature of the year.

Chemicals usable in aerial spraying are MEP and NAC, but the MEP agents (for example, Sumithion) are generally used at present. According to the results of tests conducted repeatedly so far, it is known that two sprays of MEP, each 1.5-1.8kg (by weight of the chemical) per hectare or total 3-3.6 kg/ha is the most effective.