PN-ABA-892

The FORESTRY PRIVATE ENTERPRISE INITIATIVE

School of Forest Resources
North Carolina State University

School of Forestry and Environmental Studies
Duke University

Office of International Cooperation and Development
Forest Service, Forestry Support Program and
Southeastern Forest Experiment Station

Supported and funded by
Bureau for Science and Technology
Agency for International Development

FPEI Working Papers Series
June 1987

Southeastern Center for Forest Economics Research
Box 12254, Research Triangle Park, NC 27709 Telephone (919) 541-4221

Suggestions on Improving Log Supply to Artepractico's Sawmill in Cuence, Ecuador

By

Michael F. Mussack Morales

FPEI Working Paper No. 24

FPEI Working Paper Series
June 1987

The SCFER Institutions
USDA Forest Service Southeastern Forest Experiment Station
North Carolina State University Duke University

Mussack Morales, Michael F. 1987. Suggestions on Improving Log Supply to Artepractico's Sawmill in Cuenca, Ecuador. Southeastern Center for Forest Economics Research, Research Triangle Park, NC. FPEI Working Paper No. 24, 45 pp.

About the Authors

Michael Mussack Morales is a Forester with INFORDE (Forestry Private Enterprise Initiative), Quito, ECUADOR.

About FPEI Working Papers

FPEI working papers are a special series of SCFER working papers issued by the Southeastern Center for Forest Economics Research for the purpose of sharing the research findings of the Forestry Private Enterprise Initiative. These papers are distributed in order to promote the timely release of new theories, data and findings. Working papers represent various levels of research findings and readers are encouraged to contact the author(s) for more information. Some of the papers may be published in modified form elsewhere. An updated list and copies of FPEI Working papers are available from the Center at P. O. Box 12254, Research Triangle Park, NC 27709, (919) 541-4221.

SUGGESTIONS ON IMPROVING LOG SUPPLY TO ARTEPRACTICO'S SAWMILL IN CUENCA, ECUADOR

by

Michael F. Mussack Morales

A project paper submitted to the
Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Master of Science in
Management

Department of Economic and Business
Raleigh, NC

1987

Approved by

_____ _____

_____ _____

Chairman of Advisory Committee

ACKNOWLEDGMENT

I wish to express my sincere appreciation to Dr. Jan Laarman (Chairman) for the opportunity of working for the Forestry Private Enterprise Initiative (FPEI) in Ecuador and to Vicente Molinos, FPEI Project Director in Ecuador, for the guidance and technical advice in developing the project. Appreciation is also extended to the members of my Advisory Committee for their help and guidance during the course work of my graduate program at North Carolina State University.

Special acknowledgments is given to Artepractico in Cuenca, Ecuador, especially Engineer Hernan Loyola, for their support and technical assistance.

I wish to express the deepest gratitude to my father and mother for their continued support and encouragement during my graduate years and to Marisa for the positive thinking.

January 1987

Michael F. Mussack Morales

TABLE OF CONTENTS

	Page
Acknowledgment	i
List of Tables	iii
List of Graphs, Maps, Flowcharts and Photographs	iv
List of Scientific Names and Conversion Factors	v
I. Introduction	1
II. Executive Summary	3
III. Sawmill Raw Material Supply	5
A. Characteristics of the Exploitation Region	5
1. Climatic Conditions	5
2. Present and Possible Extraction Regions	5
3. Conditions of Road and River Transportation	7
4. Sawmill Distribution in the Region	8
5. Estimated Timber Volume in the Region	8
B. Present Sawmill Requirements	9
1. Species	9
2. Quality and Dimensions	11
3. Raw Material Flow and Inventory Capacity	12
4. Waste Usage	14
C. Supply Costs	15
1. In-plant Cost of Wood	15
2. Stumpage Cost	16
3. Exploitation Costs	16
4. Transportation Costs	18
5. Permit Costs	18
6. Summary	19
IV. Possible Alternatives to Supply Problem	20
V. Recommendations	22
1. In the Short Term	22
2. In the Long Term	23
VI. Appendices	25
List of References	45

LIST OF GRAPHS, MAPS, FLOWCHARTS AND PHOTOGRAPHS

Graph		Page
1	Annual Consumption of F. Sanchez, Laurel, S. Gallina and Tangare by Artepractico's Sawmill from 1979-1986	32
2	Percent of Total Volume of Wood Consumed of F. Sanchez, Laurel and Tangare by Artepractico from 1979 to 1986	33
3	Consumption of Different Wood Species by Artepractico in 1986	34
4	Annual Average Volume per Log of Each Specie Delivered to Artepractico from 1979 to 1986	35
5	Total Monthly Volume of Wood Supplied to Artepractico from 1983 to 1986	36

Map		
1	Map of Ecuador and Exploitation Regions.	37

Flowchart		
1	Artepractico's Industrial Complex.	38
2	Artepractico's Sawmill and Log Yard.	39
3	Steps of the Exploitation Process.	40

Photographs		
1	Cacao Plantation in the Region of Babahoyo in October, 1986.	41
2	River Transportation of Logs in the River Catarama to Guayaquil in October, 1986 . . .	42
3	Log Yard and Log Crane Access Road in Artepractico in 1986.	43
4	File of Fernan Sanchez in Artepractico's Log Yard in December, 1986.	44

LIST OF TABLES

Table		Page
1	Sawmill Distribution in the Exploitation Region in 1986	26
2	Volume of Fernan Sanchez and Laurel Delivered by the Four Main Suppliers to Artepractico in 1986	26
3	Annual Consumption of Fernan Sanchez, Laurel, Sangre de Gallina, Tangare and Pine by Artepractico from 1979 to 1986	27
4	Percentage of Total Volume of Wood Consumed by Artepractico Represented by Fernan Sanchez, Laurel and Tangare from 1979 to 1986	27
5	Artepractico's Log Classification by Diameter	28
6	Annual Average Volume per Log for Fernan Sanchez, Laurel, Sangre de Gallina, Tangare and Pine Delivered to Artepractico from 1979 to 1986	28
7	Price per Volume Paid by Artepractico to Suppliers for Fernan Sanchez, Laurel, Tangare and Species from Esmeraldas in October 1986	29
8	Stihl Chain Saw Prices in Sucres in Ecuador in November 1986	29
9	Transportation Cost for Different Truckload Capacity from the Exploitation Region to the Furniture Plant in Cuenca in October 1986	30
10	Transport Cost of Wood per Volume per Distance (s/./m^3.km) from the Exploitation Region to Artepractico in October 1986	30
11	Variable and Fixed Costs in Exploiting Wood from Babahoyo in 1986	31
12	Total Supply Costs of Exploiting Wood During the Dry and Wet Seasons in Babahoyo in 1986	31

SUGGESTIONS ON IMPROVING LOG SUPPLY TO ARTEPRACTICO'S SAWMILL IN CUENCA, ECUADOR

LIST OF SCIENTIFIC NAMES AND CONVERSION FACTORS

Scientific Name

Fernan Sanchez	Triplaris guayaquilensis
Laurel	Cordia alliodora
Tangare	Carapa guianensis
Sande	Brosimum utile
Pine	Pinus radiata
Sangre de Gallina	Dialyanthera sp.

Conversion Factors

42 board feet = 1 cubic meter

1 mile = 1.6 kilometer

1 acre = 4.1 hectares

1 dollar ($) = 150 sucres (s/.)

I. INTRODUCTION

The Artepractico industrial complex in Cuenca, Ecuador was developed in 1979 with the concept of creating a vertically integrated wood industry. The purpose of the vertical integration was to ensure that all aspects of production were made in the plant because of the lack of market infrastructure in Cuenca. The main problem now with Artepractico is excess capacity, since the complex was planned for external markets in Venezuela and Colombia that have stopped buying mainly for political reasons.

The sawmill has an installed production capacity of 600 cubic meters of round wood per month with one 8-hour daily shift. However, the mill is processing only 450 cubic meters a month with one 12-hour daily shift. The sawmill also has difficulty maintaining a continuous supply to the furniture plant because of past and ongoing overexploitation of the preferred species. The sawmill operation is vulnerable to factors like the quantity and quality of wood delivered by outside suppliers, transport problems in rainy seasons and prices changes. Additionally, as part of a centralized industrial complex, the sawmill's efficiency is restricted. Most production decisions are made by the furniture plant.

The solution contemplated by Artepractico is to relocate and decentralize the sawmill by making it an independent commercial entity from the furniture plant. One of the objectives in relocating the sawmill is to supply not only the furniture factory, but also other construction and furniture markets. The

decentralization would let the sawmill make its own production decisions thus optimizing raw material utilization.

The feasibility of relocation takes into account the following factors: characteristics of the forest resources, sawmill raw material requirements, and transport and labor costs.

The area studied for sawmill relocation is a tropical humid region located on the delta of the Guayas River (Map 1). The region has very productive banana, sugar cane, cacao and coffee plantations.

II. EXECUTIVE SUMMARY

The main objective of this study is to analyze the feasibility of relocating the Artepractico sawmill to achieve higher use of its installed capacity. Secondary objectives are to reduce raw material costs and achieve a reliable continuous supply of wood for the Artepractico furniture plant. The mechanism considered to achieve the main objective is decentralizing the sawmill by making it administratively and financially independent from the furniture plant.

