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## Research and Technical Assistance Needs of the Woodworking Industry in Ecuador

By

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**RESEARCH AND TECHNICAL ASSISTANCE NEEDS OF  
THE WOODWORKING INDUSTRY IN ECUADOR**

Report prepared

by

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for

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## TABLE OF CONTENTS

	<u>PAGE</u>
INTRODUCTION	
1. THE FOREST RESOURCE	3
2. WOOD WORKING INDUSTRIES: SITUATION AND MAIN PROBLEM AREAS	4
2.1. Primary industries	4
2.2. Secondary industries	7
3. PRODUCT PROMOTION AND MARKETING	8
4. TECHNOLOGY RESEARCH AND TRANSFER	9
5. CONCLUSIONS	16
6. RECOMMENDATIONS	17

## INTRODUCTION.-

The consultant was invited by the Ministry of Agriculture of Ecuador to spend a fourteen day period in the country with the objective to review the present situation of the Wood Working Industry, in particular related to its main problem areas and to indicate which strategy should be developed to improve the present research and training facilities in the country to arrive at a research unit with qualified personnel and adequate equipment to assist the Ministry in solving its problems through extension services and basic and particularly applied research.

The report covers the forest resources available to the industry, a description of the primary and secondary wood industries and their main problem areas, research and training facilities available in the country, the promotion and marketing unit and its objectives (AIMA) and includes the recommendations how to reach the level of expertise and research facilities needed to arrive at the primary goal, i.e. the improvement of quality of the industry's final products aiming at the export market.

The consultancy was financed by INFORDE a project as part of the USAID Program in Ecuador.

### 1. THE FOREST RESOURCE

According to a report of the Interamerican Development Bank (1982), Ecuador had at that time approximately 15,623,000 hectares covered with forests, i.e. 58 percent of the national territory, and additionally about 2 million hectares of unproductive land, which eventually could be used for reforestation.

Of the total area covered with forest, approximately 30%, is located in mountainous regions and is protection forest not to be exploited. The rest (70%) consisting of mixed tropical forests, is situated in "el Litoral" (20%) and "el Oriente" (50%). These forests have been selected to supply the raw material for the wood working industry.

Except for its natural forests the country has FEW reforested areas. Till 1981 these areas consisted of 63,500 hectares of which 5,700 hectares at the coast and 57,800 hectares in the sierra. The principal species used in reforestation in the coastal region are laurel (Cordia alliodora), Cedro (Cedrela sp), both with an annual increment of 9m<sup>3</sup>/ha, teca (Tectona grandis) with an increment of 12 m<sup>3</sup>/ha; and in the Sierra principally pine (Pinus radiata) with an increment of 13.1 m<sup>3</sup>/ha and eucalypt (Eucalyptus globulus) (annual increment 27.2m<sup>3</sup>/ha). These yields have been estimated on a 15 year basis.

Although the natural forests have hundreds of different timber species, of which close to two hundred have been compiled in a publication of the Centro de Capacitación "Investigación Forestal" giving indications of their probable applications, it is interesting to note that the raw material base of the wood working industry in the country is so small. Out of the heavy, medium and light hardwoods only a total of fourteen (14) are actually being used for the different end products. So far it has not been possible to obtain reliable data concerning the supply potential of these fourteen species, however, the available resources of two species, in case laurel and cedro, seem to be rapidly depleted. Today the supply of laurel timber comes almost entirely from young plantation grown in primary or secondary forests having a great variation in quality with a high percentage of juvenile wood, large sapwood layer and small heartwood diameter, while the available cedro volume in "el Oriente" has decreased considerably because of the export of prime sawn lumber to Venezuela.

2. PRESENT SITUATION IN THE WOOD WORKING INDUSTRIES AND THE MAIN PROBLEM AREAS.

The wood working industry in Ecuador consists of:

2.1. Primary industries

- 2.1.1. Sawmills
- 2.1.2. Veneer and Plywood mills
- 2.1.3. Particleboard plants
- 2.1.4. Preservation plants

and: 2.2. Secondary (down stream) wood industries

- 2.2.1. Construction
- 2.2.2. Furniture-cabinet
- 2.2.3. Flooring-wall planelling (mouldings)
- 2.2.4. Doors and door frames

2.1. Primary industries

2.1.1. Sawmills

The country has hundreds of small sawmills of the circular saw type.

