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DEVELOPMENT OF THE TROPICAL WOOD RESOURCE

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By

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FOREWORD

This report is a partial response to a Participating Agency Service Agreement between the Agency for International Development and the USDA Forest Service (PASA Control No. TA(AJ)2-73) and concerns a study of the factors influencing the utilization of the tropical forest resource.

The information presented in this portion of the PASA obligation is based on an extensive literature review mostly focused on the period 1950-1970. This paper, together with reports of limited overseas travel for on-the-ground consultations, are the main sources of information for the final AID document.

INTRODUCTION

The Tropics of Cancer and Capricorn outline the Torrid Zone which contains almost half the forested area of the world. Tropical forest formations include a wide range of eco-systems or life zones from high-altitude coniferous stands to coastal mangroves, savanna, and scrub. However, it is the wet evergreen or tropical rain forest and the moist deciduous forest, a much simplified grouping, that has long been gleaned or creamed for their timbers. These forests extend from Central Mexico through Central America to southeastern Brazil; in Africa west to east along the Gulf of Guinea, southward to Gabon and then further inland to include the Congo River Basin; and in southeast Asia from India to Malaysia, Indonesia, and the Philippines.

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Traditionally these areas have exported mostly logs or rough squares to more developed markets for further processing. Favored species were few and capable of highly specialized performance. There is now, though, a steady trend in growth of indigenous conversion industries along with an expanding world-wide demand for forest products. Yet species choice in the harvest is still quite selective and much of the wood is unused or underused.

The present and the former Director, Forestry and Forest Industries Division of FAO in addresses to the First and Second Sessions of the FAO Committee on Forest Development in the Tropics have outlined key problem areas yet to be resolved. Mr. Osara stated that the lack of industrial development based on domestic forest resources is due to problems of supply from a complex tropical forest with a multitude of species, the lack of domestic markets, the shortage of skilled labor and professional expertise, adverse freight rates, the absence of organized market channels, political and economic instability, and shortage of investment capital. More currently Mr. Steenberg declared that forestry and forest industries have a unique part to play in the social and economic evolution of most tropical countries but that over the years tropical foresters have not provided firm answers to the many problems surrounding the regeneration and utilization of this resource: (1) We do not really know how best to utilize more than a small fraction of the thousands of species that are found in the tropical high forest; and (2) the so-called silvicultural systems that are employed do not yield the desired results. . . we do not know how to induce the natural regeneration of desired species in a truly mixed tropical forest.

These problems have long been the concern of FAO, other international agencies, tropical forest administrations, and research groups within and outside the tropical zone. It has also been the concern of several arms of the U.S. Forest Service, e.g., Division of International Forestry, Institute of Tropical Forestry, Forest Products Laboratory (FPL). Perhaps in more direct ways it has included the involvement of the Agency for International Development (AID).

This report is based on a joint FPL-AID sponsored probe into the question of a knowledge gap about physical, mechanical, and other wood characteristics of "secondary species" and if there is such a gap would closing it bring about a more rational use of the tropical forest resource. An astute understanding of the problems should lead to a properly oriented research effort. Perhaps then the forest can have a unique part in the social and economic evolution of tropical countries. A misinterpretation of the problems may not be catastrophic but it would be an ill-affordable squander of a limited research budget.

An attempt to evaluate all of the major factors that affect the industrial development of the forest resource must be beyond the scope of this mini study. Determinants other than the character of the forest

and its timbers may be population growth and food demands, shifting versus fixed cultivation, land tenure, political stability, social customs, per capita income, trade patterns, etc. Our focus, then, should be on a few selected countries with emphasis on definition of forests.

The countries selected for review are: South America. . . Surinam, Peru, and Colombia; West Africa. . . Nigeria and Gabon; Southeast Asia. . . Philippines and Malaysia (West Malaysia, Sabah, Sarawak); and they all have the following attributes:

1. An extensive forest reserve.

2. Active in an export trade.

3. External and internal trade in a few species.

4. A high volume of "secondary" species.

5. At least fair access to the forest resource.

6. Some primary and secondary conversion capabilities (sawmilling, panel production, manufacturing).

This portion of the report is based mostly on a library study and is divided into seven parts:

1. Literature Review.

2. Forest Flora.

3. Commercial Species.

4. Forest Enumerations.

5. Silvicultural Systems.

6. Characterization of Primary Species.

7. Ten-year Summary of Roundwood Removals, Production, and Trade.

Most of these sections conclude with an Interpretation Statement pointed to the main theme: Is the lack of knowledge a significant inhibition of secondary species utilization in tropical forests?

LITERATURE REVIEW

Since 1939/40 abstracts of forestry literature have been prepared by the Commonwealth Forestry Bureau, Oxford, England. All citations filed under "Auxiliary Numbers of Place" for the selected countries for the 20-year period, 1951-1970, were catalogued. These are enumerated in Table 1 by subject classifications.

Under the Oxford System of Decimal Classification for Forestry, there are nine groupings:

1. Factors of the Environment. This includes climate, soil, general biology, systematic botany, etc. Generally, by country, this category is most thoroughly documented. The total for all countries combined is 310. About 40 percent of these are Malaysia literature.

2. Silviculture. This covers silvicultural systems, regeneration, arboreta, etc. Literature fundamental to the continuity of the forest resource is scarce in the South American groups and Gabon, but somewhat substantial for Nigeria, Philippines, and Malaysia.

3. Harvesting of Wood. Involves felling, degree of utilization, storage, tools and machines, etc. Almost one-half of this literature was generated in the Philippines (13 citations) and with almost no documentation from Surinam, Peru, and Colombia.

4. Forest Injuries and Protection. Includes forest fires, damage by animals, damage by harmful plants, etc. This category has been of least concern to tropical foresters. There was a total retrieval of only 10 titles for the 20-year period.

5. Forest Mensuration. Covers systems of measurement, assessment of site quality, surveying, etc. There is a total of 56 documents in this grouping but over 50 percent of these were generated by Malaysia.

6. Forest Management. Describes working plans, yield regulation, costing, administration, etc. For the seven countries there was an average of only one title per year over the 1951-1970 period. This may suggest the exploitive nature of the timber harvest.

7. Marketing of Forest Products. Deals with demand and supply, prices, trade policy, etc. This, too, is a low output category with most of the titles coming from Nigeria and Malaysia. There is only one article from the Philippines--a high volume exporter.

8. Forest Products. Includes structure and properties, conversion, treatment, grading, etc. There is a total of 148 titles related to timbers, their properties, and uses. Seventy percent of these relate to the Philippines and Malaysia. References on the woods of Peru and Gabon are negligible.

9. National View. Covers land-use policy, ownership policy, public supervision, taxation, international activities. This is the second largest category with a total of 238 titles. These political aspects of forestry have received particularly high attention in Nigeria and Malaysia.

For all subject classifications for the seven countries, there was a total screening of 928 titles. A large proportion of the literature relates to the forests of Malaysia followed by a substantial number of publications from Nigeria and the Philippines. This total number of categories for the 1951-1970 period may not include broad regional accounts. It also would not include description of trees or timbers grown in other regions but also indigenous to the seven review countries. Number counts of documents may be a misleading representation of a country's literature. Our itemizing equates a single page leaflet with a substantial text that may be basic to a discipline. Nevertheless such a listing does give some proportional accounting as to subject matter emphasis and total documentation over a two-decade period.

The literature of Nigeria, Philippines, and Malaysia is mostly in English with some accounts in German and French. Publications related to forestry in Surinam are mainly in Dutch but some have lengthy summaries in English. A few comprehensive documents are in English. Almost all of the literature of Peru and Colombia is in Spanish. Accounts of forestry and forest products of Gabon are almost exclusively in French.

Aside from books, special reports to governments, international journals (Unasylva, Bois et Forêts des Tropiques, Commonwealth Forestry Review), etc., the literature is contained in periodicals and serials issued by Foundations, Universities, Government Research Agencies, and Professional Organizations within the countries or by associated countries. A listing of these follows:

Surinam

Periodicals--none. Serials--Jaarverslag (Landsbosbeheer, Paramariba); Mededelingen (Instituut voor de Tropen, Amsterdam).

Peru

Periodicals--Revista Forestal del Peru, La Molina; Biota, Luna; Agronomía, La Molina. Serials--Anales Cientificas (Departmento de Publicaciones de la Universidad Agraria, Luna); Mimeografiados (Instituto de Investigaciones Forestales, La Molina).

Colombia

Periodicals--Agricultura Tropical, Bogotá. Serials--Revista Facultad Nacional de Agronomía (Universidad Nacional, Facultad de Agronomía, Medellín); Publicación (Instituto Geografico, Bogotá); Boletin INDERENA and Nota Técnica (Instituto de Desarrollo de los Recursos Naturales Renovables, Bogotá); Boletín Forestal (Universidad del Tolima, Facultad de Ingeniería Forestal, Ibagué-Tolima); CEIF (Universidad Nacional, Departamento Recursos Forestales, Medellín).

Nigeria

Periodicals--Obeche, Ibadan; Nigerian Journal of Forestry, Ibadan. Serials--Forest Products Research Reports, Technical Notes, Information Bulletin (Department of Forest Research, Ibadan); Botanical Studies, Bulletin (University of Ibadan, Department of Forestry, Ibadan).

Gabon

Periodical--Bois et Forêt des Tropiques, Nogent-sur-Marne. Serials--none.

Philippines

Periodicals--Filipino Forester, Manila; Philippine Lumberman, Manila; FORPRIDE Digest, Laguna; Forestry Leaves, Laguna. Serials--Technical Note, Report, Bulletin (Forest Products Research Institute, Laguna); Occasional Paper (Bureau of Forestry, Manila); Technical Note (Forest Products Research and Industrial Development Commission, Laguna); Technical Bulletin (Department of Agriculture and Commerce, Manila). Popular Bulletin (Department of Agriculture and Natural Resources, Manila).

Malaysia--West Malaysia

Periodicals--Malayan Forester, Kuala Lumpur. Serials--Malayan Forest Records, Trade Leaflet (Forest Department, Kuala Lumpur); Research

Pamphlet (Forest Research Institute, Kepong); Report (Forest Resources Reconnaissance Survey of Malaya, Kepong).

Sabah

Periodicals--none. Serials--Botanical Bulletin, Forest Records, Report (Forest Department, Sandakan).

Sarawak

Periodicals--none. Serials--Trees and Timbers of Sarawak and Brunei: Leaflet Report (Forest Department, Kuching).

A considerable literature on silvicultural management and related forestry activities is contained in the Malayan Forester (1931-). Some classical reference material is presented in the Malayan Forest Records that date back to 1921. Bois et Forêts des Tropiques (1947- is more world-wide in scope and makes available much valuable information on the forests of Gabon and Nigeria. A quite new periodical is Revista Forestal del Peru (1966) but unfortunately, the issues are not coming out regularly. Of course, the much consulted source book for Tropical American woods is Record and Hess' Timbers of the New World.

Interpretation

Among the seven countries under review there is a considerable variation in the number of publications on forests, forestry, and wood utilization. Generally the best documentation is on the flora and other biological aspects. There is little mystery then on the kinds of trees that are to be found in these wet tropical forests, at least to the genus. Sharp taxonomic definition is always a continuous rearranging, here as well as for more familiar Temperate Zone plant material.

Citations in Forestry Abstracts in Category 8 (Forest Products and their Utilization) range from only one for Gabon to 64 for Malaysia (1951-1970 screening period). This spread in documentation will be advantageous in later discussions when we begin to relate knowledge gap and the number of commercial species in trade.

FLORA

Fundamental to the definition of forest complexes, to a comprehension of the dynamics of succession, to dendrological descriptions, to utilization of root, fruit, branch, leaf, wood is collection and

classification of the tree flora. Following is a brief résumé of the documentation of the botanical and taxonomic investigations that have been made in the seven review countries:

Surinam

Intensive and extensive collections of the plants of Surinam date back 40 years and more. The most definitive work is the Flora of Surinam edited by Pulle and published in four volumes during 1933-1942. Pfeiffer in De Houtsoorten van Suriname described the wood anatomy of 32 families, 95 genera, and 143 species of trees. A more recent and comprehensive work is Bomenboek voor Suriname by Lindeman and Mennega. Taxonomic and anatomic data is presented for 50 families, 218 genera, and 438 tree species. Stahel collected 240 woods of Surinam (Yale Collection) and also prepared some descriptive literature.

Pfeiffer, J. Ph.
1926-1927. De houtsoorten van Suriname. Kon. Inst. v.d. Tropen. Meded. XXII. Two vols. Amsterdam.