The results of the study show that the relocation of the sawmill is not recommended. But administrative decentralization is recommended since it would increase production, improve raw material utilization, and satisfy product demand of other markets.

The supply problem has reached a critical stage. The two species preferred for furniture production, Fernan Sanchez and laurel, are being brought to the sawmill in ever decreasing volumes and log sizes. The main reasons for the decline in total volume and average log size are continuous overexploitation of the region, lack of proper management of the timer to achieve good growth rates and yields, the increase in banana and sugar cane plantations, and the increase in grazing land for cattle.

The long-term strategy recommended to Artepractico to maintain a reliable and continuous supply of Fernan Sanchez and laurel is to establish a portable sawmill in the supply region of Babahoyo, Ventanas, and Machala (Map 1). This will maintain a physical presence in the regions, provide first-hand information

on timber prices, the best areas for logging and transport costs, and potential use of other species.

Second, Artepractico should design and implement an extension unit that will educate the cacao and coffee plantation owners about their timber. The topics should include management techniques for each species and expected financial returns. Loggers must be trained in proper felling and hauling techniques. In this manner the extension unit may be able to increase the region's wood supply.

Thirdly, Artepractico has acquired 350 hectares of land in the area of Babahoyo. Artepractico should develop a plantation program for Fernan Sanchez and laurel that will analyze the conditions needed to achieve good growth rates.

Fourth, the difficulty in obtaining Fernan Sanchez and laurel requires that Artepractico study alternative species to maintain the required volumes of production.

III. SAWMILL RAW MATERIAL SUPPLY

A. CHARACTERISTICS OF THE EXPLOITATION REGION

1. Climatic Conditions

The area studied is a tropical humid region which varies in altitude from zero to 1,000 meters above sea level and has an average of 3,000 millimeters of rain a year. Most of the rain occurs from December to March.

The climatic condition during the wet season is the most critical factor in defining the logging season. During the dry season loggers work intensely, sometimes up to 16 hours a day. During these months Artepractico receives almost all of its supply (Graph 5) and stocks up for the wet season. During the wet season the amount of wood exploited is minimal, and loggers dedicate themselves to the maintenance of their equipment and to rest.

2. Present and Possible Extraction Regions

The main region where Fernan Sanchez and laurel are acquired is the delta area of the Guayas River (Map 1). This area encompasses part of the provinces of Guayas, Los Rios, and El Oro. This is a rich agricultural region where the largest number of cacao and coffee plantations exist (Photo 1). In order to facilitate the study the region was divided in three sectors and named according to the largest town in each sector; these are the Babahoyo sector, the Machala sector and the Ventanas sector (Map 1).

The sector of Babahoyo was the first to be exploited in the early 1980s. Although Fernan Sanchez and laurel are still exploited, their dimensions and quality have sharply declined.

There are three main reasons why the yield per area of these species has declined. First, loggers are cutting trees which are too young. Secondly, banana and sugar cane plantations, which don't require shade trees, have increased in area. Thirdly, plantation owners do not know how to maintain shade trees to improve their yield.

The sector of Machala includes the coastal region from El Naranjal to Machala. In this sector a very small quantity of Fernan Sanchez and laurel is found because of the strong dominance of banana plantations. Machala is considered the banana capital of Ecuador. The mountains are close to the coast, and the rise in elevation affects the quality and growth rate of the species. It also makes the terrain less accessible. The small amount of wood cut in this sector is sold in the black market at the Peruvian border because of the higher price paid in Peru.

The sector of Ventanas, which includes the area north of Ventanas up to the town of Quevedo, is the most recent exploit tion sector. The best quality and largest dimensions received by Artepractico come from this sector. The area is more difficult to exploit than the Babahoyo sector because its agricultural and transport infrastructure is less developed. Most of the wood exploited in this sector is transported in the Caarama River to Guayaquil (Photo 2). The foreseeable problem

with this sector is that most of the land is being transformed into grazing land for cattle.

3. Condition of Road and River Transportation

All the areas visited have been extensively cultivated with plantations of banana, sugar cane, coffee and cacao or have been used to raise cattle. These products are cultivated for export so the harvest and transport infrastructure is well developed.

During the dry season all the access roads are easily traveled. But during the wet season the roads are almost inaccessible because of the amount of rain, poor drainage, and a lack of road maintenance during the dry season. For these reasons the amount of wood exploited during the wet season is low, and is carried out only next to a paved road.

The network of roads in the Babahoyo sector is very extensive, specially towards Guayaquil, the biggest city in Ecuador and the largest market for the region's wood. The main roads in the flat part of the region are in good condition because many export products are shipped out through Guayaquil.

In the region of Ventanas the network of access roads is not very extensive since the sector's agricultural production is not as well developed as the Babahoyo sector. In this sector most log transport is by river.

The logs are transported by trucks (usually having a capacity of six cubic meters from the cacao and coffee plantations to the river bed of the Rio Catarama. Buyers from Guayaquil purchase logs by the truckload, and pay contractors to transport them by raft to Guayaquil (Photo 2). An average raft will contain about

900 logs at a cost of s/.100 per log. With low tide, it will take about five days for the log raft to reach the bay.

Although this method is preferred because of its lower cost, it can only be used to satisfy the demand in the Guayaquil market. Secondly, it can be used only during the dry season because of the strong river current in the wet season.

4. Sawmill Distribution in the Region

The 13 sawmills located in the area of exploitation are all circular sawmills with an average production of 500 cubic meters per year of sawn wood with at least a 63% waste factor (Table 1).

5. Estimated Timber Volume in the Region

It is not possible to estimate timber volumes because there is neither a forest inventory nor a study of agricultural land use for the area. The only approach that can be used to get a rough idea of the amount of wood in the area is by observing the volumes delivered by Artepractico's suppliers. All the wood delivered by suppliers comes from the Babahoyo or Ventanas sector. According to the information supplied by Artepractico, the volume of Fernan Sanchez and laurel delivered up to August 1986 was 1,500 cubic meters (Table 2).

B. PRESENT SAWMILL REQUIREMENTS

1. Species

The different species of wood used by Artepractico can be classified in three groups. First are the species most frequently used and most preferred by the furniture plant. Second are the species seldom used but, for reasons of lack of supply in the winter of 1984 were acquired. In 1984 Artepractico was not able to keep a large enough inventory of Fernan Sanchez and laurel because management had a policy of acquiring a limited amount of wood per month. Finally, there are the species that are beginning to be used more each day in the production of furniture.

The first group includes: Fernan Sanchez, laurel and sangre de gallina. Since 1979 Fernan Sanchez and laurel represent more than 60% of the volume consumed in the production of furniture. Sangre de gallina represents more or less 50% of the volume used in the production of decorative veneer in 1986.

The annual consumption of Fernan Sanchez has decreased from its maximum of 4,110 cubic meters in 1981 to 2,821 cubic meters in 1985, a decrease of 30% in four years. Up to September of 1986 the volume consumed of Fernan Sanchez was 992 cubic meters which is below the consumption level of the previous years (Table 3).

The annual consumption of laurel has increased from 98 cubic meters in 1980 to 1,019 cubic meters in 1984. The increasing use of laurel partially offsets the decrease in Fernan Sanchez (Table 3).

The percentage of the total volume comprised by Fernan Sanchez dropped from 99% in 1981 to 63% in 1985 (Table 4).

Although before 1982 laurel never represented more than 3% of the total volume of wood consumed, since 1983 it represents more than 20% (Table 3). In 1986 the consumption distribution by species shows a marked change, since Fernan Sanchez represents 36% of the total while laurel represents 24% (Graph 2).

The wood acquired in 1984 came from Esmeraldas, a province in the north of Ecuador with large tracts of virgin land, and is made up of a great variety of tropical species such as yumbinque, sande, jigua, cedro, tangare, cuangare, canelo, copal, roble, canelon and seique (Graph 3).. The acquisition of this wood has been discontinued. It was bought at a time when the inventory of Fernan Sanchez and laurel dropped below the critical level, and wood was needed urgently to keep up with the level of production.

The third group is made up of species with a potential use in the production of Artepractico's furniture. Some of these species (tillo, maranon, guabo, jigua, palo de vaca and marfil) have undergone a trial test. However, this test was not representative because the procedure followed did not reflect the furniture production process.

Two species increasing in importance are tangare and pine. In 1979 13% of the sawnwood was tangare. During the period 1980 to 1985, its utilization did not reach 1%. Yet in 1986 it represented 26% of the sawnwood consumed, exceeding even laurel in importance (Table 4, Graph 2). In 1983 11 cubic meters of pine were utilized while 35 cubic meters were utilized in 1986 (Table 3). The purpose of trying new species is not to substitute

Fernan Sanchez and laurel but to complement them in the production of furniture.

2. Quality and Dimensions

Suppliers are paid per cubic meter of wood delivered so it is the measured volume of useful wood per log that defines the price of wood. In the measurement of the volume the dimensions and the quality of the log are taken into account.

The main defect to consider when measuring the volume of a log is its crookedness, since it is the defect that generates the largest amount of waste. Other common defects are large checks or cracks created by harsh drying conditions or mistreatment during transport (Snellgrove and Fahey, 1982).