The primitive circular saw type mill has been recognized since long as the most wasteful in converting logs into sawn lumber. The poor quality of production can be traced to the buoyant but undeveloped state of the domestic lumber market. Under these conditions, the producer is able to dispose of the lowest quality

production. Cutting is for volume rather than for grade. Even worse than circular saws is the practice in Ecuador to convert logs into lumber with portable motorchain saws. The sawmill industry is lacking any control; standardization of dimensions is almost non-existent, not to mention the complete lack of quality grading. The result is that the consumer ends up with a raw material with great differences in quality being reflected in the quality of his final product as observed in several furniture plants. This seems to be of no consequence for the local market, however, the grading of raw material used for products to be exported is far more critical and if the sawmill situation can not be changed within a foreseeable future the secondary industry has to do its own quality grading before the raw material enters the factory.

The poor situation in the sawmill industry also has its direct influence in the construction sector, since this sector depends on the availability of pre-dimensioned and graded lumber.

#### 2.1.2. Veneer and Plywood mills

Contrary to the situation in the sawmill sector the veneer and plywood industry may be considered to be advanced in applied technology; i.e. equipment, plant lay-out, internal product flow, and quality control. Average yield of raw material input is about 50%. The industry does not seem to have a residue problem. Cores are cut for blockboard manufacture. End-log trimmings, waste from log round up in the lathe, clipper waste, plywood trimmings and sander dust are used as boiler fuel to produce steam for log heating vats, veneer dryers and hot-presses.

As observed, quality control of the finished product is rigorous, especially of plywood for export. The Ecuadorian plywood industry can only compete on the world market through the delivery of a better quality product. Luckily freight charges have been lowered recently making plywood and other wood products more competitive on the international market.

In fact, this wood industry sector has few technical problems except may be for those related to glues. The nationally manufactured urea-formaldehyde glue seems to vary in quality

i.e resin solid content, initial glue viscosity and pot life. It would be advisable that the industry pays more attention to glue bond quality control. Regular control of glue and plywood glue bond-quality can be part of the service given by the Forest Products Laboratory. Another factor that should be looked into is the rough finish of decorative panels having fancy wood veneer overlays. Furniture manufacturers complain about the roughness (fuzziness) of veneer surfaces. The industry could solve this problem by using finer grits in their sanders.

#### 2.1.3. Particleboard plants

The particleboard industry is rather new in Ecuador. Established with the objective not only to supply the local market but also to export considerable portion of its production to the Pacto Andino countries, presently has only the local market as outlet since the export market was closed due to protective measures taken by the importing countries. Reason why plants have been closed down and others produce far below installed capacity.

Arising technical problems in this sector are solved by the industry itself and the sector has the great advantage of a uniform raw material supply consisting of pine and eucalypt wood from plantations, modern equipment and rigorous quality control of the final product in their own laboratories.

#### 2.1.4. Preservation plants

This sector is primarily involved in the preservation of electricity poles of eucalypt, pine and teak with CCA as preservative. For their quality control on retention (salt concentration in the wood) they are dependent on facilities in the USA and monthly samples are sent to this country since no entity in Ecuador seems to be able to offer this service to the industry at present. A research unit as proposed later in this report should be able to take over this service.

## 2.2. Secondary (down-stream) wood industries

### 2.2.1. Construction

The integral study of wood for the use in construction was part of "Los Proyectos Andinos de Desarrollo Tecnológico en el Area de los Recursos Forestales Tropicales que ejecuta la Junta del Acuerdo de Cartagena". In Ecuador 20 different species were tested on their suitability for construction components. The study involved the determination of general wood characteristics, their physical and mechanical properties, the development of span tables, preservation needs, etc, etc., till the application of these woods in the actual construction of demonstration houses. So far the impact of this study is not visible in Ecuador. Possible explanations for the stagnation of further development in the application of these woods and wood in general in construction may be: a) that architects, civil engineers, and constructors are not familiar with wood as a building material, b) that the lowest income group of the population is averse to wooden houses, c) the lumber market can not furnish dimensioned and graded construction timber, d) lack of standardization in size of beams, rafters, studs, window and door frames.

Again the lack of development in this sector points to the poor sawmill industry.