Pulle, A. (ed.)
1933-1942. Flora of Suriname. Kownklyk Vereeniging. Kolonial Instituut. Four vols. Amsterdam.

Stahel, G.
1945. Surinam timbers. Agr. Exp. Sta., Paramariba.

Lindeman, J. C., and Mennega, A.M.W.
1963. Bomenboek voor Suriname. Dienst 's Lands Bosbeheer. Suriname, Paramaribo.

Peru

An outstanding contribution to tropical plant literature is the Flora of Peru published in the Botanical Series of the Chicago Field Museum of Natural History. The vegetation of this country is one of those most intensively studied in the tropical world. Williams described a survey of northeastern Peru along the headwaters of the Amazon River westward from Caballo-Cocha. The enumeration described 74 families, 294 genera, and 634 species. Frequency of occurrence, height and diameter of trees, and some characteristics of the more common woods were given.

Recently Lao Magin prepared a list of 685 forest species of Peru but suggested that there may be some 2,500 species in all. His catalog, as of 1967, represents 75 families and 317 genera. Common names and distribution of the species are also given.

Collections of wood samples and herbarium were made jointly by the Peruvian Servicio Forestal y de Caza and the USDA-ARS. Most of the trees were from the Pucallpa, Iquitos, and Tingo Maria regions and represented 33 families, 83 genera, and 108 species.

MacBride, J. F., et al.
1936- . Flora of Peru. Botanical series vol. XIII. Field Museum of Natural History, Chicago.

Williams, L.
1936. Woods of northeastern Peru. Botanical series vol. XV. Field Museum of Natural History, Chicago.

Anonymous
1966. Identification of trees of Peru. Joint publication of Ministerio de Agricultura, Servicio Forestal y de Caza and U.S. Department of Agriculture, ARS.

Lao Magin, R.
1969. Catálogo preliminar de las especies del Péru. Revista Forestal del Péru 3(2): 3-39.

Colombia

There is a considerable literature on the flora of Colombia but much of it is fragmented and describes only plants and plant associations for disjunct regions. Valle, though, has just published a comprehensive work, Introducción a la Dendrología de Colombia and includes a description of 79 families, 274 genera, and 500 species. There are 123 reference citations!

In the first 94 volumes of Tropical Woods there are some 40 citations related to the flora of Colombia. Curran described the woody plants in a 60 mile by 30 mile tract between the Magdalena and Cauca Rivers north of El Banco. About one-half the area was forested, the remainder was in cultivation or under pasture. Tree size with some comment on wood properties were given for 40 families, 107 genera, and 137 species.

South of the area described by Curran, in the Carare and Opón del Valle del Magdalena region, Vega described the flora and stand composition for five edaphic divisions. The average number of species was 52 per hectare (10 cm. diameter at breast height (d.b.h.) and above). This ranged from 40 on Las Terrazas to 65 on La Quebrada Parra. In all 120 species were enumerated of which 108 were identified. Five families made up 54 percent of the species as follows: Leguminosae 16 percent, Moraceae 11 percent, Lecythidaceae 10 percent, Sapotaceae 9 percent, and Burceraceae 8 percent.

A recent publication issued by INDERENA lists common species found in the seven forest zones of Colombia. Little is known about the largest area "Zona Amazonas" but some principal trees are Hevea, Manilkara, Carapa, Iryanthera, and Virola.

The most intensive surveys are in the Magadalena and Sinu River valleys as part of an FAO sponsored pre-investment stud . A convenient and informative check list is that prepared by Mozo and accounts for 77 families, 216 genera, and 328 species.

Curran, H. M.
1929. The lands of Lobo, Colombia. Tropical Woods 19: 11-38.

Espinal T., L.S., and Montenegro M., E.
1963. Formaciones vegetales de Colombia. Instituto Geografico "Agustin Codazzi," Bogotá.

Mozo Morron, T.
1965. Nombres vulgares y cientificos de algunos árboles en Colombia. Estudios Technios de INCORA, Bogotá.

Vega, L. C.
1968. La estructura y composición de los bosques húmedos tropicales del Carare, Colombia. Turrialba 18(4): 416-434.

Valle A., J. I. del
1972. Introducción a la Dendrología de Colombia. Medellín.

Nigeria

Collections of herbarium material from West Africa were first made in a systematic way by the French botanist Adanson during the years 1749-1754. Early collections from Nigeria were made in 1786-1787 by Palisot de Beauvois. More recently Kennedy published an enumeration of forest flora for southern Nigeria. Most current is the work of Keay, Onochie, and Stanfield in two volumes. This is a very comprehensive account of habitat, tree size and form, leaves, flowers, and fruits, and some wood characteristics. Descriptions are for 78 families and 462 genera. This includes savanna trees that normally reach a height of 15 feet and forest trees that are 25 feet and over. Within this larger tree group there are some 360 species that reach heights of at least 40 to 50 feet and girths of over 3 to 4 feet. The species count could be increased several fold if it included the smaller trees.

Kennedy, J. D.
1936. Forest flora of southern Nigeria. Gov. Printer, Lagos.

Keay, R.W.J., Onochie, C.F.A., and Stanfield, D. P.
1960/1964. Nigerian trees. Vol. I, Fed. Gov. Printer, Lagos.
Vol. II, Dept. Forest Res., Ibadan.

Gabon

In 1961 the first volume of Flore du Gabon was issued. The series includes morphology, distribution, habitat, uses, local names, etc. Under the editorship of Aubreville and later Aubreville and Leroy, number 19 was published in 1972. This work makes up a considerable portion of the forest literature of Gabon. Perhaps of more direct interest to foresters is La Forêt du Gabon by Saint Aubin. Descriptions of trees from 42 families, 149 genera, and 159 species are given. Also presented are notes on habitat, size, diameter distributions, and volumes per hectare. There are also illustrations of stem, foliage, and fruit or seed.

Aubreville, A. (ed.)
1961-1972. Flore du Gabon, Nos. 1-19. Muséum National d'Histoire Naturelle, Paris.

Saint Aubin, G. de
1963. La Forêt du Gabon. Centre Technique Forestier Tropical Pub. No. 21.

Philippines

Comprehensive floras of the Philippines date back some 60 years. Whitford described principal forest trees in 1911. Shortly thereafter Merrill enumerated flowering plants in four volumes. A more relevant work is that of Reyes where he describes trees of 57 families, 165 genera, and 464 species. Some 264 of these species are considered important because of size, abundance, and/or wood characteristics. Local names, distribution, supply, size of tree, general wood properties, anatomical characteristics, and wood uses are also noted.

The trees described by Reyes make up about 12 percent of the Philippine tree flora. There are in all about 3,800 species including some 300 exotics. A revised and more current nomenclature was prepared by Salvosa.

Whitford, H. N.
1911. The forests of the Philippines. Part II. The principal forest trees. Bureau of Forest Bull. No. 10.

Merrill, E. D.
1923-1926. Enumeration of Philippine flowering plants. Four vols. Bureau of Sci. Manila.

Reyes, L. J.
1938. Philippine woods. Dept. of Agr. and Commerce Tech. Bull. No. 7.

Salvosa, F. M.
1963. Lexicon of Philippine trees. Forest Prod. Res. Inst. Bull. No. 1.

Malaysia--West Malaysia

An early collection of Malayan Peninsula flora was made by King and Gamble. About the same time Ridley prepared a series of bulletins on the timbers of Malaya, then during 1922-1925 he published his Flora of the Malay Peninsula. Another early work with more emphasis on forestry aspects was prepared by Foxworthy on Commercial Woods of the Malay Peninsula. Six years later (1927) a more elaborate document--Commercial Timber Trees of the Malay Peninsula--was published. This included notes on common names, distribution and abundance, habit, bark, leaves, flowers, fruits, description and uses of the wood, and some silvicultural aspects. Thirty families, 94 genera, and 287 species were described.

In 1941 the first volume of Desch's Manual of Malayan Timbers was published. A second volume was published in 1954. Emphasis here was on wood characteristics but much information on dendrological features was also given. Woods from 81 families, 310 genera, and 955 species were described. Descriptions of minute anatomy were also given.

Currently in preparation and partially completed (vol. I) is a four volume work, Tree Flora of Malaya, edited by Whitmore. When completed, there will be a review of 94 families and over 3,000 species exclusive of the Dipterocarpaceae. The first volume contains a description of 28 families, 284 genera, and about 1,400 species.

The flora of the Dipterocarpaceae, not covered by Whitmore, was well described by Symington and includes 10 genera and 168 dipterocarp species. Notes on geological history, world distribution, ecological distribution, and keys for identification based on bark, flowers, and fruits are given.

Malaysia: Sabah and Sarawak

Enumeration and studies of the flora of West Malaysia, Sabah, and Sarawak are closely interrelated. Much of the plant material of Sabah and Sarawak are botanically similar and for this reason the two regions will be reviewed together.

Large volumes of Sarawak's commercial timbers are being removed from the peatswamp forests. Anderson has described the plants in such areas, including the ferns. Of interest to foresters is Smythies' Common Sarawak Trees. This contains a description of trees, silviculture, and timber of 34 families and species belonging to 130 genera (non-dipterocarps). A mimeograph series, Trees and Timbers of Sarawak and Brunei is another source of information on the flora of the area.

More current is the Timbers of Sabah by Burgess. Botanical description, distribution, habitat, and wood characteristics are noted for 47 families, 200 genera, and about 1,200 species. Much of the information is based on an earlier work by Keith. Burgess also gives the reader an extensive bibliography of 277 citations. A valuable supplement is the work of Wood and Meijer, Dipterocarps of Sabah, where 16 genera and 153 species are described.

West Malaysia

King, G., and Gamble, J. S.
1889-1912. Materials for a flora of the Malay Peninsula. J. As. Soc., Bengal.

Ridley, H. N.
1901-1902. The timbers of the Malay Peninsula. Agr. Bull. Str., Malay St. 1.

_____
1922-1925. Flora of the Malay Peninsula. Five vols. L. Reeve and Co., Ltd. London.

Foxworthy, F. W.
1927. Commercial timber trees of the Malay Peninsula. Malayan Forest Records No. 3.

Desch, H. E.
1941/1954. Manual of Malayan timbers. Two vols. Malayan Forest Records No. 15.

Symington, C. F.
1941. Foresters' manual of dipterocarps. Malayan Forest Records No. 16.

Whitmore, T. C. (ed.)
1972. Tree flora of Malaya: A manual for foresters. Vol. I. Malayan Forest Records No. 26.

Sabah--Sarawak

Keith, H. G.
1954. The timbers of North Borneo. N. B. Forest Records No. 3.

Wood, G.H.S., and Agama, J.
1956. A check-list of the forest flora of North Borneo. N. B. Forest Records No. 6.

Anderson, J.A.R.
1963. The flora of the peatswamp forests of Sarawak and Brunei, including a catalogue of all recorded species of flowering plants, ferns, and fern allies. Gardeners' Bull. 20(2): 131-228.

Wood, G.H.S., and Meijer, W.
1964. Dipterocarps of Sabah. Forest Dept. Sabah Forest Records No. 5.

Smythies, B. E.
1965. Common Sarawak trees. Borneo Literature Bureau.

Burgess, P. F.
1966. Timbers of Sabah. Forest Dept. Sabah Forest Records No. 6.

Ashton, P. S.
1968. A manual of the dipterocarp trees of Brunei State and of Sarawak. Supplement. Borneo Literature Bureau.

Interpretation

There is a considerable tree flora literature pertaining to the seven review countries. Some areas, though, have been more intensively studied than others. This section cites references where taxonomic and dendrological descriptions are given for thousands of species. Explorers have covered, quite well, some of the most remote regions. Perhaps least known is the "Amazonas" sectors of Colombia and Peru.

Nevertheless, in none of these countries should there be an anticipation of discovery of large tracts of land supporting sequoia-like trees, hitherto unknown, with ambrosial wood properties. Botanically, the forest resource has been well assayed.

COMMERCIAL SPECIES

In the previous section on botanical aspects, we have described in some detail the rich mixes of tree species "available" in the selected countries. This section will list which of these species are being harvested for domestic and foreign trade.

Surinam

The Surinam Forest Service has issued a publication describing 48 main timber species. Of these, 29 are classified as readily available in quantity (group I). It includes species that occur in volumes of 1 cubic meter per hectare (Simaruba amara) to those that may yield more than 10 cubic meters per hectare (Eperua falcata). The other classification (group II) includes species that are found more infrequently in the forest.

A large integrated industrial complex in Paramaribo may handle some 30 species but most of their production is based on only five species: Virola sp., Dicorynia guianensis, Goupia glabra, Vouacapoua americana, and Tabebuia serratifolia.