After the logs' volumes have been measured, the logs are arranged in piles depending on their dimension and species. The size classification of the logs is by diameter (Table 5).

Due to overcutting of Fernan Sanchez and laurel it is very hard to find large logs. Exploitation of trees under 15 cm. in diameter has increased. This represents a great loss to Artepractico because of low yield in conversion.

In 1979 the average volume per log for Fernan Sanchez was .105 cubic meters, decreasing annually until 1982 when it reached .090 cubic meters. Then in 1984 it increased to .102 cubic meters and decreased to .087 cubic meters in 1986 (Table 6, Graph 4). Laurel, on the other hand, showed an increase in the average volume per log from .087 cubic meters in 1983 to .098 cubic meters in 1985, but then decreased to .091 cubic meters in 1986 (Table 6, Graph 4, Photo 3). These changes in the average volume of wood

per log are directly related to the changes of extraction sites. As an old site is overexploited, the average volume per log decreases because the remaining best logs are cut first. When a new area is discovered, the average log size increases until it reaches a maximum, and then starts to decrease. This is because some initial exploration is needed to locate the very best timber.

To optimize the use of the sawmill equipment the logs should meet the sawmill working parameters. At Artepractico the optimum log diameter should not be less than 15 cm. and not more than 60 cm. (FAO, 1982).

3. Raw Material Flow and Inventory Capacity

The months of higher log acquisition are between May and October, which is the dry season. During these months it is easy to access the exploitation area because of the dry conditions. During the winter months, November to April, the acquisition of logs is sharply reduced (Graph 5).

The yard is set to have a continuous flow of logs in the direction of the sawmill. This continuous flow is very difficult to maintain. Reasons include the different places where suppliers set the logs, the time it takes to measure the volume of the logs, and the sawmill's sawing priority. Also the sawmill has not found a suitable way to dispose of sawdust, presently stored in an area designated for the storage of logs.

This problem also interferes with maneuvering of the log crane (Photo 4). The logs usually have to be moved two or three times to different piles. First the crane unloads the logs from the supply trucks; then they are classified by species and size.

Sometimes because of a lack of space, they are moved a third time. This extra movement of logs accounts for lost crane time that could be used more productively.

Besides the lack of space in the yard, other problems that impede the flow of logs towards the sawmill are the lack of an area designated specifically for unloading supply trucks, the lack of easy access to certain piles, and the lack of adequate drainage.

First, since there is no specific unloading zone the supply trucks are unloaded in the most accessible areas. This is usually close to the sawmill, creating a crowded condition at the sawmill entrance. This also implies a greater movement of logs, since they have to be transported back to the appropriate pile and eventually moved forward again according to the sawmill's sawing orders.

Second, the lack of adequate access to certain piles makes them the last alternative for sawing. Instead of the logs being sawn on a first-in first-out basis, many logs spend much more time in the yard than others.

Third, the lack of adequate drainage creates various puddles in the yard. If the logs are located on one of these puddles all the possible rot and discoloration created by the direct contact with water may appear. For example if two piles of 20 meters long are in direct contact with the ground and each log has an average diameter of 20 cm., the number of logs affected by the water is 200. Besides creating defects, the dirt on the logs may cause problems for the saw's blades during sawing. If the puddles are

in the operating areas of the crane, they will greatly hinder its mobility.

4. Waste Usage

Lately Artepractico has been buying logs under 15 cm. in diameter containing a very small amount of useful wood. These logs should not be sawn since they are below the working parameters required by the sawmill. Suppliers should be required to meet a minimum log diameter, or Artepractico should develop an alternative use for these small logs in order to minimize waste and reduce supply costs.

The waste in the form of sawdust goes to three storage silos and is used in the particleboard plant. The particleboard plant is located in the same complex as the furniture plant. In October 1986 the sawdust storage silos were full since the particleboard plant is not operating at full capacity. Hence sawdust was rapidly accumulating in an area designated for log storage.

Considering that the average monthly production in 1986 was 297 cubic meters with an average waste factor of 26%, the monthly waste is 77 cubic meters. It is necessary to find a way of disposing of this, sawdust since it is occupying vital yard space. The rapidity and high volume of accumulation will complicate the problem even more in the future.

C. SUPPLY COSTS

All the supply cost data are based on information furnished by Artepractico or collected in the field from persons involved in the logging, trucking, and sale of timber. The field information cannot be treated as very representative because in many cases data from only one source could be obtained. This was due mainly to the mistrust existing in the industry about information considered confidential.

1. In-Plant Cost of Wood

The prices paid by Artepractico for wood depend on the species and the volume of wood per log, but the price for wood from Esmeraldas is the same for all species (Table 7).

Each log's volume is measured, taking into account its defects. Then the volume of all the logs in each category is added up, and payment is made to the supplier according to the price per volume in each category (Table 7). The highest price, 7,100 s/./cubic meters, is paid for logs with more than .075 cubic meters or an average of only about 20 cm. in diameter. Artepractico is paying 2,000 s/./cubic meters for logs with an average diameter of less than 15 cm., where the volume of wood obtained is very small and the volume of waste produced is high.

The cost of wood acquired from Esmeraldas is higher because it includes higher transportation costs. Secondly, the wood from Esmeraldas arrives squared, minimizing waste at the sawmill, and justifying a higher price.

2. Stumpage Cost

In the cacao and coffee plantations wood is bought by the tree, not by area like in the primary forests. The cost and availability of wood for sale by plantation owners, depends on the market price and the time of harvest of cacao and coffee. If the selling price is high and the harvest is good, plantation owners are not willing to sell their shade trees. Also, during harvest time when the plants are bearing fruits, owners are not willing to sell because they fear the extraction process will damage the plants and the soil (FAO, 1978).

In October 1986 in the area of Babahoyo, a log 2.50 meters in length, regardless of its diameter and quality, of Fernan Sanchez was priced at s/.180 and laurel at s/.200. During the same month in the area of Ventanas a log of Fernan Sanchez was priced at between s/.225 and s/.250, while laurel was between s/.250 and s/.310. The difference in price between the two species is because laurel is considered a more valuable wood. The difference in price between the regions is because extraction near Ventanas is more recent than extraction near Babahoyo, so the log quality and average diameter are higher near Ventanas.

When a logger locates a plantation with good potential, he surveys the area and selects and buys only the trees ready to cut. The most important criteria are the tree's straightness, height and diameter.

3. Exploitation Costs

The exploitation cost includes the cost of the chain saws to cut and buck the trees to the standard 2.50 meters length, and the

labor costs of the chain saw operators. The operators are helped by two assistants who clear the area where the tree is felled, and who measure and mark the logs.

The largest cost item in the exploitation process is the acquisition of the chain saw. In the region there is a well established market for new and used chain saws (Table 8). After the logs have been bucked they are hauled to the access road by tractor, animal or person and loaded on a truck (Flowchart 1). The existing road infrastructure for collecting and transporting cacao and coffee facilitates the exploitation and transport of wood.

The cost of maintaining a chain saw of 30 inches is about s/.10,000 a month. This cost includes s/.4,500 for a spare chain and s/.5,500 a month for gasoline. The personnel cost is of s/.800 a day for the chain saw operators, if they are not the owners, and s/.600 a day for the assistants. The cost of transportation and food is paid by the contractor. The rent of a pickup truck for transporting personnel and equipment is s/.1,500 a day and an average meal is s/.100.

After the logs have been hauled to the access road, which is always less than 1 km, they are loaded on a truck by a crew of four. The crew, in October 1986, was paid between s/.600 and s/.1,000 a load depending on the size of the truck. Four persons loading a 6 cubic meters Ford 750 truck can load a maximum of two truckloads per day. Considering an average diameter of 20 cm. and 2.50 m. in length a 6 cubic meters truck load has 18 logs.

4. Transportation Costs

The transport cost from the exploitation region is per load, so it does not matter if the truck is carrying half a load or a full load the cost remains the same (Table 9). The distance from the exploitation region averages 325 km., but the elevation changes from about 7 meters above sea level to 2,600 meters above sea level at the furniture plant. The driving time to the furniture plant with a loaded truck is about 13 hours from Babahoyo and 16 hours from Ventanas. The road that goes up the mountain is steep and hard on the trucks. Each supplier's truck makes between four and six trips a week. A low component of the transportation cost is gasoline which in October 1986 cost 35 cents of a dollar for one gallon.

The average transport cost to the furniture plant from Babahoyo is 6.0 s/./m^3km and from Ventanas it is 6.1s/./m^3km showing little variation in the cost per kilometer (Table 8). All of the Fernan Sanchez and laurel supplied to Artepractico comes from these regions.

5. Permit Costs

In order to transport wood from the provinces of Guayas and Los Rios to Cuenca, every truck must carry a mobilization permit issued by the Ministry of Agriculture. This permit, which costs s/.250 per cubic meter, must be presented at all the control posts (FAO, 1978).

The Ministry of Agriculture is considering imposition of an extraction permit similar to the one issued for logging in the virgin forests. The logger buys a permit from the Ministry of

Agriculture for the right to extract a certain volume of wood. As he logs an area the volume removed is subtracted from the total permitted until he reaches zero. This permit will help the government control the levels of timber harvesting in the area.