### 2.2.2. Furniture-cabinet industry

This industry is quantitatively, although not always qualitatively, the largest sector of the secondary wood working industry in Ecuador, ranging in size from workshops to small factories. The sector has to be divided into two segments, i.e:

a) factories manufacturing modular furniture using mainly particleboard as core material with vinyl, formica, impregnated paper or decorative veneer overlays. This segment manufactures primarily office furniture from partitions, filing cabinets, bureaus, conference tables to chairs, while others produce kitchen and bathroom cabinets. This segment has few problems related to production and manufacturing while the techniques are pretty straight forward and uncomplicated. Probably the only need of assistance is in designing, although several manufactueres visited

produce furniture according to international accepted modern styles.

b) workshops and small factories manufacturing solid wooden furniture of combinations of decorative plywood with solid wood. This industry has a lot of problems from solid wood drying a related dimensional stability, through machining (tool maintenance) and finishing. The shops/factories are small, lack adequate space for good plant lay-out, sometimes lack the necessary machinery to automate to a minimum their machining operations and even do not separate their machining (sanding) operations from their finishing. Because this segment wants to become export oriented it is one of the secondary wood using industries requiring technical assistance immediately in all the aspects of cabinet making.

### 2.2.3. Flooring, wall panelling (mouldings)

Many of the problems mentioned under 2.2.2 b are valid for flooring (parquet, strip) and panelling the more difficult part is to obtain uniform quality sawn lumber. Besides this problem drying, machining and finishing are the main problem areas.

### 2.2.4. Doors and frames

Solid wooden doors are a luxury item which has outlets on national and international markets. The national market today still accepts doors with defects, such as the use of different species in one item, borer holes, color variations, etc. however, an export market is far more stringent on quality than the present home market. A manufacturer wanting to export solid wooden doors should take into consideration the moisture content of the wood, the dimensional stability of the wood (since front doors on one side are exposed to the weather outside and either air-conditioning or central-heating inside), perfect grading, machining and finishing of the final product.

## 3. PRODUCT PROMOTION AND MARKETING

Promotion and marketing of any kind of product probably is the most important link between the manufacturer and the consumer. A product can be of prime quality, however without promotion and marketing it is due to fail in the

market place. Ecuador has the great advantage in having an aggressive, qualified body for promotion and marketing of wood products in AIMA (Asociacion de Industriales Madereros). The association is a private non-profit organization. Its main objective is to promote the development of the wood industry in the country, especially in relation to developing and maintaining forest resources through reforestation, industrialization of the wood using industry and the promotion of wood products. Among the many goals of the association there is one related directly to the objectives of this mission i.e. the investigation of diverse technological problems affecting the industry and the improvement of product quality through technical assistance, however, for this the association has to depend on a third party.

#### 4. TECHNOLOGY RESEARCH AND TRANSFER

After the foregoing discussion on the forest resource, the composition of the industry and the problem areas in each sector it is clear that this industry needs a research unit to solve immediate and long term problems. Although research and training facilities exist in Ecuador i.e. the Forest Products Laboratory of the Ministry of Agriculture in Conocoto and the Forestry Department of the National University in Loja, the first entity has little direct contact with industry and is not aware of the problems in this sector while the latter educates forest engineers with a general theoretical background in wood technology and utilization but has no direct link with the wood working industry.

To have an idea how a Forest Products Research unit should function and what the responsibilities of a university as the one in Loja should be to assist in the development and improvement of the wood working industry, which, except for supplying the local market, should be export oriented, some background information is needed.

##### 4.1. Problem oriented research in a Forest Products Laboratory

This kind of research is directly related to solving problems in industry and trade (claims). Highest priority should be given to problem areas, because in many cases they cause severe financial losses and might even cause the loss of the the market for the exported product. This may be illustrated by the following example:

A major deterrent to furniture export to the USA and Europe is the fact that temperature and humidity conditions in the receiving countries are different from the ones in the manufacturing countries. Differences in conditions create changes in the moisture content of the wood within the product. Results can be disastrous. Often times the consultant has observed severe splitting and warping of wooden furniture in the importing countries. A major point here is that much money is being lost by the manufacturer in the exporting countries because the product failed in the market. Such loss could and should be avoided by doing the test work in the exporting country. A Forest Product Laboratory should be equipped with conditioning chambers in which different climatic conditions can be simulated to test the reactions and dimensional changes of furniture items under these conditions.

This type of testing is strongly recommended and should be part of a furniture export program if not a prerequisite.

A Forest Product Laboratory, valuable to industry must have the expertise and equipment to solve problems, such as in lumber drying, machining, tool maintenance, finishing etc. as quickly as possible.