A survey was made in four regions for three forest types to measure volumes of timber present for each species. The proportional volumes of the nine most common species to total stand volume for all species (35 cm. d.b.h. and over) was as follows:

Region	Forest Type		
	High	Marsh	Savanna
	Pct.	Pct.	Pct.
Cottica-Commewijne	50	35	35
Commewijne-Suriname	37	25	35
Saramacca-Coesewijne	51	29	40
Coesewijne-Coppename	42	17	9

Most of the volumes are in species that have air-dry weights that range from 45 to 65 pounds per cubic foot (p.c.f.) (density of hickory averages about 48 p.c.f.). Stumpage for all species combined comes to about 80 to 200 cubic meters per hectare. On favorable coastal swamp sites not included in the above enumerations, Virola sp. may yield 10 to 20 cubic meters per hectare.

In 1972, 90 percent of roundwood exports were in two species (Goupia glabra and Carapa sp.); 95 percent of the sawnwood exports were in three species (Dicorynia guianensis, Ocotea rubra, and Goupia glabra); 97 percent of hewn timber exports was in Dicorynia guianensis. All of the plywood production and trade was in Virola sp.

Though foreign and domestic commerce is mostly in just a handful of species, there is a large pool of data on the physical and mechanical properties of almost 50 main timber species. This technical information includes: (1) Shrinkage and movement data, fiber saturation point, and kiln schedules; (2) specific gravity; (3) mechanical properties--green and air-dry conditions; and (4) working properties, durability, uses, and supply.

Vink, A. T.
1965. Surinam Timbers. Surinam Forest Service, Parabaribo.

Peru

Peru has a narrow dry coastal plain, a cordillera 300 to 400 kilometers wide, and a large forested region covering the eastern slopes of the Andes Mountains and the Amazon River lowlands. Timber production along the Pacific Coast and in the Peruvian Sierra is in high demand for fuelwood. Extensive areas are being planted to eucalpyts to meet this need.

In the wet lowlands of the eastern areas, timber extraction is very selective. About 50 percent of the lumber production is in Cedrela sp. and Swietenia macrophylla. A survey of the Lima lumber market in 1965 showed that only a few native woods were available: Cedrela, Swietenia, Tabebuia, Hura, Cedrelinga, and Aniba. The first three made up about 25 percent of the volume held by dealers. Some 60 percent of the lumber was imported conifers. Another 10 local woods made up 10 percent and the balance, 5 percent, was in a mix of woods not identified.

An early 1954 listing of lumber production showed 98 percent of the volume was in only 12 species. The survey included Iquitos, Pucallpa, Tingo Maria, Chanchamayo, Oxapampa, Satip-Pangoa, Madre de Dios, and Cuzco regions. Generally most of these areas were sawing only three to six species. Cedrela, Podocarpus, Swietenia, and Tabebuia made up 80 percent of all the fellings.

Anonymous
1955. Estadistica de producción, exportación, y importación de maderas, derivados, y otros productos forestales 1951-1954. Ministerio de Agricultura. Dirección de Colonización y Bosques, Lima.

Colombia

The lands of the Lobo report by Curran listed some of the main commercial species in the Magdalena River drainage basin near El Banco and noted that 50 to 75 percent of the total cut in the riverine forests were Spondias, Terminalia, and Samanea. Almost all of the fellings were in 12 species. The adjacent hill forests supplied primarily Cedrela and Aspidosperma and the main species from the mountain areas were Cariniana pyriformis, Anacardium rhinocarpus, and Clathrotropis brachypetala.

Currently the main exploitation is in coastal areas where there are more gregarious species and accessibility is good. Species include Prioria copaifera (cativo), Cariniana pyriformis (abarco), Iryanthera joruensis (cuangare), Virola sp. (virola), Camnosperma panamensis (sajo), and Brosimum utile (sande). Further inland, in the Sinu-San Jorge Zone, Swietenia macrophylla (caoba) and Cedrela sp. (cedro) are the most exploited timbers.

A considerable literature has been developed on the properties of the above timbers and many others. In Maderas Colombianas the characteristics of 68 species are detailed. Information includes: Common names, distribution, form and size of tree, wood color, grain, and figure, mechanical properties, working characteristics, drying, durability, and uses. In a series of Information Pamphlets, the physical and mechanical properties of 95 species are given in a concise way. Included is a classification under some 14 to 18 end-use categories.

Barghoorn et al. have published a detailed review of the properties of 41 species of the Carare-Opon region. Data on identification and field collecting is also given. This presentation covers 237 pages.

Curran, H. M.
1929. The lands of Lobo, Colombia. Tropical Woods 19: 11-38.

Barghoorn, A. W. et al.
1967. Estudio orientativo de algunas propiedades anatomicas y fisico-mecanicas de 41 especies maderables de la region Carare-Opon. Instituto de Investigaciones y Proyectos Forestales y Madereros de la Universidad Distrital "Francisco José de Caldas." Bogotá.

INDERENA
1970. Aspectos forestales de Colombia. Instituto de Desarrollo de los Recursos Naturales Renovables "INDERENA." Colombia.

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INDERENA
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INDERENA
n.d. Resultados de los estudios fisico-mecanicos de 23 especies maderables de differentes zonas de Colombia. Instituto de Desarrollo de los Recursos Naturales Renovables. "INDERENA" Plegable Divulgativo No. 3.

PROEXPO
n.d. Maderas Colombianas. Fondo de Promoción de Exportaciones. "PROEXPO." Bogotá.

Nigeria

Commercial timber fellings in Nigeria have always been highly selective. In 1911 the total recorded trade from southern Nigeria was in three species: Camwood, ebony, and mahogany. By 1938 the export was mostly in sapele, mahogany, obeche, iroko, and African walnut.

In 1960, 25 species made up 97 percent of the exported log volume. Six species accounted for about 90 percent. They were sapele, mahogany, obeche, iroko, agba, and abura. This is quite similar to the 1938 list.

Lumber exports were just as selective in 1960. The same 25 species accounted for 94 percent of this trade but only 5 species made up 70 percent of the volume: obeche, agba, African walnut, afzelia, and guarea.

Properties and characteristics of 53 Nigerian timbers are described in a brochure issued by the Federal Ministry of Information. It includes notes on common names, color, grain, texture, density, seasoning, working characteristics, strength properties, and uses.

A guide to the use of Nigerian woods in construction was prepared by Okigbo. Woods suitable for framing, millwork, floors, shingles, siding, etc., are listed. Woods are also suggested for heavy timber construction. Short notes on distribution and characteristics of 22 woods are given. Some 40 timbers are described as to strength properties, durability, movement, treatability, and shrinkage.

Considerable information on Nigerian woods and their characteristics is also available in the "Forest Products Research Reports" first issued by the Federal Ministry of Information in 1965. A useful guide to woods of Nigeria and in-print for almost 30 years is the booklet "Timbers of West Africa." The 1950 edition describes in some detail the characteristics of the commercial woods. Information includes common names, general wood characteristics, seasoning, strength, durability, working qualities, and uses.

An even earlier work is Unwin's "West African Forests and Forestry," first published in 1920. For Nigeria there are descriptions of trees, wood color, grain, texture, working qualities, durability, and uses. Notes are on all of the woods well known in the trade and many others that are mostly of local interest.

A very recent regional account is Bolza and Keating's "African Timbers--The Properties, Uses, and Characteristics of 700 Species." All of the common trees of Nigeria are included with notes on tree size, wood density, strength, shrinkage, durability, color, grain, working characteristics, and uses.

Unwin, A. H.
1920. West African forests and forestry. T. Fisher Unwin. London.

Jay, B. A.
1950. Timbers of West Africa. Timber Development Assoc. London.

Pollard, J. F.
1955. A history of the effort made to export timbers from Nigeria. Commonwealth Forestry Review 34(3): 285-293.

Okigbo, L.
1963. A guide to building timbers in Nigeria. Fed. Dept. Forest Res. Ibadan.

Anonymous
1964. Some Nigerian woods. Fed. Ministry of Information. Lagos.

Bolza, E., and Keating, W. G.
1972. African timbers--the properties, uses, and characteristics of 700 species. CSIRO, Division of Building Research. Melbourne.

Gabon

Current log exports from Gabon include about 30 species. Okoumé (*Aucoumea klaineana*) alone makes up 85 percent of the volume. Five species account for 97 percent of the trade: Okoumé, ilomba, limba, ozigo, and tola.

Jay's "Timbers of West Africa" (see reference under Nigeria) lists 33 principal timbers of Gabon and gives details on tree and wood characteristics. A quite complete documentation of the physical and mechanical properties of 55 species growing in Gabon was prepared by Sallenave ("Propriétés Physiques et Mécaniques des Bois Tropicaux"). A first edition was available since 1955. Another general reference is the Bolza and Keating summary sheets on African timbers (see reference under Nigeria).

Sallenave, P.
1971. Propriétés physiques et mécaniques des bois tropicaux. Deuxième Supplément. Centre Technique Forestier Tropical. Nogent-sur-Marne.

Philippines

There are over 3,800 tree species growing in the Philippines but less than 100 are classified by Monsalud and Tamolang as commercial. An earlier work by Reyes was more inclusive. He described the physical and mechanical properties of 264 important timbers. Note was made of another 200 species that were considered of minor importance.

A series of reports, first issued in 1959 and the sixth and last prepared by Lauricio and Siopongco in 1970, presented the mechanical and related properties of 144 species. Data was for both the green and air-dry condition. Of the 100 species in the Monsalud and Tamolang listing only seven are considered as having prime commercial importance. They are all in the Philippine mahogany grouping and include five species of *Shorea*, one *Parashorea*, and one *Pentacme*. In eastern Mindanao the all-lauan associations are dominated by *Shorea squamata*, *Shorea almon*, *Shorea polysperma*, *Shorea negrosensis*, *Parashorea plicata*, and *Pentacme contorta*.

For many years the Forest Products Research and Industries Development Commission (FORPRIDECOM) and its predecessors have conducted tests on the properties and characteristics of Philippine woods. Much of this work has been summarized by Monsalud and Tamolang in their review "General Information on Philippine Hardwoods." The work includes listing of current commercial woods, dominant commercial woods in foreign trade, potential commercial woods; descriptions of physical, mechanical, and

chemical properties; machineability, permeability and treatability, response to steam bending, drying and gluing, charcoal yields, etc. The work also classifies the species into 53 possible end-use categories.

Quimbo, in the Philippine Lumberman, reviewed selectively the timber harvest. Of some 3,897 tree species, 2,820 are small trees (3 to 30 cm. d.b.h., 2 to 5 m. height), 761 are medium-sized trees (30 to 40 cm. d.b.h., 5 to 15 m. height), and 316 are classified as large trees (over 40 cm. d.b.h., over 15 m. height). The author also states that Bureau of Forestry regulations do not permit felling of trees with diameters less than 40 centimeters. He notes that some small to medium trees may have desirable properties for pulp and other specialty uses but that they are not available in quantity in any one region or area. Of those species in the large-tree category, about 26 percent are in a "Fairly Abundant" grouping and only 6 percent are "Obtainable in Large Quantities." Then many trees that are large as well as abundant do not reach commercial markets because of undesirable wood characteristics (Ficus). Quimbo then states, "To make the conclusion that since there are 3,897 tree species and only 60 of these reach the local market, therefore, there are 3,837 tree species in the country, the anatomical, physical, mechanical, and chemical properties which should be studied thoroughly for the benefit of the wood-using industries is good arithmetic but is a distortion of facts."

Reyes, L. J.
1938. Philippine woods. Dept. of Agr. and Commerce Tech. Bull. 7. Manila.

Monsalud, M. R., and Tamolang, F. N.
1969. General information on Philippine hardwoods. Philippine Lumberman 15(6): 14-38; 15(7): 46-72.

Lauricio, F. M., and Siopongco, J. D.
1970. Sixth progress report on the mechanical and related properties of Philippine woods. Philippine Lumberman 16(6): 17-24.

Quimbo, L. L.
1971. Philippine commercial trees--their number, distribution, and abundance. Philippine Lumberman 17(2): 10-18.

Malaysia--West Malaysia

Generally some 60 percent of the forest volume in West Malaysia is in the Dipterocarpaceae. There are localized areas where 90 percent fall in this grouping.

Roundwood exports are mostly in the light and medium weight dipterocarps and are designated dark red meranti, light red meranti, and red meranti. These are directed to the veneer and plywood producers. The identification of sawn timber trade is more specific. In 1971, 44 percent of the lumber export was in the meranti groupings of Shorea sp., 32 percent was identified as keruing (Dipterocarpus sp.), 5 percent kempas (Koompassia sp.), 3 percent ramin (Gonystylus), and 4 percent jelutong (Dyera sp.). Almost 90 percent of this trade, then, was in three species and two species groupings. Yet some 2,500 species of trees are described for the Malaya Peninsula. Of these, Desch has described in some detail the physical, mechanical, and anatomical characteristics of 955 species.