6. Summary

Comparing the total supply costs with the price Artepractico pays its suppliers, the cost of supplying wood less than 75 dm^3 log is higher than the price paid, while the cost for wood greater than 75 dm^3/log is lower than the price paid by Artepractico (Tables 11 and 12).

The main items of the variable costs are the acquisition of wood (51%) and the transportation to the plant (38%) while the main item of the variable costs is labor (53%) (Table 11).

IV. POSSIBLE ALTERNATIVES TO SUPPLY PROBLEM

There are three alternatives to protect Artepractico from running out of raw material. Although each alternative on its own will not directly solve the problem, the strategy is to find the right combination of all three.

(1) The sawmill should be decentralized from the furniture plant and made a separate profit center. The objective of decentralization is to use the presently idle capacity to produce for the construction market of Cuenca.

The decentralized sawmill would still have to supply the furniture plant's sawnwood requirements. Production for outside markets would utilize other species and would more fully utilize dry kiln capacity.

(2) Establish a portable sawmill in the exploitation zone to maintain a physical presence in the area. This physical presence would give Artepractico first-hand learning experience with logging costs, transportation costs, and the price of wood. The company's forestry department could establish long-term relations with plantation owners to find out where the best wood is, and to instruct the owners on the proper techniques to improve the size and quality of the trees in the plantation. Although the portable sawmill would contribute less than 20% of the present volume supplied, it would have the flexibility of moving to high-volume areas. The portable sawmill would square the logs into the largest possible pieces before they are transported to the sawmill in Cuenca. This would help reduce supply costs by having a selection process at the exploitation area and not after

transporting the logs 350 kilometers. Also by transporting square pieces the volume of waste transported is minimized.

If management decides that investment in a new portable sawmill is not cost effective, an alternative would be to rent one of the existing circular sawmills in the area and analyze its results over a period of time.

(3) Artepractico has 350 ha. of land in Ruidosa close to La Troncal. This was the site to which the sawmill was expected to be relocated. The forest department of the sawmill should begin experimenting with plantations of Fernan Sanchez and laurel to gain the knowledge in achieving good growth rates and yields per area and eventually manage their own plantations.

V. RECOMMENDATIONS

1. In the Short Term

- Coordinate better with suppliers the quality and dimensions required by the sawmill in order to reduce supply costs and minimize waste.
- Enlarge the log yard and designate exclusive areas for unloading. This area should preferably be in the back so the area in front of the sawmill is of easy access.
- Design an adequate log flow system to ensure a first-in first-out criteria.
- Improve yard drainage and use a naturally resistant wood as support for the piles to prevent direct ground contact.

2. <u>In the Long Term</u>

- Establish an extension unit to instruct loggers and plantation owners about proper techniques to obtain better yields. The main objective is to teach loggers the best methods to cut and haul trees in cacao or coffee plantation, and to teach plantation owners the type of silvicultural maintenance required by the different species to achieve good growth rates. The shade trees found in the plantations have no economic value to the owners because of the present trees' characteristics. If the proper maintenance of these trees could be encouraged, they can become a new source of income for plantation owners and loggers.
- Analyze the Guayaquil, Cuenca and Quito construction and furniture markets to find out the wood products demanded and production costs involved. With this information a production and marketing strategy can be developed by the sawmill to satisfy the market demands.
- Establish a work plan to test new species in all the steps involved in the production of furniture. The study must establish a minimum volume to be tested, and methods of analyzing the behavior of the wood in each step of the process, to obtain reliable data on the potential use of different species. The study should become an integral part of the Forestry Department so it can have the necessary data on the species, such as the existing volumes, costs, facility of acquisition, and ease of

sawing, drying, machining, staining and finishing. This will give Artepractico the flexibility on the supply side to acquire these species if for any reason the supply volume of Fernan Sanchez or laurel is lower than the volume required by the plant.

Analyze marketing strategies to attract some of the wood going to Guayaquil toward the sawmill in Cuenca. In order to compete with the Guayaquil market, certain advantages of transporting the wood to Cuenca must be studied.

VI. APPENDICES

Table 1

Sawmill distribution in the exploitation region.

Sector	Location	Quantity
Babahoyo	Babahoyo	2
	Pueblo Viejo	1
	La Troncal	2
	El Triunfo	3
	Mata de Cacao	1
	Simon Bolivar	1
Ventanas	Ventanas	2
	Voluntad de Dios	1

Table 2

Volume (m^3) of Fernan Sanchez and Laurel delivered by the four main suppliers to Artepractico in 1986, up to August.

Suppliers	Month									Per-cent
	Jan	Feb	Mar	Apr	May	June	July	Aug	Total	
R.Arevalo	67	--	--	--	51	228	288	177	811	53
S.Matute	--	--	--	--	--	45	168	165	378	25
P.Tapia	--	--	--	--	--	58	95	67	220	14
M.Matute	26	--	--	--	--	--	12	66	104	7
J.Parra	--	--	--	--	--	--	--	5	5	4
J.Campoverde	--	--	--	--	--	6	--	--	6	4
J.Tapia	--	--	--	--	--	--	--	8	8	1
Totals	93	--	--	--	51	337	563	488	1,532	--

Table 3

Annual Consumption of Fernan Sanchez, Laurel, Sangre de Gallina, Tangare and Pine by Artepractico from 1979 to 1986.

Year	Fernan Sanchez	Laurel	Sangre de Gallina	Tangare	Pine
	----------	----------	m^3	----------	----------
1979	3,119	--	--	457	--
1980	3,486	99	--	55	--
1981	4,110	9	--	--	--
1982	3,809	--	2	12	13
1983	1,872	832	242	21	11
1984	2,638	1,020	1	--	--
1985	2,821	745	1	--	20
1986*	993	667	298	712	35

*Up to September 1986.

Table 4

Percentage of total volume of wood consumed represented by Fernan Sanchez, Laurel and Tangare in Artepractico from 1979 to 1986.

Year	Fernan Sanchez	Laurel	Tangare
	----------	%	----------
1979	86	0	13
1980	89	3	1
1981	99	2	--
1982	93	0	3
1983	59	24	1
1984	65	25	--
1985	69	18	--
1986*	36	24	26

*Up to September 1986.

Table 5

Artepractico's Log classification by diameter.

Group	Diameter of Logs cm	Classification
1	15 to 30	Small
2	31 to 45	Medium
3	46 to 60	Large

Table 6

Annual average volume (dm^3) per log for Fernan Sanchez, Laurel, Sangre de Gallina, Tangare and Pine delivered to Artepractico from 1979 to 1986.

Year	Fernan Sanchez	Laurel	Sangre de Gallina	Tangare	Pine
	----------	----------	dm^3	----------	----------
1979	105	--	--	154	--
1980	101	92	--	147	--
1981	96	139	200	--	--
1982	91	--	83	309	217
1983	93	90	179	118	230
1984	102	92	157	--	--
1985	100	98	--	--	105
1986*	87	91	--	101	185

*Up to September 1986.

Table 7

Price per volume paid by Artepractico to suppliers for Fernan Sanchez, Laurel, Tangare and species from Esmeraldas in October 1986.

	Log Size		
	Volume dm^3	Diameter* cm	Price s/./m^3
Fernan Sanchez	<60	<15	2,000
Laurel and	60-75	15-20	4,400
Tangare	>75	>20	7,100
Esmeraldas Wood	100	20 x 20**	10,400

*Considering the standard 2.50 meter length.
**Squared.

Table 8

Stihl chain saw prices in Sucres* in Ecuador in November 1986.

Length of Blade in.	Chain Saw Price s./
25	104,000
30	142,000
60	152,000

*Exchange rate s./150/1$ in November 1986.

Table 9

Transportation cost for different truckload capacity from the exploitation region to the furniture plant in Cuenca in October 1986.

Region	Truckload Capacity			Distance
	6 m^3	12 m^3	18 m^3	
Babahoyo	15,000	20,000	25,000	307
Ventanas	18,000	22,000	30,000	356
Guayaquil	15,000	--	--	266

Table 10

Transport cost of wood per volume per distance (s/./m^3.km) from the exploitation region to Artepractico in October 1986.