#### 4.2. Basic research in a Forest Products Laboratory

Basic research in the pure sense, implies the gaining of fundamental knowledge about wood and its properties. Such activities usually include the determination of general anatomical features and characteristics, physical and mechanical properties, drying behavior, preservation and machining properties. This kind of research is valuable to arrive at the classification of species in end-use categories. At least 120 new species have been tested in Ecuador and as mentioned earlier in this report the raw material base of the wood industry is very small and this type of research results will assist in widening this base. However, research should not stop there. It is the consultant's experience that too many basic research data although extremely valuable, end up in drawers, because they are of little practical importance to industry.

#### 4.3. Product oriented research in the Forest Products Laboratory

Therefore, the next step should be a follow-up or product oriented research program. A certain ignorance exists on the part of the technological research laboratories concerning the requirements for specific end uses and especially this information is of particular interest to the manufacturer. They expect the selection of a wood species for a

specific end use not to be based solely on its technological quality, but also on very special requirements which are often of equal or even more significance for the acceptance of a wood than the basic information offered by the laboratory. This may be illustrated by two examples:

a. Windows, window frames, doors and cladding in direct contact with outside weather conditions. The criteria for these applications can be divided into three categories: i.e a) general wood characteristics: natural durability of heartwood, weight over volume, direction of grain, reaction wood and shrinkage; b) tendency to exudate resins, gums and latex, tendency to corrode metals, discoloration of wood in contact with metals, discoloration of adjacent materials through leaching of colored extractives in the wood; and c) velocity of drying, tendency of the wood to check and warp, machining behavior, especially in planing with modern tools and equipment, dulling effect on planer knives and nailing properties. In the international trade, maximum desirable and minimum tolerable levels have been established for each characteristic in the three categories.

b. Furniture

In this secondary wood processing sector in Ecuador the demand for more information is strongly felt. Research in the laboratory should aim at the more applied, oriented type, which is sorely needed. The criteria for furniture depend primarily on fashion trends. Design, wood color and figure demands change over the years, however, except for color and appearance the basic criteria determining the suitability of a wood species for furniture, particularly for solid wooden furniture, are basically the same as in the past and comprise machining (sawing, planing, turning, routing, mortizing and sanding), silica and extractive content, glueability, mechanical fastener holding abilities, wood bleaching and wood finishing.

In the context of this report it is valuable to mention what kind of wood U.S. furniture manufacturers look for and what their property preferences are and might be helpful to Ecuadorean manufacturers when looking for suitable species for export furniture. These preferences include: medium density (0.55-0.65), light even color (yellowish to brown) and open grain (coarse texture). The characteristic of open grain allows fillers of different colors to be used in the finishing scheme, thus allowing the natural grain to be accentuated. The major reason why light colored woods are preferred is because of flexibility in finishing. If red colored woods are used some are bleached first to a white color, then the pigmented, and dye colorants are added during the finishing process.

#### 4.4. Role of National University of Loja in Wood Product Development

Students in the Forestry School of the University of Loja with interest in the field of Wood Technology and Utilization should have a choice of thesis subjects either related to problem areas (e.g. dimensional stability of wood) or the development of new products (e.g. glues based on natural renewable resources). As much as possible the practical part of their thesis work should be done in the industry directly connected to their research and industry should eventually assist through financial support and the supply of materials needed during the period the student needs to complete his thesis.

#### 4.5. Present situation in the Forest Products Laboratory in Conocoto

##### 4.5.1. General observations

The Forest Products Laboratory in Conocoto (Centro de Capacitación e Investigación Forestal) falls under the jurisdiction of the Ministry of Agriculture. Its staff consists of agricultural engineers, licenciados, and peritos forestales (total 6). The equipment of the unit, in general terms, consists of instruments and equipment to carry out research in the field of anatomy, wood pathology and entomology, determination of physical and mechanical properties, preservation properties, drying behavior of wood and machining properties. Except for the structural engineering division, and the wood machining division, which are the best developed and installed sectors of the laboratory, research so far has been restricted to pure basic research.

The results are a considerable number of publications on basic data of a large number of non-commercial species of Ecuador and there and then, except for the more advanced research on modern structures (housing, bridges), the research has stopped. These publications on basic data have never reached industry and their impact on forest products development has been practically nil for the reasons mentioned under sub. 4.2.