Malaysia--Sabah

Roundwood and sawnwood in roundwood equivalents exported from Sabah in 1970 was about 5 million cubic meters as follows: 43 percent red seraya (111 species of Shorea), 23 percent white seraya (41 species of Parashorea), 12 percent kapur (5 species of Dryobalanops), 10 percent keruing (15 species of Dipterocarpus), and 7 percent yellow seraya (4 species of Shorea). Some 95 percent of the trade volume was in five groupings of 39 species. The remaining 5 percent was in 50 other species.

Literature on the properties of Sabah timbers is extensive. In the work by Burgess, there are detailed descriptions of wood color, texture, grain, strength, density, working properties, durability, etc., for some 1,200 species. Similarly Wood and Meijer describe 150 dipterocarp species.

Malaysia--Sarawak

In 1969 timber export volumes were classified as follows: 21 percent ramin (Gonystylus bancanus), 8 percent jongkong (Dactylocladus stenostachys), 6 percent alan (swamp species of Shorea), 35 percent meranti (hill species of Shorea), 8 percent kapar (Dryobalanops becarii), and 1 percent keruing (hill species of Dipterocarpus). Only three species, two groupings of Shorea and one grouping of Dipterocarpus made up about 80 percent of the export volume. Most of the balance was a mix of swamp species.

Murthy and Yong issued a report on the marketing potential of Sarawak timbers. They list eight species or species groupings as class 1 Inventory, 25 in class 2, and 21 in class 3 or a total of 54 species or species groups that have present or future potential for marketing.

Desch, H. E.
1941/1954. Manual of Malayan timbers. Two vols. Malayan Forest Records No. 15.

Wood, G.H.S., and Meijer, W.
1964. Dipterocarps of Sabah. Sabah Forest Records No. 5.

Burgess, P. F.
1966. Timbers of Sabah. Sabah Forest Records No. 6.

Anonymous
1972. Sabah's timber trade with the United Kingdom. Timber Trade Journal. Annual Special Issue: 55-57.

Smythies, B. E.
1965. Common Sarawak trees. Borneo Literature Bureau.

Ashton, P. S.
1968. A manual of dipterocarp trees of Brunei State and of Sarawak. Supplement. Borneo Literature Bureau.

Murthy, L.S.V., and Yong, J.
1970. The utilization and marketing potential of Sarawak timbers. Malayan Forester 33(4): 295-299.

Interpretation

Except for Peru, each country has been developing an extensive literature on the characteristics and properties of their "commercial" timbers. The number of species described in detail ranges from about 50 in Surinam and Nigeria to almost 1,000 for West Malaysia. But for each area some 90 percent or more of the trade volume is in only five or six species or species groupings. This is about the same number of species making up the main commerce in Peruvian timbers where there is little technical literature.

FOREST ENUMERATION

Forest inventory data is fundamental not only to investment planning and rationalization of extraction but also is essential to the development of effective silvicultural systems. Unfortunately, this type of information is lacking for much of the forested land in the tropics. Recently, though, projects have been under way to measure the resource. Many of these studies are under FAO sponsorship.

This section briefly reviews some forest enumeration aspects for the several selected countries:

Surinam

Data are available from 2 percent strip surveys of merchantable volume and frequency of timber species for three vegetation types located in four forest areas. This is summarized by Vink in "Surinam Timbers." For trees with d.b.h. over 35 centimeters, total volumes in the Savanna Forests ranged from 80 to 95 cubic meters per hectare. Marsh Forests inventoried 125 to 140 cubic meters per hectare. The High Forest averages ranged from 166 to 208 cubic meters per hectare. In the High Forests some 40 to 50 percent of the volume was in nine species or species groups. Particularly high volumes were in Dicorynia, Qualea, Eschweilera, Eperua, Parinari, Licania, and Ocotea. The Marsh Forests are more diversified and the volumes of the most common trees make up 20 to 35 percent of the total stand volume. In the Savanna Forests, volume of these common species varies from 10 to 40 percent of total volume. Eperua falcata (walaba) is quite common in all of the surveyed forests. Often there are 5 to 10 trees per hectare.

Recently a 40 hectare tract of Mapane High Forest was clear-cut for a pulping study of mixed species. Average volume per hectare was 191 cubic meters of which some 70 percent was harvested. In this area 146 species were enumerated and most were with volumes considerably less than 1 cubic meter per hectare. Eight species or species groups had more than 5 cubic meters per hectare and they were: Protium, Tetragastris, Goupia, Chaetocarpus, Couratari, Eschweilera, Eperua, and Piptadenia. These made up 40 percent of the volume. Of 2,500 stems classified by diameter, 235 were over 60 centimeters. Many of these larger trees were: Ormosia, Couratari, Protium, and Eperua.

Vink, A. T.
1965. Surinam timbers. Surinam Forest Service. Paramaribo.

Surinam Forest Service
1969. Jaarverslag van de Dienst Landsbosbeheer--1969. Forest Service. Paramaribo.

Peru

In the coastal areas the forest resource has been almost depleted and in the mountain zones eucalypt plantations are needed to meet fuelwood demands. Plantations cover some 25,000 hectares. Exploitable forests exist only in "la selva" or the wet tropical forests in the eastern zone.

A forest survey in the Rio Huallaga area showed gross volumes of 178 cubic meters per hectare. Net volume of sawn timber in trees with diameters of 26 centimeters and above was 135 cubic meters. Volume in trees 45 centimeters and above was 82 cubic meters per hectare. However net volume considered to be usable in an integrated industrial complex was estimated to be only 25 cubic meters per hectare. It should be noted that transport in this region is only by river and only 24 species out of the 60 surveyed are floatable.

At the headwaters of Rio Marañon in the Nazareth area, surveys indicated that there were 87 cubic meters per hectare in trees of present commercial value with diameters of 35 centimeters and above.

In another region to the south and east centered on Pucallpa about 20 cubic meters per hectare was designated as exploitable timber. Cedrela and Swietenia make up only 0.6 percent of this volume. Species of Ocotea, Nectandra, and others with current commercial value made up some 53 percent of the volume. The balance was in species with potential value.

Aulló, U. M.
1965. Los recursos forestales en el desarrollo economico y social. FAO Informe al Gobierno del Peru No. 2106. Rome.

Hederström, T., and Adlers, L.
1971. Desarrollo de las cuencas hidrograficas del Huallaga Central, Chiriyacu, y Nieva, Peru. Posibilidades de desarrollo forestal industrial. FAO AGS: SF/PER 21 Informe Técnico 2. Rome.

Colombia

In the last few years there has been considerable study of the forest vegetation of Colombia. Much of this, though, has been concentrated on the drainage areas of the Rios Magdalena and Sinu. Bégué gave a summary report of an inventory of the Carare region. Varying with four vegetation types, total volumes per hectare ranged from 74 to 188 cubic meters. Volumes of commercial species made up 40 to 60 percent of the total volume.

In a more detailed report for the same area Vega noted that there were 40 to 65 species per hectare. Five families accounted for 55 percent of the species: Leguminosae, Moraceae, Lecythidaceae, Sapotaceae, and Burceraceae. Data on relative abundance showed that 65 percent of the trees were represented by 19 species or species groups. Only five species or species groups represented 35 percent of the trees: Brosimum, Pouteria, Bowdichia, Inga, and Protium.

In another inventory reported by Henning, 35 species were classified as commercial, 36 species were rated potentially commercial, and 187 species were designated as having no commercial value. One study area showed that 31 commercial species made up 39 cubic meters per hectare, 32 potentially commercial species had a volume of 33 cubic meters and noncommercial species had a volume of 31 cubic meters for a total volume of 103 cubic meters per hectare. This was for a "tierra firme" site. On "pantanosa" or swamp areas 13 commercial species had a volume of 13 cubic meters per hectare, 18 potentially commercial species measured 31 cubic meters per hectare, and noncommercial woods added up to 15 cubic meters or a total of 59 cubic meters per hectare.

For the commercial species enumerated on "tierra firme," Cariniana, Protium, Caryocar, Couratari, Ormosia, Goupia, Virola, and Clathrotropis made up about one-fourth of the total stand volume or 25 cubic meters per hectare. However, three-fourths of this volume is in heavy woods with air-dry densities over 0.7. In the "pantanosa" areas, four species or species groups made up 50 percent of the commercial volume: Basiloxylon, Caryocar, Anacardium, and Virola. The latter two have fairly low densities.

For the high volume species on "tierra firme" sites, some 40 percent of the Cariniana trees may have diameters over 100 centimeters with a frequency of about one tree per hectare. Some 30 to 40 percent of Protium stems range between 50 to 100 centimeters in diameter with a frequency of one tree per hectare. About 50 percent of the Caryocar stems are over 60 centimeters in diameter. These trees may be very infrequent to about one tree per hectare. Species of Virola have quite small diameters with only 10 to 15 percent of the trees over 60 centimeters. Again, on the average, there is one tree per hectare.

Bégué, L.
1965. Les formations végétales de la Colombie. Bois et Forêts des Tropiques No. 102: 63-70.

Vega, C. L.
1968. La estructura y composición de los bosques húmedos tropicales del Carare, Colombia. Turrialba 18(4): 416-436.

Henning, N.
1970. Estudio de preinversion para el desarrollo forestal en los valles del Magdalena y del Sinu. Inventario forestal. FAO:FO: SF/Col. 14, Informe Técnico 4. Rome.

Nigeria

Many enumerations of forest reserves have been made mostly during 1932-1957 covering an area of about 3,000 square miles. Much of this data, though, is not available in summarized form or is no longer applicable. De Rosayro et al. have prepared a forest vegetation map of the Oyo-Shaki area of western Nigeria. The lands have been divided into closed and open forest formations. The former includes the "High Forest" that is near climax with large-crowned emergents, chiefly Meliaceae and "Old Secondary Forests" that correspond to the Triplochiton-Celtis association of Ghana and is rich in Sterculiaceae and Leguminosae. The Open Forest Formation describes the several savanna types where trees are generally scattered.

Fellings in the lowland rain forest (High Forest) average about one to two trees per acre with a volume yield of about 8 cubic meters. These are usually emergents of Khaya and Entandrophragma, with diameters that range from 100 to 160 centimeters. Other common trees are Guarea cedrato, Gossweilerodendron balsamiforum, Lovoa trichilioides, Triplochiton scleroxylon, and Terminalia superba.

On some moist semi-deciduous sites average yields may be 800 cubic feet per acre and as high as 2,000 cubic feet (138 cu. m. per ha.). The average number of trees felled per acre is six. Chief species and percentages of the harvested volume are: Triplochiton scleroxylon, 25 percent; Entandrophragma cylindricum, 16 percent; Nesogordonia papaverifera, 19 percent; Sterculia rhinopetala, 9 percent; Khaya grandifolia, 4 percent; and Terminalia superba, 5 percent.

Age of trees with a girth of 9 feet on lowland rain forest sites are estimated to be 40 years for Triplochiton and over 200 years for Lophira.

Redhead has recently reviewed the timber resources of Nigeria. For various sites and several species classes, stocking of trees for girth breast heights from 2 to over 12 feet are given. Class 1 species (those of economic importance) with girths of 8 feet or more (75 cm. d.b.h.) have a frequency per 100 acres that ranges from 20 to 66 stems. He then states that commercially valuable species are conspicuously few, particularly iroko and the mahoganies which have been heavily logged in the richer forests.

De Rosayro, R. A., et al.
1965. Land use survey of the Oyo-Shaki area, West Nigeria. Report to the Government. FAO No. 2108. Rome.

Redhead, J. F.
1971. The timber resources of Nigeria. Nigerian Journal of Forestry 1(1): 7-11.

Gabon

Saint Aubin has reported in some detail results of enumeration studies of tree volumes to a minimum 35 centimeter diameter limit. A sampling of some 5,636 hectares representing 19 sites has been made. Most of the test plots were in the First Zone (Coastal). The most common species and their volumes per hectare were: Okoumé, 16 cubic meters; coula and ozigo, 8 cubic meters; ozouga, omvong, and alep, 6 to 7 cubic meters; and miama, niové, ebo, and odzikuna, 3 to 5 cubic meters. Eight species had smaller volumes of 2 to 3 cubic meters per hectare, 16 species each had volumes of 2 cubic meters, and 23 species each had volumes less than 1 cubic meter per hectare. The 57 species inventoried had a basal area of 11.95 square meters or 80 percent of the total stand basal area of 15 square meters per hectare.