Region	Truck Load Capacity			Average
	6 m^3	12 m^3	18 m^3	
Babahoyo	8.0	5.4	4.5	6.0
Ventanas	8.4	5.2	4.7	6.1
Guayaquil	9.4	--	--	9.4

Table 11

Variable and Fixed Costs in Exploiting Wood From Babahoyo in 1986

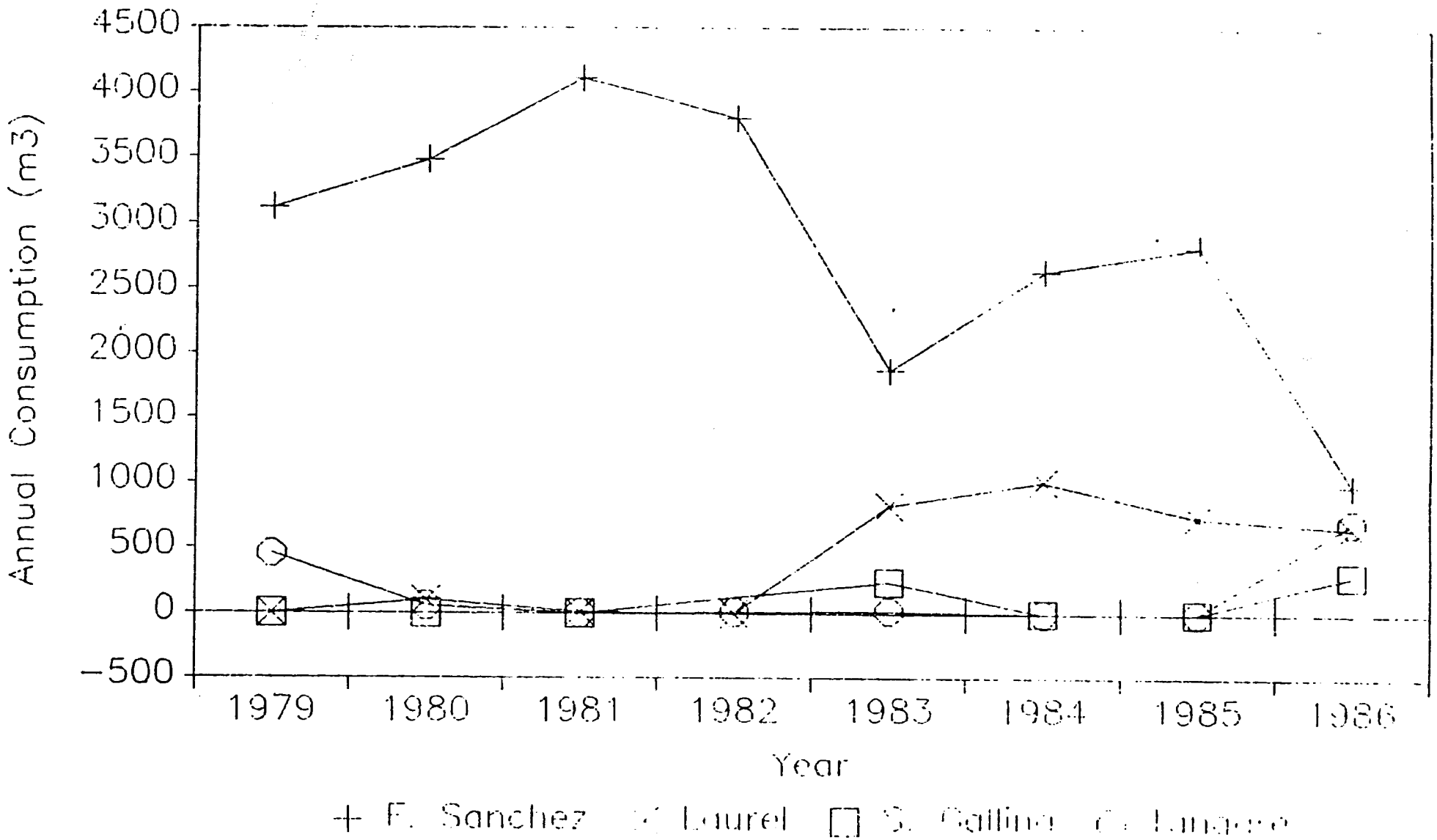
Variable Costs (s./m³)		Fixed Costs (s.1/mo.)	
Cost of Wood	3.000	Chain Saw Maintenance	10.000
Loading	400	Operators	22.400
Transport	2,200	Assistants	16,800
Permit	250	Personnel Transport	3,000
		Meals (4 workers)	11,200
TOTAL	5,850 s./m³		63,400 s./mo.

Table 12

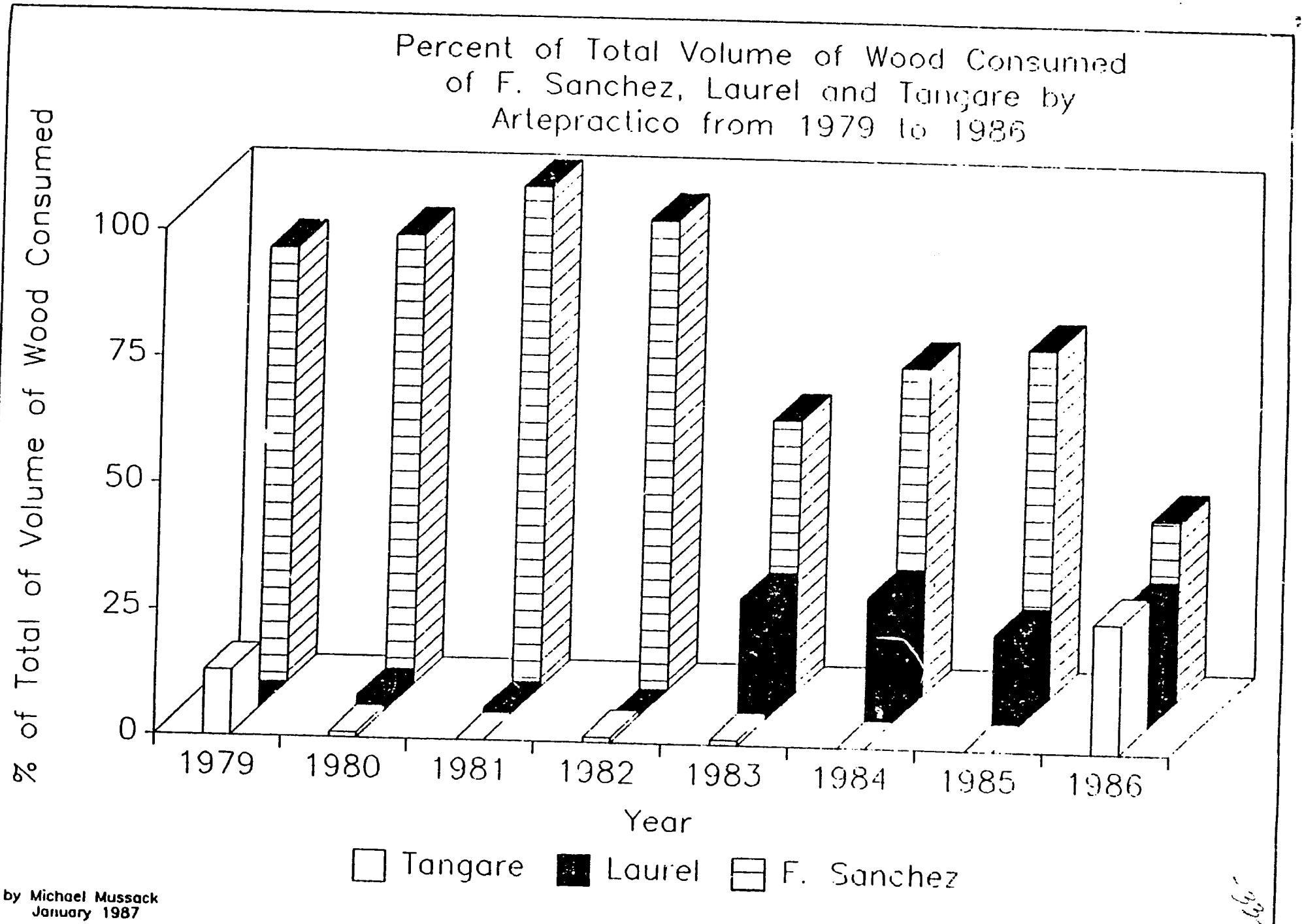
Total Supply Costs of Exploiting Wood During the Dry and Wet Seasons in Babahoyo in 1986

Season	TOTAL SUPPLY COSTS				
	Avg. Monthly Acquisition of Wood	Fixed Costs	Avg. Fixed Cost of Wood	Variable Costs	Total Supply Costs
	(m³/mo.)	(s./mo.)	(s./m³)	(s./m³)	(s./m³)
Dry	520	63,400	122	5,850	5,972
Wet	204	63,400	311	5,850	6,161