Furthermore, the unit's personnel has no contact with industry and its problems and for this reason is isolated.

Except for the malfunctioning of equipment in several areas i.e. drying (drykilns out of order), mechanical testing (Instron Universal Testing Machine not functioning) and the preservation plant (malfunctioning pump). The majority of equipment and machinery is in good working order.

While it is clearly demonstrated in this report that circular saws are completely outdated and should not be used anymore in the mechanical conversion of logs into sawn lumber it is remarkable that the research institute in Conocoto and the Forestry School in Loja both have this type of sawmill instead of modern band saws (headrig) and resaws, which means that both institutions miss the chance to assist this industry through demonstrations and training to change to a better and far more economic system of mechanical conversion.

#### 4.5.2. Strategy to improve situation in Forest Products Laboratory.

##### 4.5.2.1. Personnel

Except for the head of the laboratory the entity lacks qualified personnel to assist industry in solving problems requiring immediate and short-term action, which should be one of the primary goals of the unit. To be able to develop a staff capable to fulfill this role an improvement in quality is needed of the personnel already present and an injection of new people in the fields of sawmilling, lumber grading, lumber drying, machining and tool maintenance and final finishing is required. It is the experience of the consultant that the formation of a qualified staff reaching a level acceptable to industry is time consuming and will take at least 2 to 3 years. Except for the Forestry School in Loja which is more forestry than wood product oriented in its education program the facilities in Ecuador to train Wood Utilization Technologists are non existent.

In the selection of new personnel for the FPL two educational levels should be considered, i.e. academic and technical. Personnel at the academic level not necessarily has to have a background in forestry. It is the consultant's experience that

civil and mechanical engineers, chemists and biologists are often better qualified than forest engineers and adapt themselves easier to the different wood technology and utilization branches. As an example, for a civil engineer wood is just another construction material while a forest engineer hasn't the slightest idea of construction.

As an example of the necessity to have qualified personnel at the technical level tool maintenance is a prime field of concern. INSOTEC could play a role in solving this problem.

What are the options to arrive at a qualified staff with sufficient prestige to be accepted in the industry?

a. In service training at the FPL.

For this kind of training it is necessary to contract an all-round expert with long technical experience in Wood Technology and Utilization for a period of at least two years.

b. Short-term on the job training abroad for a period of 3 to 6 months.

The consultant has good experience with this kind of training where personnel of a FPL actually have to go through all the process stages in a model plant abroad preferably in a country where the trainee has no language problems.

c. Long-term post graduate training abroad.

Post-graduate training in specific fields of Wood Technology and Utilization should be a long term goal. To upgrade the level of a Forest Products Laboratory staff, however, at the present stage options a and b give quicker results and give the opportunity of newly recruited staff to become acquainted with the problem areas in the wood working industry.

4.5.2.2. Equipment

The first step in improving the equipment situation in the FPL, Conocoto is to repair instruments and machinery presently out of order. Critical fields of consideration are the sawmill and the available drykilns. It is strongly recommended

to replace the circular saw by a combination of a main band saw (headrig) and a resaw. In case the available dry kilns are irreparable the installation of a new kiln should be considered.

To be able to assist industry at the quality control level an additional chemistry unit should be added to the Forest Products Laboratory. This unit needs equipment to test the quality of glues, (e.g. viscosimeter), instruments for quality control of preserved wood products such as poles, posts and construction components.

The unit should also have the necessary equipment to carry out research in wood finishing such as a compressor, spray guns, a dust free chamber (water spray booth) etc. to test different types of finishing products available on the market under different environmental conditions.

Luckily the FPL has a good functioning climate chamber in which a whole range of different climatic conditions can be simulated which is of great importance for testing furniture stability.

#### 4.5.2.3. Structure of the Forest Products Laboratory

The FPL in Conocoto falls under the jurisdiction of the Forestry Department of the Ministry of Agriculture and is a sector of the Forestry Department of this Ministry. Considering the restructuring of the Forestry Department in the near future and its possible change into an Institute with more flexibility in its administration and funding the Forest Products Laboratory in Conocoto should be allowed to develop itself as a semi-autonomous entity with strong links to industry, its own administration and budget.

The laboratory's budget shall consist of:

- a. contributions from the private industry earned through direct services to this industry.
- b. funds made available by the public sector.
- c. funds obtained through bilateral aid and international organizations.