Okoumé is found throughout Gabon except in the northeastern part of the country and is the most important commercial timber. On a 100 hectare site, diameter distributions have been found to be: 60 trees with d.b.h. over 100 centimeters, 127 trees with d.b.h. 70 to 90 centimeters, and 157 trees with diameters 40 to 60 centimeters. This comes to about 1.87 trees per hectare with diameter above 65 centimeters.

Saint Aubin, G. de
1961. Aperçu sur la forêt du Gabon. Rev. Bois et Forêts des Tropiques No. 78: 3-17.

_____ 1963. La forêt du Gabon. Publ. Cent. Tech. For. Trop. No. 21.

Philippines

Undisturbed dipterocarp forests have been inventoried by Chinte and they showed the following diameter distributions: diameter group 20 to 30 centimeters, an average of 69 trees per hectare with a volume of 41 cubic meters of which 26 trees were dipterocarps with a volume of 17 cubic meters; diameter group 40 to 55 centimeters, 22 trees per hectare with a volume of 56 cubic meters of which 17 trees were dipterocarps with a volume of 41 cubic meters; for trees with diameters of 60 centimeters or more, there were 23 trees per hectare with a volume of 163 cubic meters of which 22 trees were dipterocarps with a volume of 149 cubic meters per hectare. Thus, about 90 percent of the stand volume of the large-diameter trees were dipterocarps but only some 40 percent of the small-diameter trees belong to this group. Total stand volume in trees 20 centimeters in diameter and over was 260 cubic meters per hectare of which 80 percent was dipterocarps. Annual increment in stands after harvest was measured to be 3.7 cubic meters per hectare for all species combined and 2.5 cubic meters per hectare for dipterocarps alone.

In eastern Mindanao, where the above surveys were made, there are two distinct forest types: The apitong-yakal association and the all-lauan association. Dominant species in the former are apitong, yakal, red lauan, mayapis, tangile, almon, and white lauan. In the latter the dominants are mayapis, almon, bagtikan, tangile, red lauan, white lauan, and mangasinoro.

Tagudar, E.
1967. A silvicultural treatment of a tropical virgin forest in the Philippines for sustained-yield management with special reference to the operations of Bislig Bay Lumber Company. Philippine Lumberman 13(3): 30-33.

Chinti, F. O.
1972. Structure and yield of uneven-aged PICOP dipterocarp forest. Philippine Lumberman 18(1): 48-53.

Malaysia (West Malaysia, Sabah, Sarawak)

As for the Philippines, the dominant commercial timbers are the dipterocarps. These usually make up 50 to 60 percent of total stand volumes (12 in. d.b.h. and over). The most abundant group is red meranti. Species of value other than dipterocarps are: *Intsia palembanica*, *Koompassia malaccensis*, *Dyera costulata*, and *Tarrietia* sp. All are emergents. These trees may have diameters between 24 and 48 inches but rarely up to 60 to 80 inches. A typical acre might contain the following emergents: two or three *Shorea* sp. (red meranti group), one *Dipterocarpus* sp., one other light *Shorea* sp., one other dipterocarp, one of the four non-dipterocarps listed above, and one or two rare non-dipterocarps.

Symington reported the results of enumeration surveys covering 7,900 acres of lowland and hill dipterocarp forest types. This showed 22 trees per acre with a d.b.h. of 12 inches or over with a total volume of 2,085 cubic feet (145 cu. m. per ha.). Though some 30 percent of the trees were dipterocarps this accounted for 56 percent of the stand volume. Actual commercial fellings over large areas may yield only 500 cubic feet per acre (35 cu. m. per ha.).

Enumeration data for Sabah and Sarawak was not available, but tree counts and volume measurements in adjacent Brunei have been published by Anderson. Eight timber groupings of trees 20 inches d.b.h. and over made up the inventory. Results per acre were: resak, 0.30 tree, 70 cubic feet; selangan batu, 0.87 tree, 248 cubic feet; dark red meranti, 1.00 tree, 369 cubic feet; red meranti, 1.27 trees, 267 cubic feet; yellow meranti, 1.38 trees, 274 cubic feet; keruing, 1.17 trees, 382 cubic feet; kapur, 1.17 trees, 337 cubic feet; and mersawa,

0.08 tree, 19 cubic feet. Total dipterocarp representation was 7.3 trees per acre with a volume of 1,966 cubic feet (138 cu. m. per ha.).

Fox reported on second-cut yields from a lowland dipterocarp forest 40 years after the first felling. On a 50 acre tract there were 481 trees with a girth over 4 feet. Of these, 46 trees had a girth of 10 feet or more. Based on tree counts, Shorea leptoclados, Parashorea tomentella, Dryobalanops lanceolata, and Dipterocarpus caudiferus represented two-thirds of all the stems. In the second harvest, 183 trees were felled with a total volume of 40,450 cubic feet (Hoppus). Production per acre came to 809 cubic feet (about 70 cu. m. per ha.). This is close to yield estimates given by Symington for uncut virgin stands.

Symington, C. F.
1941. Forester's manual of dipterocarps. Malayan Forest Records No. 16.

Landon, F. H.
1957. Malayan tropical rain forests. In Tropical silviculture, vol. II. FAO Forestry and Forest Products Studies No. 13. Rome.

Anderson, J.A.R.
1957. The enumeration of 235 acres of dipterocarp forest in Brunei. Malay. Forester 20(3): 144-150.

Fox, J.E.D.
1971. Second cut in lowland dipterocarp forest. Malay. Forester 34(3): 167-176.

Interpretation

In the "High Forests" of the wet tropics, timber volumes are substantial, generally running from 150 to 200 cubic meters per hectare. On good sites in the Philippines this may reach 250 cubic meters and more. Exploitable volume may be as low as 10 to 20 cubic meters per hectare in some areas of South America to as much as 10 times this volume in West Africa and Southeast Asia. Though forest heterogeneity is typical in all of the review countries (where many hundreds of woody plants have been described), some dozen or so species commonly may make up 50 percent of the stand volumes. But it is also not unusual to require a gathering of 50 species per hectare to accumulate one-half of the timber volume. Stand "purity," however, is most highly developed in the Philippines where 90 percent of the volume may be in dipterocarps. Much of the

wood-use patterns and exploitation trends would be almost self-explanatory if we had a better documentation of the forest inventory. These quantitative measurements together with species enumerations would more clearly indicate the rationalization behind current harvest practices.

FOREST MANAGEMENT--SILVICULTURE

This aspect of tropical forestry is not often of much concern to the "timber trade." Involvement with the forest resource has been mostly extraction with little thought to some kind of manipulation to sustain supply. The highly scattered but once fairly common Honduras mahogany has been selectively harvested for over two hundred years. Supplies are now difficult indeed to obtain. In just a few decades rich stands of okoumé in the coastal areas of Gabon have been heavily cut and now exploitation is reaching inland to the "Second Zone."

An excellent basic paper on management practices and techniques that have been adopted to regulate species and growth in tropical forests has been prepared by the Centre Technique Forestier Tropical. A short summary of this paper for background information is given here and will be followed by more specific comments on the selected mini-study countries.

Exploitation techniques in tropical countries have advanced considerably and there have been some substantial increases in yield, however, desirable species in the international trade are still few. The small proportion of the total possible yield that these species represent is a major obstacle to a better economic return from the forest. Silviculturists have generally sought to simplify the composition of the forest and at the same time tried to develop methods of natural regeneration. Methods used have varied from the most complex to the most simple and have included shelterwood fellings with successive cuttings, monocyclic fellings, and selective fellings or "loggers choice."

Growth studies have been carried out in many tropical countries on a small number of different species. The untouched natural forest grows only to the extent of making good losses resulting from aging and climatic accidents. Forests in the Congo Basin grow 1 percent of its volume a year or nearly 3 cubic meters per hectare. In Cambodia the figure obtained is 0.33 cubic meter per hectare per year and in Puerto Rico, 1.7 to 3.5 cubic meters.

Measurements in young natural stands of okoumé in Gabon showed that a mean diameter of 0.70 meter is reached in 50 years. It has been concluded that no natural mixed forest in Africa can produce more than 1.5 cubic meters per hectare per year without treatment. Observations made on the relation between size and position of stems and the various

causes of slow growth has led to pessimistic findings on the possibilities of silvicultural manipulation in tropical Africa.

Except in a very few places experiments of most tropical silviculturists do not extend beyond 50 years. The various silvicultural systems have been imported or conceived in the tropics by foresters from the European schools. The tropical forests can be classified into two main types: those where the number of species is small and with or without dominance between them, and those where the number of species is large and within which there is no strongly marked dominance.

Initial management in the heterogeneous and multi-aged forest has been attempts to simplify composition by reducing the number of species. First silvicultural operations were tried in Asia in forests with already simplified composition and which had the advantage of fairly easy and regular natural regeneration and with moderate secondary growth already established. These first attempts then were shelterwood systems with several successive cuttings. However, the progressive cuttings were not always saleable and technical and economic problems of extraction resulted in a single main felling.

The application of the shelterwood system in the very mixed forest was not successful in obtaining regeneration of desired species without also obtaining a multiplicity of less desirable species and an intrusion of lianas and weeds. It was then necessary to reduce light in the stand to control weed growth but this also restricted the desired species many of which are light demanders. Thus, shelterwood systems were applicable only within very narrow limits.

Malayan and Burmese foresters begun to replace difficult and uneconomic weedings by poisoning the larger undesirable trees and cutting the small ones simultaneously with the main felling operation. This uniform system is being applied in the dipterocarp stands. The technique has been introduced in Africa in deciduous and semi-deciduous forests of Ghana and Nigeria. Evaluation of the method indicated that there is no real increase in regeneration but only an improvement of pre-existing regeneration. Also costs of treatment are considered too high. The primary objective of the conversion of the mixed irregular forest into a more regular stand, if successful, still leaves unresolved the silvicultural management of the resulting forest.

The other silvicultural procedure is a "Selective System" but the choice of trees are merely based on commercial exploitation with little thought to regeneration. This is the technique used presently throughout most of the tropics. Some control, nevertheless, is being attempted. This is usually in the form of setting minimum diameter limits in felling. Also trees for extraction may be marked to assure proper distribution of seed trees. Management, then, is poorly defined and the idea of sustained yield is quite foreign to the reality. Difficulties due to

the nature of the forest complex and to current economics have rarely been mastered. Developed and effective silvicultural systems are known to exist for natural tropical forests but they are limited to some types in Southeast Asia. The success in this region makes the general failure all the more conspicuous.

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Surinam

Here the forest lands are divided into three general vegetation types: Hydrophytic (mangrove swamp, marsh), Xerophytic (savannah), and Mesophytic (high forest). Management is the responsibility of the Surinam Forest Service, activitated in 1947. They issue timber prospecting licenses, cutting permits, and control timber concessions which are given out for a maximum period of 10 years.

For the most common merchantable timber species the minimum exploitable diameter is 30 centimeters. Other cutting restrictions, reservation of seed trees, or additional measures may be required to ensure forest regeneration.

About 200,000 hectares of forest lands have been inventoried and actual marketable volume per hectare in the high forest type is 25 to 30 cubic meters. Volumes removed from the swamp and savanna forests are usually lower. Studies of regeneration showed that, even after selective logging, desirable species are common in the pole and sapling stages. One usual treatment is poisoning of overstory weed trees over 10 to 15 centimeters d.b.h. and repeated liberation of young desirable species for several years. Studies are continuing to determine levels of liberation required and possible advantages of obtaining regeneration throughout an area versus cultivation in strips. It is believed a rotation of 60 to 80 years may suffice for medium and heavy hardwoods, to reach a 60 to 80 centimeter d.b.h.

About 2,000 hectares of pine plantations have been established with a now planned 30-year rotation for sawtimber. Mean annual increment of 15 cubic meters per hectare is anticipated. Other trees being tried as replacements for the mixed natural forests are species of Virola, Simaruba, Cordia, Cedrela, and Eucalyptus.

Bhadran's report on forest management suggests for several Working Circles the introduction of a "conversion to uniform" silvicultural system. Except for some enrichment plantings of Virola, this is not clearly defined for Surinam forests.

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Peru

In the coastal and mountain areas of Peru demand for croplands and fuelwood have cleared the natural forests. This is being remedied somewhat by replacement plantings of Casuarina and Eucalyptus which are managed for posts, poles, mining timbers, and fuel. Scarcity of labor, the lack of easy communication with the highly populated Pacific Coast, and the very long distances to the Atlantic have hindered development of the eastern forests, "la selva."