Graph 1



by Michael Massack
January 1987

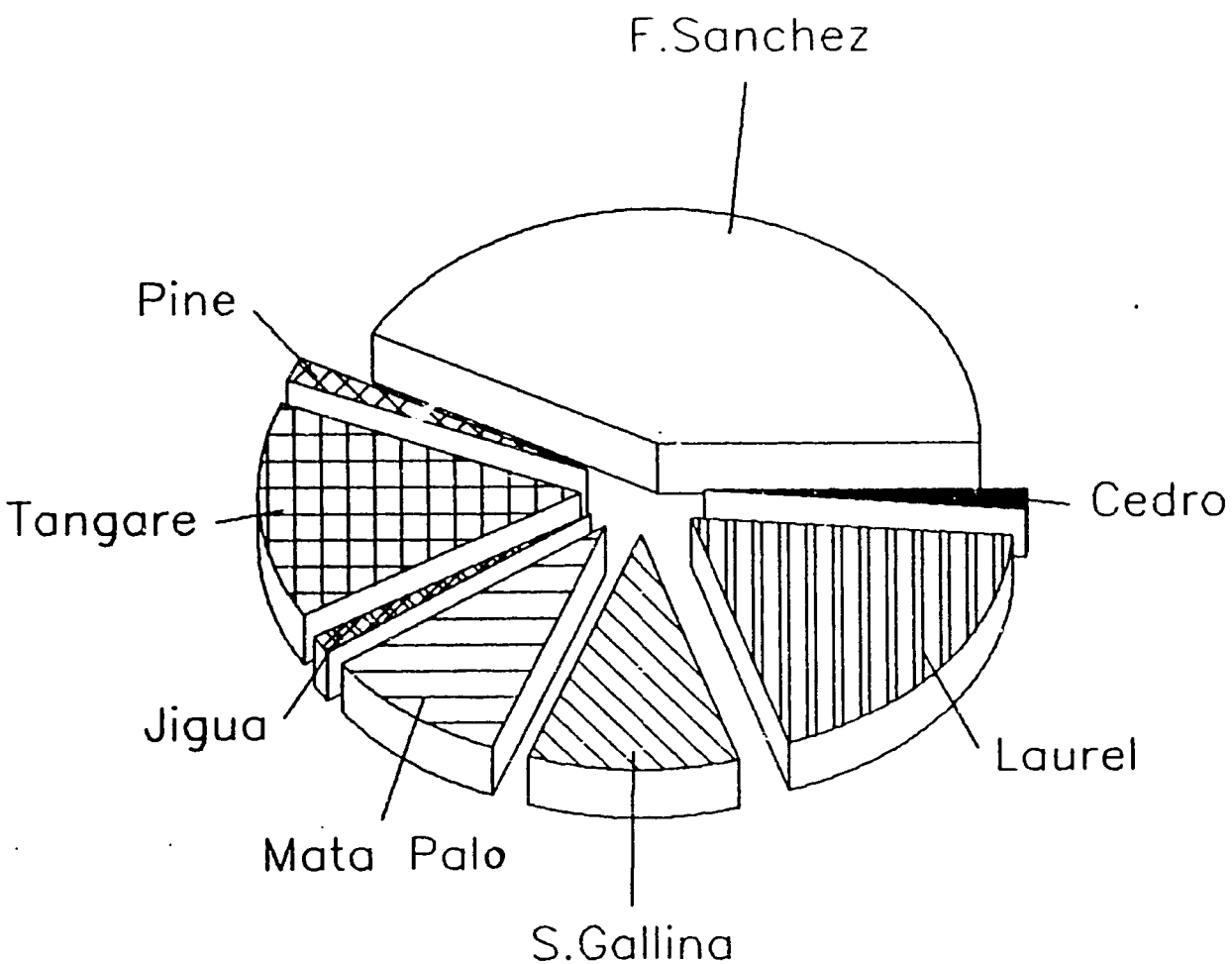


by Michael Mussack
January 1987

Graph 2

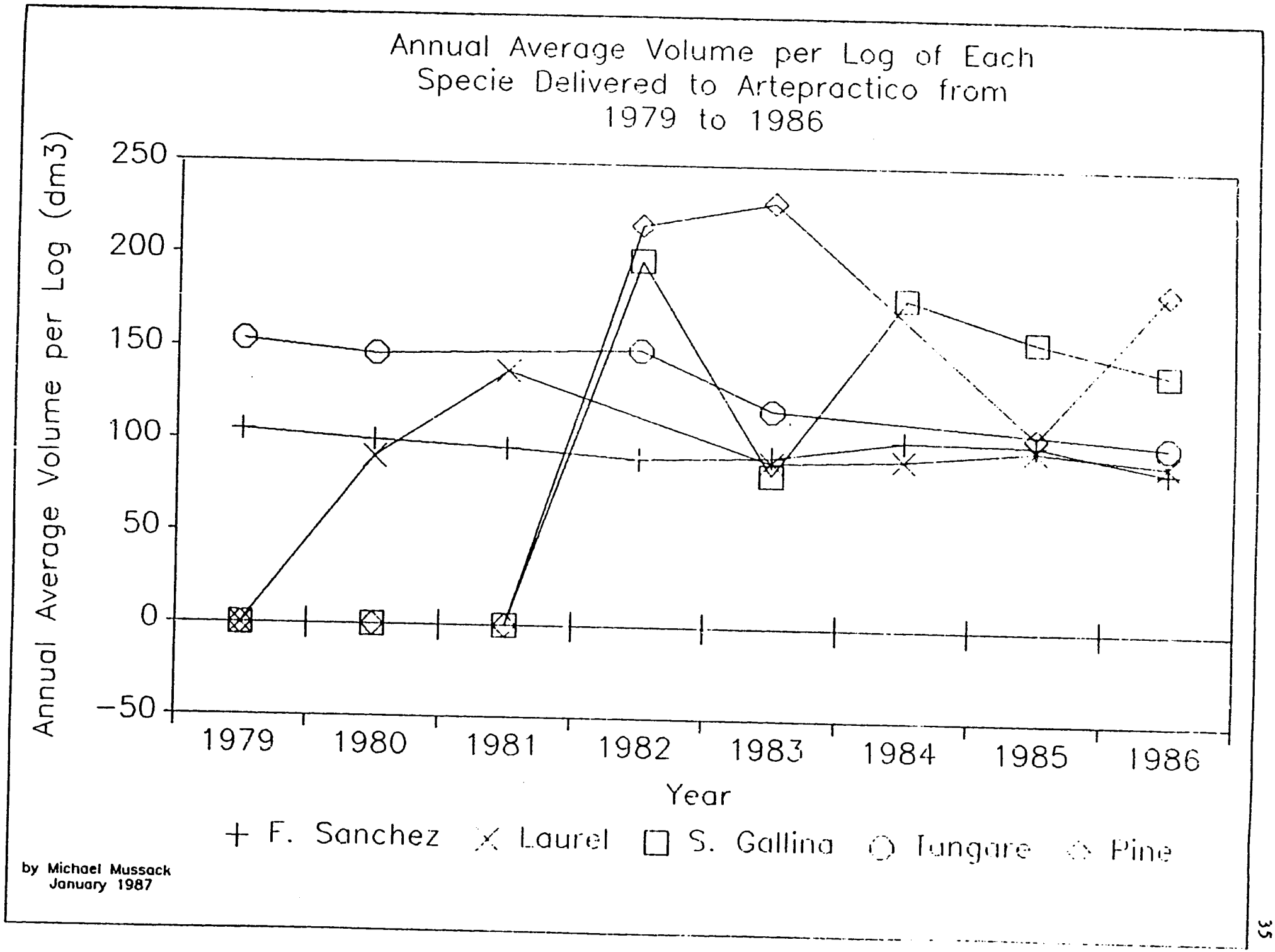
Graph 3

Consumption of Different Wood Species by Artepractico in 1986

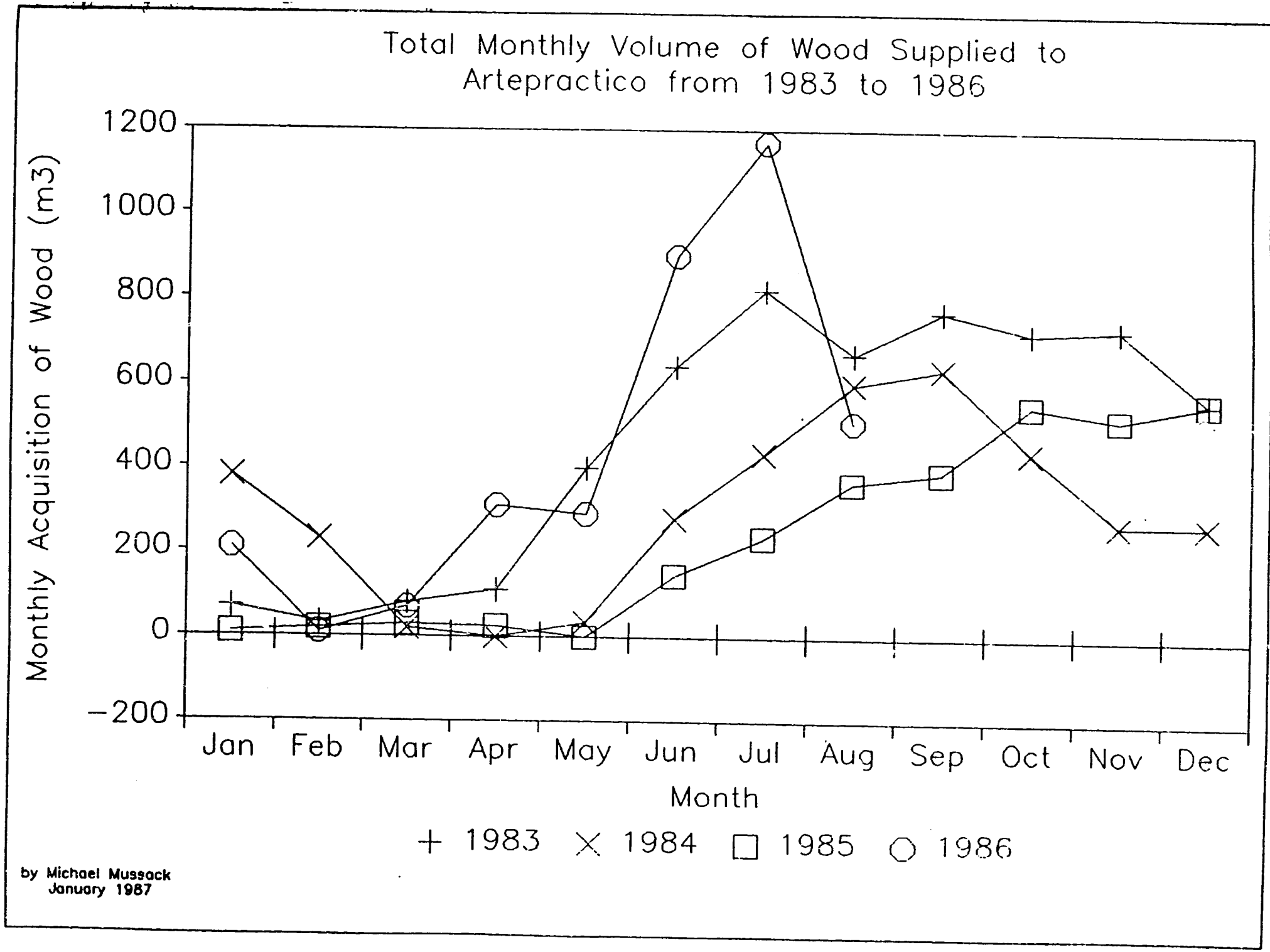


	42.1%
	1.7%
	14.7%
	1.3%
	9.5%
	10.5%
	18.9%
	1.3%

by Michael Mussack
January 1987


Annual Average Volume per Log of Each Specie Delivered to Artepractico from 1979 to 1986
Annual Average Volume per Log (dm3)
250
200
150
100
50
0
-50
1979
1980
1981
1982
1983
1984
1985
1986
Year
F. Sanchez
Laurel
S. Gallina
Tangare
Pine
by Michael Mussack
January 1987

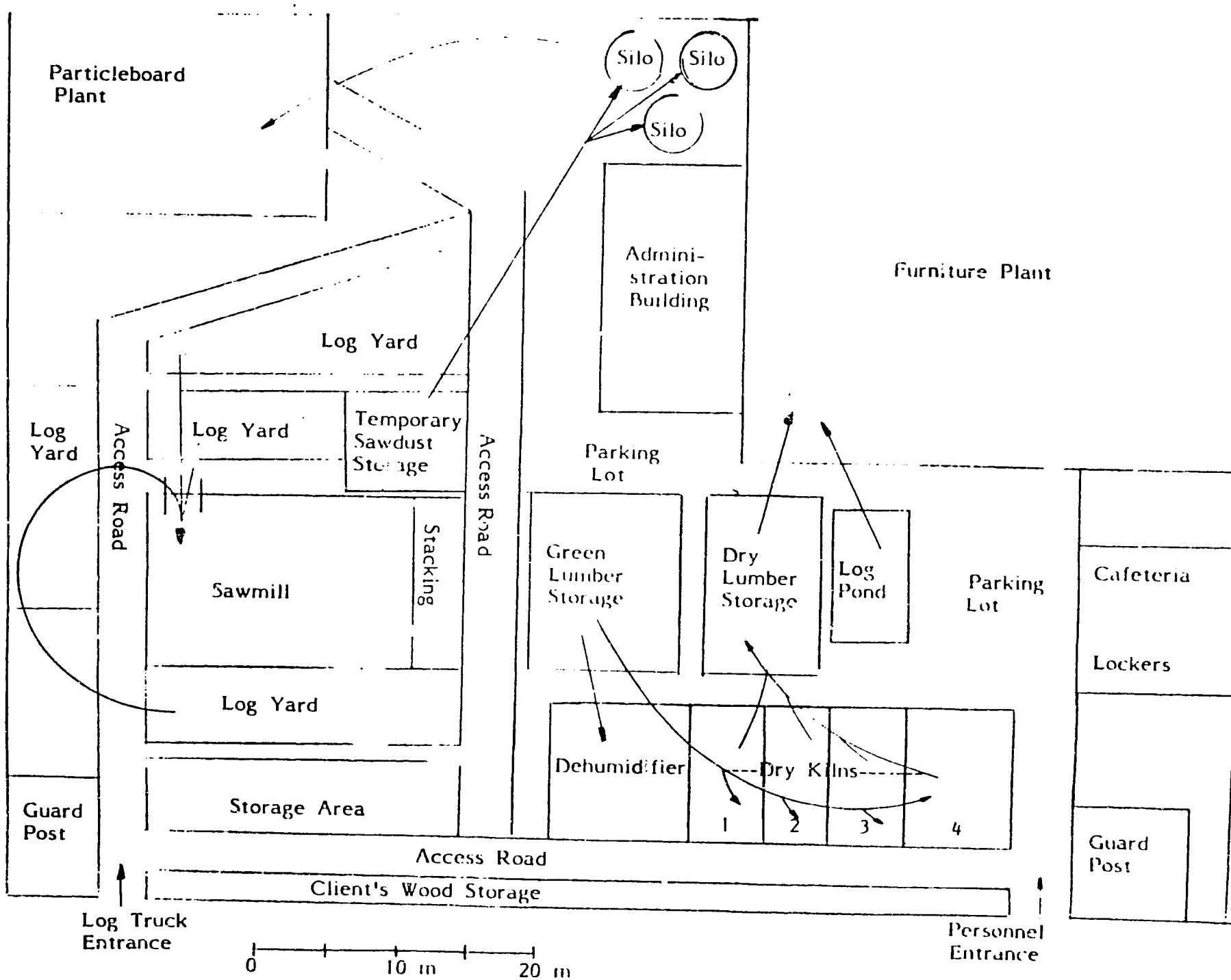
Graph 4


Total Monthly Volume of Wood Supplied to
Artepractico from 1983 to 1986
Monthly Acquisition of Wood (m3)
1200
1000
800
600
400
200
0
−200
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
1983
1984