During the first two or three years the entire will depend heavily on funds from the public sector for salaries, overhead costs, etc. and international funds for training and foreign expertise. This situation then can change after the laboratory has a qualified staff and has gained sufficient prestige to assist industry with their short-and long term problems.

The laboratory should aim at becoming a "commercial" entity selling its services to industry and the public sector, charging for the smallest service offered e.g. the identification of wood quality control of products, etc. to assisting the selection of machinery, plant layouts, etc. for new industries and the restructuring of old industries.

A main problem in developing and maintaining highly qualified staff are salary levels. Since salaries in the public sector are usually much lower than in the private industry the chance exists that industry takes over the qualified personnel from the laboratory. For this reason the laboratory personnel should not be paid according to public sector salary scales and certain flexibility should exist in the remuneration of laboratory staff and technical personnel.

### CONCLUSIONS

1. Raw material base of all industry should be widened through introduction of at present non-commercial species. A large amount of basic research data available, but not being divulged and not known by industry.
2. In the primary industries the sawmill sector extremely backward, using circular saws resulting in high waste, poor quality product, great variation in dimensions and non-application of any type of grading rules. Poor quality lumber supply to secondary industries, such as construction furniture, moldings, etc., cause of high cost and non-acceptance in the construction sector and variation in quality of final products in the other down stream industries.
3. Need of technical assistance in the wood working industry strongly felt in particular in secondary industries, i.e. furniture, flooring, panelling etc. Special problem areas raw material, drying (extremely important in connection with final moisture content requirements of products for export

markets), machining and in particular tool maintenance, plant layout and final finishing.

4. Technical assistance at present not available in the country. The only entity carrying out research in wood technology and utilization in Ecuador is the FPL in Conocoto. This laboratory lacks the important link with industry, is isolated and unaware of problem areas in industry. Furthermore, the technical level of its personnel, with a few exceptions, is low reason why the entity had had no acceptance by industry so far.
5. The training facilities in the country in wood technology and utilization are limited to the Forestry School of the National University in Loja. Wood Technology and Utilization, although part of the curriculum of the school can be considered not to be one of the more important training fields of forestry students.

#### RECOMMENDATIONS

1. The Forest Products Laboratory of MAG, in Conocoto is the only entity in research in the field of Wood Technology and Utilization in Ecuador and it is recommended that this entity shall be developed into a professionally managed unit having prestige in the private as well as the public sector.
2. The research to be developed in the FPL shall be primarily oriented to problem areas in the wood working industry and secondary shall be more product oriented than in the past.
3. The personnel in the FPL shall be allowed to improve their knowledge during a) short training periods (maximum 6 months) abroad in very specific fields of direct interest to industry b) through in-service training in the FPL under the guidance of an all-round expert in Wood Technology and Utilization to be contracted through bilateral aid programs or international organizations for a two year period and c) after having gone through training phases a) and b) staff members of outstanding performance should have the opportunity to follow post graduate training abroad with the objective to raise the level and prestige of the laboratory staff.
4. The staff of the FPL should be expanded to 10 people. Preferably, candidates should have backgrounds in mechanical and civil engineering and chemistry.

5. The equipment available at the FPL must be upgrade  
Defective items have to be repaired as soon as possibl  
Secendly it is recommended that new equipment be purchas  
i.e a) a modern bandsaw mill consisting of a headrig and  
resaw which can serve as a demnstration and training mil  
b) a new drykiln while the two kilns present are beyo  
repair; c) a chemistry laboratory is added to the FPL havi  
instrumnts for quality control of glues (viscosimeter  
preservatives and quality of preservation (retention) etc.

## REPORTS CONSULTED

1. Anonymous: Ecuador, Inventario y Aprovechamiento de los Bosques del Sur Ecuatoriano. D. Ensayos tecnológicos. 1 Conclusiones generales y clasificación propuesta. Dirección de Desarrollo Forestal (MAG)
2. Anonymous: Descripción General y Anatomica de 105 Maderas del Grupo Andino. Gadt-Refort - Junta del Acuerdo de Cartagena.
3. Anonymous: El Sector Forestal en Ecuador. PRONAF, Banco Interamericano de Desarrollo (MAG) Consejo Nacional de Desarrollo, 1982
4. Hanover, S.J. Secondary, solid wood processing programs, extention and research. Report to CPPF/INPA/-CNPq, Brazil 1981