On the lower mountain slopes in the more humid regions, commonly exploited species include Persea, Aniba, Virola, Swietenia, Cedrelinga, Cedrela, Ocotea, etc. Natural regeneration is good and a felling rotation of 40 to 80 years is possible. At still lower elevations in the "flatlands" almost all of the fellings are in Swietenia and Cedrela. Thus most of this region is hardly disturbed. Stems small enough to be easily moved by hand labor and within short distances of streams are generally cut. Regulation of extraction or some concept of forest management is not practiced. The only governmental intrusion is the granting of concessions and collection of cutting fees.

Colombia

About 70 percent of Colombia's population lives in the mountainous areas of the country. These highlands are almost bare of forest cover. Again, as in Peru, food and fuelwood demands by high population

concentrations forced a clearing of the land. Some 30,000 hectare of denuded areas have been planted in several species of Pinus, Cupressus, Eucalyptus, and Acacia.

The present exploitation of the natural forests is limited to a selective extraction without applying any techniques for improving the composition or quality of the forest. However in 1968 the Institute for Development of Renewable Natural Resources (INDERENA) was created and is responsible for forest administration and execution of forest policy. Various studies are being supported and include regeneration of native species, plantation cultures, forest inventory, etc.

Three types of cutting permits are issued:

1. Small concessions. Involves volumes of timber less than 2,000 cubic meters and land areas less than 500 hectares. The permit is for up to 2 years. It requires a work plan by a technical forester.

2. Large concessions. This is a one-time permit for over 2,000 cubic meters of timber and for a period of 5 years. A work plan is required.

3. Long-term concession. Volumes removed are dependent on the capacity of the forest with a concern for regeneration and sustaining the yield. Time of lease is over 5 years and generally will be at least long enough to amortize the investment. A working plan is required and must include silvicultural treatments.

Other timbered lands may be made available through public auction. The effectiveness of the system is yet to be demonstrated.

Much of the current export is supplied by timber harvests in the coastal swamp forests where gregarious species prevail. Stands are very rich with high volumes of relatively few species. Regeneration is usually ample after these high volume removals.

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Nigeria

Exploitation of the forest resource in Nigeria is carried out by large companies using modern logging and transport equipment. Concessions are based on agreements that involve supply of logs for 20 years or so.

The Nigerian Tropical Shelterwood System is based on a gradual opening of the canopy and the establishment of regeneration by cleanings before felling of the economic timber trees. As originally practiced, this involved frequent cleaning and climber cutting over a period of 4 to 5 years, poison girdling of large undesired trees, commercial harvest, and then continued weeding as needed. Poison girdling of trees over 5 feet in girth is generally not practiced. It was soon recognized that 12 or so operations during the regeneration period was physically and economically prohibitive though the systems did usually result in adequate stocking.

About 40 percent of the forested area suitable for commercial exploitation is under forest management. The rest is set aside for agricultural uses. However, a significant volume of timber comes from areas outside of the forest reserve.

Current research studies on regeneration of natural moist forests showed that seedling growth is very slow and that none reached heights over 15 feet in 10 years. Factors such as position in canopy, girth, condition of bole, crown characteristics, and creeper infestation as they may affect growth are being evaluated.

In the drier savanna areas as well as in the wetter zones, plantation culture is growing in favor. Depending on site, teak, obeche, Gmelina and species of Terminalia and Eucalyptus are being set out. The taungya system, where both food crops and much needed wood products can be sustained on the same area, is encouraged particularly for fuelwood rotations near villages. Future supplies of the more valuable furniture woods are also of concern and taungya plantations may include a mixture of Nauclea, Lovoa, Khaya, and Entandrophragma. Line plantings have had some application under special conditions and is a compromise between natural regeneration and the pure plantation culture. Obeche is showing promise under this system.

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Lamb, A.F.A.
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Gabon

Forest exploitation has gone through several stages of development in Gabon. In the "First Zone," a region that extends inland to the end of navigable sections of the rivers, exploitation during the period 1900-1914 was based on skidding by hand labor to nearby streams. A second phase during the period 1920-1939, was the "rail and winch" and was followed by a third development, tractors and tractor trucks. After 1961 this permitted leaving the heavily cut First Zone and made accessible the Second Zone.

Meanwhile a system of enrichment plantings was introduced to assure a continuity of supply of Aucoumea. Spacings between lines were set to be equal to the expected crown diameter at the end of the rotation. In practice this meant 500 stems per hectare were planted to yield 80 or 90 dominants at harvest. But enrichment planting has now progressed to a more favored system, "La Méthode okoumé." This involves clearing the land in rather large blocks and planting at a spacing that may vary from 3 by 3 meters to 12 by 12 meters. About 16,000 hectares of okoumé have been planted of which some 14,000 hectares were established using "La Méthode." Average diameter increment per year is 1.25 to 1.50 centimeters and the rotation has been tentatively set at 60 years. At the end of the rotation, a yield of 200 to 300 tons of peeler logs from 60 to 65 trees is anticipated.

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1965. Sylviculture en forêt dense africaine. Revue Bois et Forêts des Tropiques No. 100: 5-18; No. 101: 3-16; No. 102: 3-16; No. 103: 3-16; and No. 104: 17-29.

Philippines

A 264-page handbook on selective logging has been issued by the Philippine Bureau of Forestry. It is in 12 sections and gives details on tree marking, road systems, inventory, timber stand improvement, record keeping, etc. The document is based on a 10-year evolvement of a selection system originally based on a flexible 70-centimeter diameter

limit. Currently, the marking of trees prior to logging is aimed at saving 60 percent of the stems in the 20- to 70-centimeter diameter class. Trees to be left are marked to set them off from trees to be cut. The system is designed for dipterocarp management.

After logging, timber stand improvement by thinning and weeding is needed. The system attempts to maintain a residual growing stock that will be economical to harvest in 30 to 50 years. Log landings, skid and cable ways, etc., that have been cleared may be planted with fast-growing species (Albizzia falcata, Eucalyptus deglupta, Anthocephalus chinensis).

A study of a residual stand in one concession area showed 53 percent of the stems in the 20- to 35-centimeter d.b.h. class, 32 percent in the 40- to 55-centimeter class, and 15 percent in the 60- to 70-centimeter class. There were some 82 trees per hectare of which 36 percent were dipterocarps. It was estimated that 35 years after logging there will be about 200 cubic meters of timber per hectare.

A recent article by Francia reviewed current forest management problems and overall impact on the timber reserves. About 9 million hectares of forest land is under some form of license. Old growth forests, in 1969, made up only one-fourth of the forest lands. The rest was in young growth, reproduction and brush, unproductive forests, and denuded.

There are several classes of forest permits and the most important are the long-term license agreements. Many detailed regulations have been established to control concession operations but management directives are rarely followed. Silvicultural operations have been confounded by the frequent intrusion of shifting agriculture (kaingin-making). Much of the logging, then, is opportunistic with insufficient concern for the future harvest.

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Francia, F. C.
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1972. Structure and yield of uneven aged PICOP dipterocarp forest. Philipp. Lumberman 18(1): 48-53.

Malaysia

The "Malayan Uniform System" has been developed for the lowland dipterocarp forests. This consists of removal of virgin timber in one operation where regeneration is already well established. Defective relics and noncommercial species are then poison girdled. An elaborate system of check enumerations are called for to assure adequate stocking of desired species. In general the system has been effective in gently undulating country where there is an abundance of fast-growing, light-demanding species of Shorea. Attempts to apply this system to hill forests have not been successful. Burgess tentatively suggests seven prescriptions for various conditions of forest and terrain. On midslopes where regeneration is already adequate, he recommends poisoning of bamboo 1 year before harvest. Log trees down to 4 feet girth (39 cm. d.b.h.), girdle non-dipterocarps down to 1 foot girth, but retain dipterocarp relics. When stand is fully stocked (5 yr.), girdle the relics. Other suggestions include nonexploitation of forests on precipitous lands. Where regeneration has not been adequate then enrichment plantings are prescribed. Much of the hill forests require this treatment. In devastated areas, plantations of fast-growing species are being established. A favored species is Pinus caribaea.

The above brief review applies to West Malaysia. In Sarawak silvicultural treatments differ somewhat. In Mixed Swamp Forests regeneration is good and the only treatment besides the harvest is to remove relics down to 12 inch d.b.h. which may involve poisoning 20 to 30 trees per acre. Rotation is fixed at 60 years. Ramin is slow-growing, shade tolerant, and regenerates well but would require a rotation of 120 years to reach sawlog size. Regeneration in the Peatswamp Forests are not so assured. Here some plantation trials are being made using wildlings and nursery stock of Shorea albida. Little silvicultural work is being done in the Hill Forests.

Logging in Sabah outside of the permanent Forest Reserves is mostly a "once for all" operation and it is believed that this timber supply will be exhausted by 1980. A study by Meijer of regeneration in old logging areas showed that a selective system of logging, with a marking of trees to be retained, could assure a sustained yield under a 60 to 80 year rotation. He found that the same species composition of a mature forest has returned to a logged over area where about five scattered mother trees per acre were kept. But if there was much disturbance of the soil then there would be an encroachment of Anthocephalus chinensis. Dipterocarps in the girth class 4 to 6 feet and defective relics above 6 feet should be left undisturbed as far as possible during logging to safeguard regeneration.

Though silvicultural systems are being developed within a research matrix of 50 years standing, sustained yield is still not a reality. Sirin warns that allowable annual cuts are being exceeded and that a

large backlog of untreated exploited forest reserves is growing. In 1957 the total area of unregenerated forest lands was some 238,000 acres. By 1967, this increased to 432,000 acres. Included are 26,000 acres of "poor forest" and 104,000 acres of "devastated areas" that can no longer be regenerated into the natural forest type but must be brought into a plantation culture (pine, jelutong, etc.).

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Interpretation

Though techniques are now known for obtaining regeneration of desired species for certain tropical forest types under favorable growth conditions, often they are not applied for economic or other reasons. For most tropical forests, where a highly complex mix of many species make up the stand, there is no system for perpetuating species of choice. Often then, as an alternative, plantations are established with a preference for fast-growing exotics. Present use of these natural mixed forests is exploitive and "loggers choice" is the common expediency. Use of other than the more gregarious timber species then is a "one shot" harvest for there is little chance of regeneration. An understanding of this is fundamental to planning of tropical woods research programs.

CHARACTERISTICS OF "PRIMARY" SPECIES

Most relevant to the central theme of this study is a comprehension of why certain species are highly favored in both domestic and foreign trade and others are overlooked. Commercial timbers or "primary species" have been identified for each of the countries under review.

In this section we shall describe tree and wood characteristics of some of the most prized species and thus perhaps identify their common attributes. If these qualities can be defined then perhaps ways would be indicated for enhancing the characteristics of the "secondary species."

Surinam

Almost all of the production as well as export trade is in group I species (volumes of 1 to 10 cu. m. commonly found per ha.). Most of the commerce is in seven species.

Virola sp. (baboen).--Tree 30 to 35 meters high, 60 to 70 centimeters d.b.h., frequent in high swamp forest, common in marsh and riparin forest. Sapwood not differentiated from heartwood, light gray-brown to pinkish gray. Luster moderate, texture coarse. Air-dry specific gravity at 15 percent moisture content 0.50 (31 lb. per cu. ft.). Shrinkage high to very high, movement low to medium. Difficult to season, collapse common. Strength properties comparable to yellow-poplar. Works easily, not difficult to glue or finish. Nondurable, rapidly attacked by stain and pin-hole borers during logging. Requires prompt conversion or storage under water. USES: plywood, veneer, particleboard, and furniture.

Dicorynia guianensis (basralokus, angélique).--Tall tree up to 45 meters, 80 to 90 centimeters d.b.h., straight cylindrical bole, common to frequent in High Forest. Sapwood 4 to 7 centimeters wide, heartwood reddish-brown-gray, frequently with dark-brown streaks. Attractive figure, luster moderate, texture medium, straight grain though sometimes interlocked. Silica ranges from 0.2 to 2.0 percent. Air-dry specific gravity 0.78 (49 lb. per cu. ft.). Shrinkage moderate, movement low to moderate, somewhat difficult to season but dries rapidly. Superior to teak and white oak in most strength properties. Working qualities generally satisfactory, sawing with stellite-tipped blades suggested. Finishes smoothly, easy to glue, difficult to nail and screw. Durable and highly resistant to insect attack, good resistance to marine borers. USES: marine and harbor construction, house framing, millwork, flooring, boat building, furniture, and crossties.