1985
1986
by Michael Mussack
January 1987

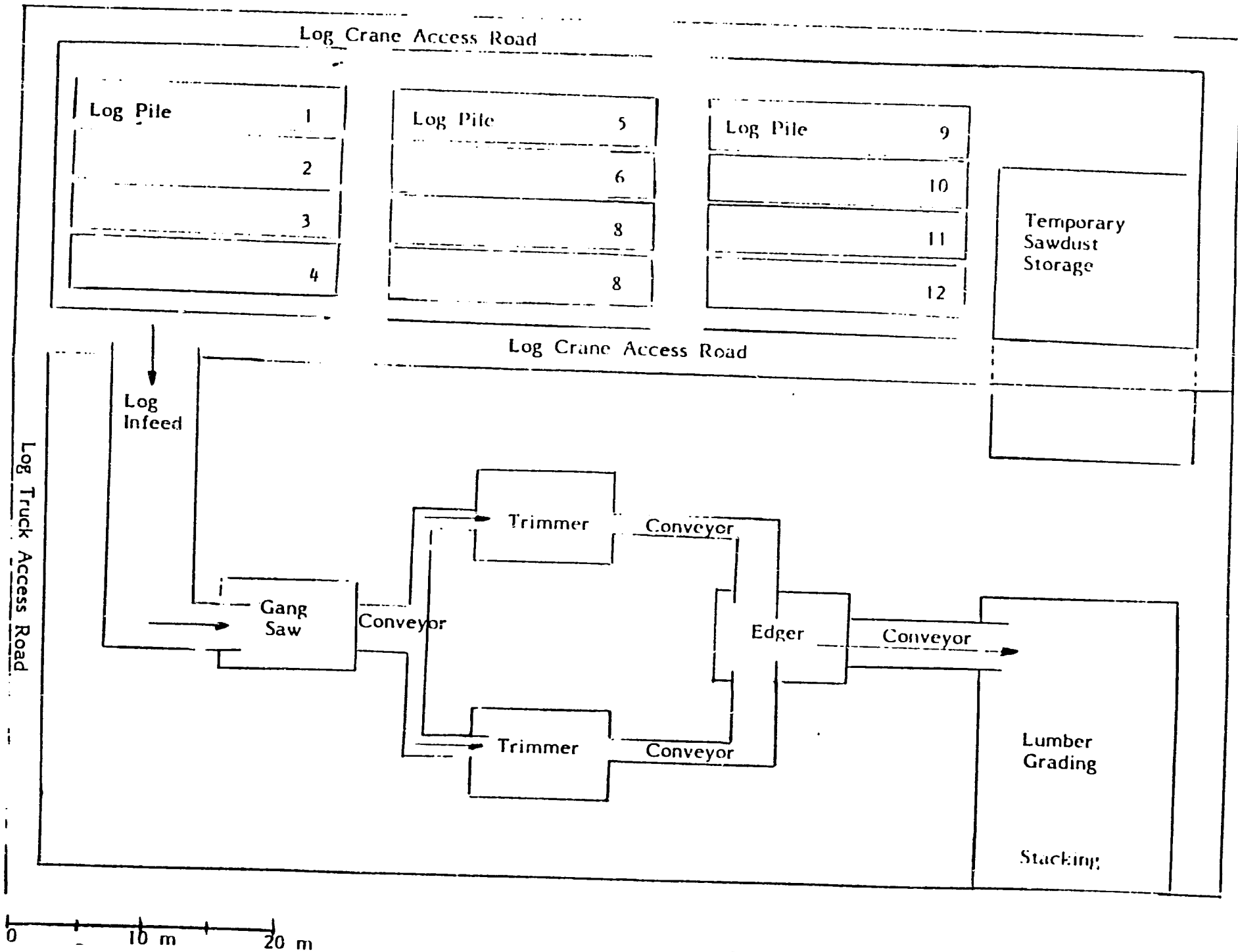
Graph 5

BOUNDARY REPRESENTATION IS NOT NECESSARILY AUTHORITATIVE
Colombia
Esmeraldas
Imbabura
Ibarra
Lago Agrio
Quito
Napo
Pichincha
Cotopaxi
Manabi
Chone
Flavio Alfaro
Bahia de Caraquez
Manta
Portoviejo
Jipijapa
Quevedo
Latacunga
Ambato
Tungurahua
Los Rios
Bolivar
Guaranda
Babahoyo
Riobamba
Chimborazo
Puyo
Tena
Francisco de Orellana
Nuevo Rocafuerte
Pastaza
Guayas
Guayaquil
Santa Elena
Playas
Golfo de Guayaquil
Isla Puna
Machala
Pasaje
Tumbes
El Oro
Loja
Zamora
Zamora Chinchipe
Sullana
Macas
Morona-Santiago
Azuay
Cuenca
Peru
Rio Napo
Rio Aquarico
Rio Nushino
Rio Curaray
Rio Tigre
Rio Pastaza
Rio Santiago
Ecuador
International boundary
Provincia boundary
National capital
Provincia capital
Railroad
Road
0 50 100 Miles
0 50 100 Kilometers

Map 1



Flowchart 1. Artepractico Industrial Complex.



Flowchart 2. Artepractico's Sawmill and Log Yard

Flowchart 3. Steps of the Exploitation Process.

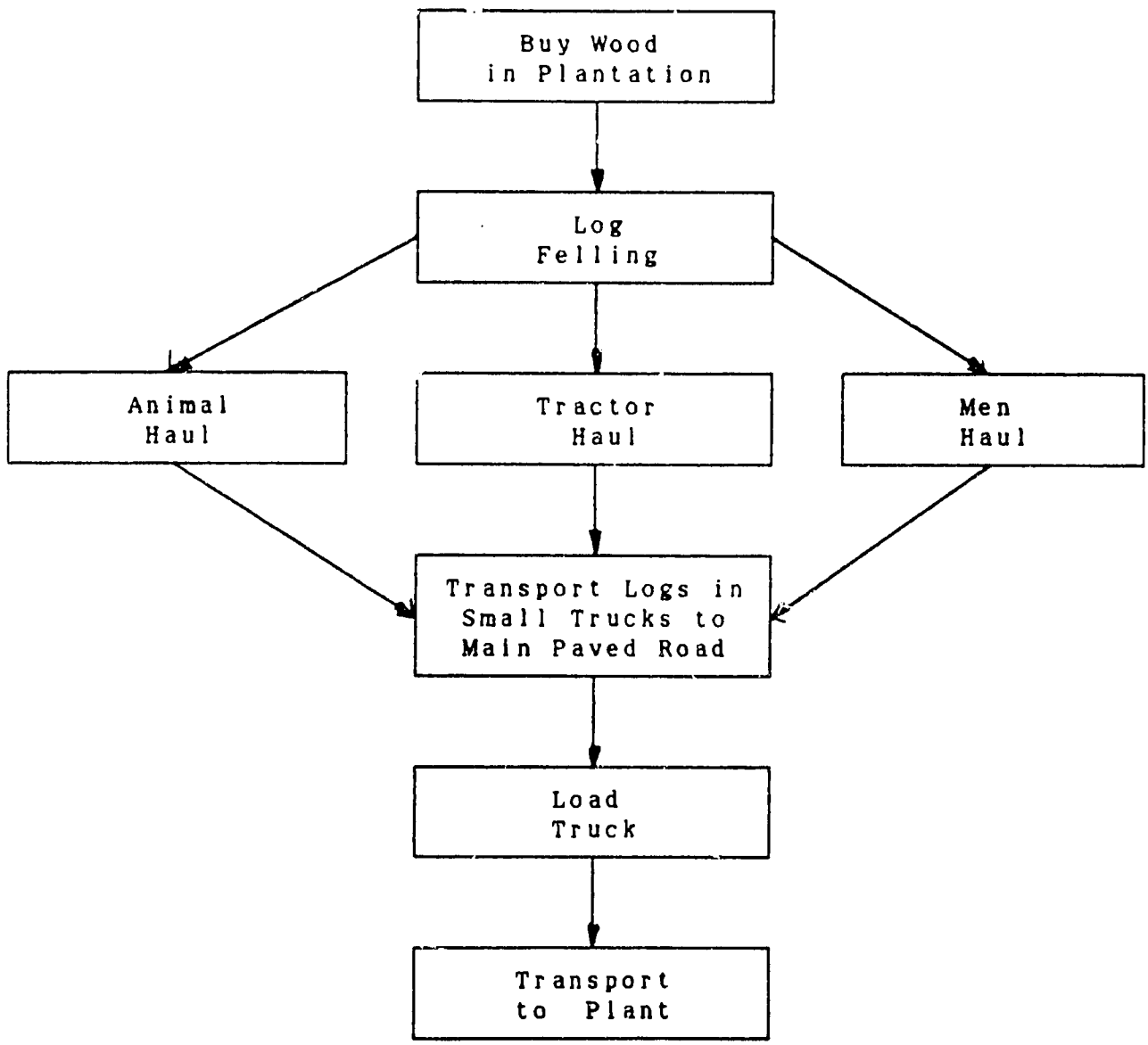


Photo 1. Cacao plantation in the region of Babohoyo in October, 1986.

Photo 2. River transportation of logs in the River Catarama to Guayaquil in October, 1986.

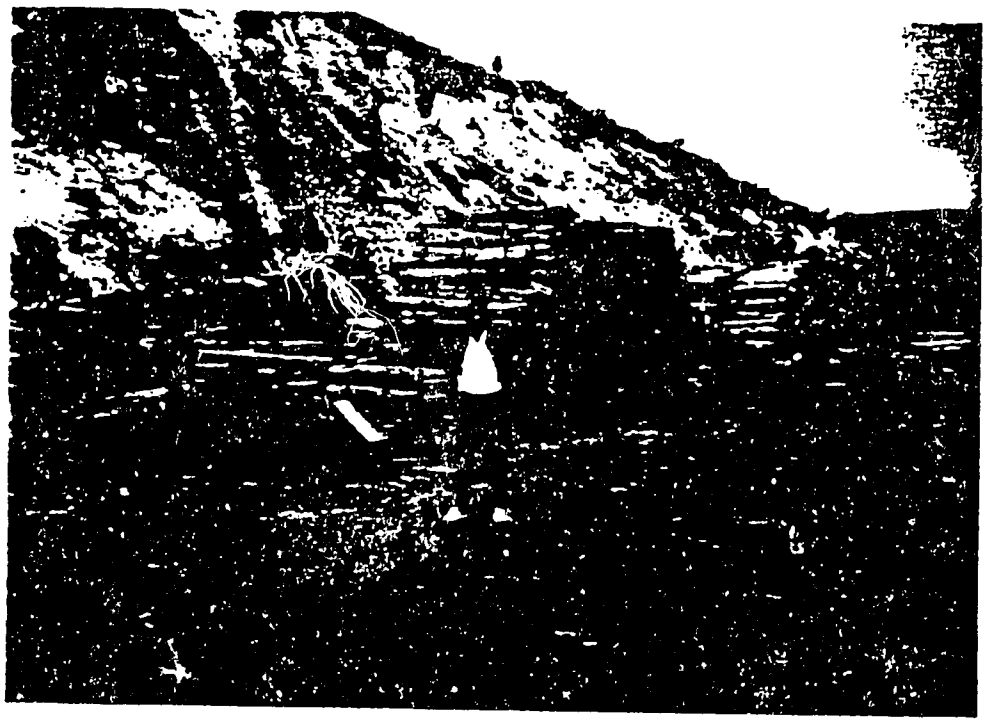


Photo 3. Log Yard and Log Crane access road in Artepractico in 1986 (square pieces is the wood from Esmeraldas, light brown species is Fernan Sanchez and light gray species is Laurel)

Photo 4. Pile of Fernan Sanchez in Artepractico's Log Yard in December, 1986.

LIST OF REFERENCES

Campinhos, E., Jr. 1982. The importance of Using the Correct Species and or Provenance in a Commercial Plantation Program. In "Short Course in Nursery Management, Tree Improvement and Forestry Management," CAMCORE, Chaguaramas, Venezuela.

Duerr, W.A. 1960. *Fundamentals of Forestry Economics*, McGraw-Hill Book Company, NY.

FAO. Food and Agriculture Organization of the United Nations. 1982. *Small and Medium Sawmills in Developing Countries*, FAO, Rome, Italy.

FAO. Food and Agriculture Organization of the United Nations. 1978. Forestry for Local Community Development, FAO, Rome, Italy.

Lunstrum, S.J. 1981. *Circular Sawmills and Their Efficient Operation*, U.S.D.A. Forest Service State and Private Forestry, Madison, WI.

Rich, S.U. 1970. *Marketing of Forest Products: Text and Cases*, McGraw-Hill Book Company, NY.

Snellgrove, T.A. and T.D. Fahey. 1982. *Scaling Small Logs for Volume in "Manufacturing Lumber from Small Logs,"* E. Williston, Seattle, WA.