Goupia glabra (kopi).--Large buttressed semi-deciduous tree, 40 meters high, 80 to 120 centimeters d.b.h., widely distributed in High Forest. Heartwood brick red to reddish-brown, luster moderate, texture somewhat fine to coarse, grain straight to interlocked, fetid odor when fresh cut. Air-dry specific gravity 0.85 (53 lb. per cu. ft.). Shrinkage low, movement rather high, moderately difficult to air-season, dries at moderate rate. A hard, strong wood but low in shock resistance. Somewhat difficult to work but surfaces smooth in sawing, boring, turning; torn and chipped grain common in planing. Finishes well.

Moderately durable, high resistance to dry-wood termites but little resistance to marine borers. USES: general and heavy construction, flooring, joinery, and furniture.

Ocotea rubra (wana, determa).--A large tree 25 to 40 meters high, 100 centimeters d.b.h., common to frequent in High Forest. Sapwood 5 to 6 centimeters wide, heartwood light yellowish to reddish-brown, luster medium, golden sheen when dry, texture coarse, grain straight to interlocked. Air-dry specific gravity 0.65 (41 lb. per cu. ft.). Shrinkage low, movement low to moderate, difficult to season, slow to dry, prone to collapse. Below average in strength properties for its weight but compares with white oak in bending and compression. Works well with all tools, finishes and glues well, good performance in exposure to the weather. Durable in ground contact and fairly resistant to termites and marine borers. USES: interior and exterior construction, millwork, boat building, flooring, tight cooperage, furniture, and cabinet work.

Vouacapoua americana (bruinhart).--A canopy tree with a clear bole length of 14 to 17 meters, diameter to 60 centimeters. Common to frequent in High Forest, gregarious in places. Heartwood dark brown or reddish-brown, attractive figure, moderately lustrous, texture coarse. Air-dry specific gravity 0.95 (59 lb. per cu. ft.). Shrinkage moderate to low, movement low, somewhat difficult to season, dries at moderate rate. Strong wood but below average for its weight in toughness, hardness, shear, and cleavage. Surfaces smooth in sawing and planing, turns well, glues well. Very durable and highly resistant to insects. USES: heavy and light construction, carpentry, flooring, quality furniture, and cabinet work.

Tabebuia serratifolia (groenhart, bethabara).--A large tree but often with crooked bole, clear stem 15 to 20 meters, diameter 80 centimeters and more. Sapwood 3 to 9 centimeters wide, heartwood light to dark olive brown, moderately lustrous, texture fine, grain straight to interlocked. Air-dry specific gravity 1.05 (66 lb. per cu. ft.). Shrinkage rather low for its weight, low movement, easy to air season, dries rapidly. Very hard, strong, tough wood equal in strength to greenheart. Moderately difficult to machine, finishes well, requires preboring for nailing or screwing. Highly resistant to decay fungi and insects but vulnerable to marine borer attack. Yellow dust may cause dermatitis. USES: heavy construction, parquet flooring, textile mill items, and tool handles.

Carapa guianensis (krappa, crabwood, cedro macho).--A canopy tree with straight bole 10 to 15 meters long, diameter 50 centimeters. Frequent in Marsh Forests. Heartwood varying in color from pale pink to red brown to dark brown, luster and texture variable. Air-dry specific gravity 0.65 (41 lb. per cu. ft.). Shrinkage rather high but movement

is moderate to low, somewhat difficult to dry, seasons slowly, growth stresses common in logs. Strength about average for its weight, about equal to yellow birch. Works easily with hand and machine tools, glues and finishes well, tends to split on nailing. Durability is highly variable, not resistant to termites, weathers well. USES: general construction work, millwork, furniture, cabinet work, and veneer.

Peru

The two most important species harvested in Peru, cedro (Cedrela sp.) and caoba (Swietenia macrophylla), have long been favored in the trade. Their characteristics are too well known to be described here. Other species commonly marketed locally are:

Hura crepitans (catahua, possumwood).--A large, straight, well-formed tree, up to 40 meters high, diameters to 100 centimeters are common, widely distributed and gregarious on some sites. Heartwood pale yellow brown, olive gray, or dark brown, medium or coarse textured, grain straight to interlocked. Air-dry specific gravity about 0.46 (28 lb. per cu. ft.). Shrinkage is low with only moderate movement, moderately difficult to air-season, dries rapidly. Similar to yellow-poplar in strength characteristics. Easy to work but fuzzy, chipped, torn grain are common, takes a good finish, easy to nail and glue. Wood only moderately durable and vulnerable to sap stain and insect attack. USES: general carpentry, construction, and crating.

Tabebuia sp. (tahuari, tahuari amarillo).--A large tree up to 30 meters high with diameters to 60 centimeters, good form, widely distributed and of frequent occurrence. Heartwood pale yellow to yellowish brown to dark greenish brown, fairly fine to medium texture. Air-dry specific gravity up to 1.25 (78 lb. per cu. ft.). Shrinkage is low, not difficult to dry, only slight degrade, little movement. A very tough and strong wood. Highly durable and very resistant to insect attack. Rather difficult to work but takes a smooth polish. USES: rollers for sugar cane mills, heavy construction, piling, turnery, crossties, and charcoal.

Aniba sp. (moena amarilla).--Generally a small tree but several species reach a height of 30 meters with a straight cylindrical bole up to 90 centimeters d.b.h., common in the lowlands. Heartwood typically yellowish with a greenish hue when fresh but becoming pale brown on exposure, fairly fine to medium textured, spicy odor. Wood is moderately dense, easy to work, takes a lustrous finish, moderately durable. USES: veneers, cabinet work, fine furniture, and construction.

Cedrelinga catenaeformis (tornillo rosado).--A very large tree up to 50 meters high with an enormous trunk 150 to 250 centimeters in diameter, common and of frequent occurrence. Heartwood pale brown with a golden luster, fresh timber has disagreeable scent. Moderate weight, air-dry

specific gravity about 0.55 (34 lb. per cu. ft.). Easy to cut and can be finished smoothly but may saw woolly. Fairly durable. USES: general construction and utility furniture.

Colombia

Aside from the highly preferred trade in caoba and cedro, woods offered by exporters are heavily concentrated in the coastal swamp forests. Here many species are gregarious and more easily accessible in commercial volumes. Some of the more common timbers and their characteristics are:

Brosimum sp. (sande).--Large trees up to 35 meters high with straight cylindrical boles in clear lengths of 25 meters, diameters 80 to 120 centimeters. Heartwood yellowish-gray, medium textured with low luster. Air-dry specific gravity 0.67 (40 lb. per cu. ft.). Volumetric shrinkage is high, moderately difficult to dry with a tendency to twist. Somewhat difficult to work due to silica content, takes a good finish. Durability is low and vulnerable to insect attack. USES: general construction, flooring, furniture, cabinet work, plywood, and particleboard.

Campnosperma panamensis (sajo).--Trees up to 18 meters high with well-formed clear boles, diameters 40 to 60 centimeters. Heartwood reddish-gray, sometimes with a yellowish cast, straight grain, fine texture, high luster. Air-dry specific gravity 0.43 (26 lb. per cu. ft.). Wood seasons rapidly with little or no degrade, volumetric shrinkage is very low. Not resistant to attack by decay, fungi, or insects. USES: box construction, millwork, furniture, plywood, particleboard, and fiberboard.

Iryanthera juruensis (cuangare).--Trees up to 40 meters high, boles straight and clear to 30 meters, diameters up to 120 centimeters. Heartwood is reddish-brown, texture medium and uniform, medium luster. Air-dry specific gravity 0.41 (25 lb. per cu. ft.). Volumetric shrinkage is moderate, wood is easy to air- or kiln-dry but there is a slight tendency to warp and check. Wood is easy to work, durability is low, vulnerable to insect attack. USES: furniture, millwork, boxes, plywood, particleboard, and fiberboard.

Prioria copaifera (cativo).--Trees 30 to 40 meters high, well-formed clear boles to 20 meters, diameters 40 to 100 centimeters and reaching 150 centimeters. Heartwood dark reddish-brown with light and dark streaks, medium texture, and medium to high luster. Air-dry specific gravity 0.54 (33 lb. per cu. ft.). Volumetric shrinkage is moderate, heartwood tends to collapse in drying but can be avoided with care.

Easy to work, takes a good finish, high gum content may be troublesome. Durability and insect resistance are low. USES: veneer, carpentry, furniture, cabinet work, and millwork.

Nigeria

Six species make up about 90 percent of the log export volume.

Triplochiton scleroxylon (obeche).--A very large tree up to 55 meters high, bole straight and cylindrical and clear to 25 meters, diameter above narrow buttresses 90 to 150 centimeters. Wood is pale straw-colored, texture moderately coarse, grain interlocked, high luster. Air-dry specific gravity 0.38 (24 lb. per cu. ft.). Air seasoning or kiln drying rapid with little tendency to warp or check. Easy to work with hand or machine tools, nails and glues without difficulty. Wood is not durable and powderpost beetle attack may be severe. USES: joinery, furniture, millwork, pattern wood, model making, and plywood.

Mitragyna ciliata (abura).--Tree reaches a height of 30 meters with clear boles 18 meters or more, buttress-free, diameters 100 to 150 centimeters. Heartwood light yellowish-brown or pinkish-brown, grain moderately straight, texture fine. Air-dry specific gravity 0.56 (35 lb. per cu. ft.). Movement is small, air and kiln dries with little degrade. Works well with hand and machine tools, easy to glue, takes a good finish, highly resistant to acids. Wood is not durable, vulnerable to insect and termite attack. USES: joinery, furniture, cabinet work, flooring, veneer, and plywood.

Entandrophragma cylindricum (sapele).--Trees 45 meters high but may reach 60 meters, bole straight and clear to 30 meters or more. Heartwood reddish-brown with well-marked roe figure, occasionally mottled, texture fairly fine, cedar-like scent. Air-dry specific gravity 0.62 (39 lb. per cu. ft.). Movement is medium, if quartersawn, the wood seasons fairly rapidly with little degrade. Wood is easily worked but tends to chip grain in planing quartersawn material, easy to glue and finish. Heartwood moderately durable but liable to pinhole borer attack. USES: furniture, plywood, decorative veneers, joinery, flooring, and boat building.

Gossweilerodendron balsamiferum (agba).--A large tree to 60 meters height, with clear bole free from buttresses to 30 meters, diameters 150 to 200 centimeters. Heartwood is yellowish-pink to reddish brown, texture fine, grain straight to moderately interlocked, resin pockets common. Air-dry specific gravity 0.51 (32 lb. per cu. ft.). Movement is small, dries fairly rapidly with little tendency to warp or check. Easy to work but resins may foul the tools. Glues and finishes well.

Resistant to decay but liable to longhorn beetle attack. USES: joinery, general construction, interior trim, furniture, flooring, plywood, and boat building.

Khaya ivorensis (African mahogany).--Tree up to 60 meters high, clear bole up to 27 meters, diameter 150 to 180 centimeters. Heartwood pale pink when freshly cut but darkens to deep brown with golden luster, grain straight to interlocked with medium to coarse texture, attractive roe figure in quartersawn material. Air-dry specific gravity 0.53 (33 lb. per cu. ft.). Movement is small, dries fairly rapidly with little degrade. Easy to work but grain tends to pick up in planing, not difficult to glue or finish. Heartwood moderately durable but liable to pinhole borer and longhorn beetle attack. USES: furniture, cabinet work, paneling, veneer, millwork, plywood, and boat building.

Chlorophora excelsa (iroko).--Tall trees to heights of 50 meters, bole clear for 21 meters or more, diameters up to about 250 centimeters, buttresses small or absent. Heartwood golden-brown, grain interlocked, texture rather coarse. Air-dry specific gravity 0.64 (40 lb. per cu. ft.). Large deposits of calcium carbonate common. Movement small, dries rapidly with little degrade, sticker stain common. Wood machines fairly well but tools often damaged by calcareous deposits, glues and finishes well. Heartwood very durable and with good resistance to insects and termites. USES: joinery, flooring, general construction, boat building, marine work, and plywood.

Gabon

Five species make up 97 percent of the log exports, okoumé accounts for 85 percent. Tree and wood characteristics for these are:

Aucoumea klaineana (okoumé).--A large tree, occasionally up to 60 meters high, bole cylindrical and clear to 25 meters and more, diameters 80 to 110 centimeters and may reach 200 centimeters. Heartwood pinkish-brown, texture medium, grain interlocked with a slight stripe when quartersawn. Air-dry specific gravity 0.43 (27 lb. per cu. ft.). Wood seasons rapidly with little tendency to degrade. Timber rather difficult to saw with some dulling due to silica, sanding or scraping may be necessary for good finish, easy to glue. Wood is not durable and logs liable to insect attack. USES: plywood, millwork, furniture, particleboard, and fiberboard.

Pycnanthus angolensis (ilomba).--A medium-sized tree 25 to 35 meters high with long, straight, clear bole, diameter 60 to 100 centimeters or occasionally more. Heartwood rather plain, grayish-white to pinkish-brown, texture medium to coarse, straight grain. Air-dry specific gravity 0.51 (32 lb. per cu. ft.). Timber seasons rapidly but is prone

to collapse. Works well with hand and machine tools and is an excellent peeler. Wood is not durable and sapwood is prone to powderpost beetle attack. USES: joinery, furniture, millwork, and plywood.

Terminalia superba (limba).--A large tree reaching heights of 45 meters and more, clear boles to 27 meters, diameters above buttresses 100 to 150 centimeters. Heartwood darkens to a light red-brown, nearly black markings give an attractive appearance, texture moderately coarse, grain straight to interlocked. Air-dry specific gravity very variable, averages 0.55 (34 lb. per cu. ft.). Movement is small, dries rapidly with little degrade. Wood works easily with hand and machine tools, finishes and glues well. Heartwood is not durable, sapwood liable to powderpost beetle attack. USES: veneers, plywood, furniture, joinery, and general utility wood.

Dacryodes sp. (ozigo).--A large tree up to 40 meters high, clear, straight boles to 20 meters or more, diameters to 120 centimeters, normally not buttressed. Heartwood grayish-brown with pronounced interlocked grain, texture rather coarse. Air-dry specific gravity 0.61 (38 lb. per cu. ft.). Timber works fairly easily but tends to chipped grain in planing. Some difficulty in drying and should be air-seasoned under cover to reduce warp and checking, shrinkage is high. Heartwood is not durable, sapwood liable to powderpost beetle attack. USES: cabinet work, flooring, plywood, millwork, and general carpentry.

Gossweilerodendron balsamiferum (tola).--See description under Nigeria (agba).

Philippines

The lightweight woods of Parashorea, Pentacme, and Shorea are grouped in the market as red lauan or dark red lauan and white lauan or light red lauan. The former includes Shorea negrosensis, Shorea polysperma, and selected material of Shorea squamata. The latter includes Parashorea plicata, Pentacme contorta, Shorea almon, and also selected material of Shorea squamata. These are the dominants harvested in Mindanao.

Red lauan.--Large trees that reach heights of 70 meters, boles clear and well-formed, diameters up to 150 centimeters. Heartwood red to dark red-brown, texture rather coarse, grain interlocked. Air-dry specific gravity 0.62 (39 lb. per cu. ft.). Movement is small, seasons fairly rapidly, but with some tendency to warp and check. Wood works rather easily with hand or machine tools, sometimes tears in planing, takes a good finish and is easy to glue. Wood is moderately durable but the sapwood is liable to powderpost beetle attack. USES: general construction, millwork, plywood, flooring, and boat building.

White lauan.--Large trees up to 60 meters high with well-shaped clear boles to 30 meters, diameters to 100 centimeters. Heartwood variable in color from pale pink to light red, texture coarse, grain shallowly interlocked. Air-dry specific gravity about 0.51 (32 lb. per cu. ft.). Movement is small, timbers generally dry fairly rapidly with little warp. Easy to work with all tools, glues and finishes without difficulty. Heartwood is not durable and sapwood liable to powderpost beetle attack. USES: plywood, furniture, millwork, and general carpentry.

Malaysia--West Malaysia

Most of the roundwood exports belong to the groupings of dark red meranti and light red meranti. These have already been described as red lauan and white lauan respectively for the Philippines. In addition, keruing supplies substantial volumes to the foreign trade.

Dipterocarpus sp. (keruing).--Trees commonly 30 to 60 meters high with clear, straight boles to 21 meters, diameters are 100 to 180 centimeters. Heartwood varies from pinkish-brown to dark brown, sometimes with a purple tint, texture moderately coarse, grain usually straight or shallowly interlocked, resin exudation common. Air-dry specific gravity mostly between 0.72 and 0.80 (45 to 50 lb. per cu. ft.). Movement is medium to large, wood generally dries slowly, cup is often considerable and slight collapse may occur. May be difficult to machine due to resin exudates, straight-grained material planes well but quartersawn interlocked material gives a fibrous finish, gluing is variable. Heartwood is moderately durable and sapwood is liable to powderpost beetle attack. USES: heavy construction, housing, joinery, flooring, and boat building.

Sabah

Roundwood and sawnwood exports are mostly made up of the red seraya grouping. These wood are similar to the red meranti of West Malaysia and the red lauans of the Philippines (already described). Other important export groups are white seraya, kapur, and keruing.

Parashorea sp. (white seraya).--A very large tree 45 to 60 meters high with straight cylindrical boles up to 30 meters, diameters 100 to 150 centimeters or more above the large buttresses. Heartwood straw-colored to very pale brown, sometimes with a pinkish tinge, texture moderately coarse, grain interlocked producing a broad striped figure on quartersawn surfaces. Average air-dry specific gravity about 0.53 (33 lb. per cu. ft.). Movement is small, dries fairly rapidly with little degrade except for slight tendency to cup. The wood is easy to work with hand and machine tools, glues and finishes well. Heartwood is moderately

durable but sapwood is vulnerable to powderpost beetle attack. USES: furniture, cabinet work, light construction, flooring, millwork, and plywood.

Dryobalanops sp. (kapur).--Large trees to heights of 60 meters and more with straight bole to 30 meters above well-developed buttresses, diameters usually 100 to 150 centimeters and more. Heartwood light to dark reddish-brown, fairly straight grained, moderately coarse texture, fresh-cut wood has a camphor-like odor. Air-dry specific gravity 0.77 (48 lb. per cu. ft.). Movement is medium, timbers air-dry slowly with a tendency to cup. Wood works well with hand and machine tools, but there may be some gumming of cutters, dulling of tools can be considerable. Heartwood durable but not resistant to termites, sapwood vulnerable to lyctus and pin-hole borers. USES: building construction, flooring, exterior trim, furniture, and stadium seats.

Dipterocarpus sp. (keruing).--Already described under West Malaysia.

Sarawak

In addition to meranti, keruing, and kapur (already described for Sabah), other important export woods are:

Gonystylus sp. (ramin).--A tall tree up to 25 meters high with a clear, unbuttressed, cylindrical bole to 15 to 18 meters, diameter ranges from 60 to 110 centimeters. Heartwood uniform pale straw color, texture moderately fine and uniform, straight grained to shallowly interlocked. Air-dry specific gravity 0.66 (41 lb. per cu. ft.). Wood has unpleasant smell when first cut. Movement is large but dries readily with little warp, there is some tendency to surface check and end split. Wood can be worked fairly easily and takes a good finish. Heartwood is not durable, sapwood liable to lyctus attack. USES: general utility, furniture, joinery, millwork, and novelty items.

Shorea albida (alan).--A large tree, diameters 60 to 120 meters, a common tree of the peat swamps. There is considerable variation in color, weight, texture, and related properties. Air-dry densities range from 20 to 57 pounds per cubic foot, probably averaging about 48 pounds per cubic foot. Shrinkage is moderate and the wood can be air seasoned or kiln dried without serious degrade or difficulty. Heartwood is moderately durable. Log breakdown and conversion to veneers made difficult by frequent hollow cores as well as large volumes of low-density juvenile wood. USES: plywood, heavier grades used locally for general construction and crossties.

Interpretation

A review of the characteristics of the "primary species" shows a remarkable spread of properties. The various woods include those with very attractive figures and colors and others quite bland in feature; very light and structurally weak timbers and heavy strong timbers; woods that have little in-place movement, dry rapidly, and with no warp or checking, and others with high movement, slow and difficult to dry, and prone to collapse, warp, etc.; woods that are easy to machine and others that gum the cutters, dull the tools, and tend to chipped and torn grain; and there are woods that are highly durable, not attacked by beetles or termites, and resist marine borer activity, and others that are highly perishable and vulnerable to insect attack both in the green logs and finished lumber. The only feature common to all these woods are the large sizes of the trees and their relatively frequent occurrence in the forest. At best many of these would be considered rare in a temperate zone forest. Also though air-dry densities for the woods under survey range from 24 to 78 pounds per cubic foot, all except four species have weights about equal to white oak and sugar maple or less.

ROUNDWOOD REMOVALS, PRODUCTION, AND TRADE

The previous segments have emphasized some of the qualitative aspects related to tropical wood use. In this section focus will be on measurements of the forest yield and a survey of the quantities that flow to domestic and foreign trade. Also included is the measurement of negative balances or imports of wood and wood products.

Statistics on the wood harvest, primary processing, and the import-export trade for the decade 1960-1969 are given by country in tables 2 through 10. This information has been compiled by the Forestry and Forest Industries Division of FAO together with the Economic Commission for Europe and has been abstracted from the relevant "Yearbooks of Forest Products."

For each of the selected countries (and separately for the regions of Malaysia), domestic consumption by commodities may be estimated by adding or subtracting the balance of export-import to or from the production values. Statistics on fuelwood removals are mostly incomplete and are generally only approximate. For some regions only recorded fellings for fuelwood are given resulting in very large underestimates of consumption, particularly by the rural inhabitants.

As in the previous sections, a country by country presentation will be made.

Surinam (table 2)

Of the three tropical American countries under review, Surinam has the lowest volume of "Industrial Roundwood Removals." This ranged from 210,000 to 260,000 cubic meters (r) per year over the decade with no particular trend in output. Recorded fuelwood fellings make up a very minor component.

Sawnwood production was irregular but there is an upward trend with the highest output of 64,000 cubic meters (s) in 1969. Plywood production ranged from 13,000 to 19,000 cubic meters per year with peak outputs in 1963 and 1969. Particleboard production was fairly irregular with lows of 9,000 to 10,000 cubic meters in 1960 and 1968 and 24,000 cubic meters during peak years, 1964 and 1966.

Roundwood exports per year were mostly about 20,000 cubic meters (r). Some 50 percent of this trade was in poles and piling. Yearly log export made up less than 10 percent of the industrial removals. A moderate but increasing export of sawnwood was recorded. Only 2,000 to 3,000 cubic meters (s) was shipped in 1961-1962 and about 6,000 cubic meters (s) in 1969. Some 14,000 cubic meters of plywood was exported per year (80 pct. of the production). Particleboard production too was geared for foreign trade with the same proportion held for domestic use.

Roundwood imports per year ranged from 6,000 to 22,000 cubic meters (r) and was destined mostly for plywood production. In 1969 this made up one-fourth of the peeler log supply. Only very modest amounts of sawnwood and fiberboard were imported during this period. Paper imports during 1961-1965 were less than 2,000 tons per year but at the end of the decade this increased to 8,000 tons or 21 tons per 1,000 population.

Peru (table 3)

Industrial Roundwood Removals have been fairly constant ranging mostly between 500,000 and 700,000 cubic meters (r). Fuelwood demands make up between 80 and 90 percent of total forest removals. This was 2.5 million cubic meters (r) annually towards the end of the decade.

Sawnwood production, though low, almost doubled during the decade to 239,000 cubic meters (s) for 1969. Plywood production is first reported for 1964 at 7,000 cubic meters, but after a few years this increased to 12,000 cubic meters. Particleboard is also a new commodity with a start of 2,000 cubic meters in 1963 with a rise to 8,000 or 9,000 cubic meters for 1968-1969. Though not shown in the table, veneer sheets came into production in 1967 with an output of some 7,000 cubic meters per year. Pulp production increased more than twofold to 73,000 tons

in 1969. This is entirely from nonwood fiber, bagasse. There is also a parallel increase in paper production which reached 95,000 tons at the end of the period.

Exports of forest products were negligible. Log shipments reached a maximum of 1,000 cubic meters (r) per year for 1963-1965. Sawnwood peaked at 7,000 cubic meters (s) in 1964-1965. Most of the veneer production was shipped.

Roundwood imports are small but sawnwood imports make up a large component of the domestic consumption. Usually this was 20 to 35 percent of the needs. Plywood imports dropped as domestic production came on the market. Also only small and irregular amounts of particleboard and fiberboard came in from abroad. Paper products, though, are an important component of imports rising from 40,000 tons in 1961 to 64,000 tons in 1969. Combined imports and domestic production in 1969 was 159,000 tons or an apparent consumption of 12.5 tons per 1,000 population.

Colombia (table 4)

For the 1960-1969 period, annual Industrial Roundwood Removals were fairly constant at about 3 million cubic meters. Except for 1960, fuelwood consumption was estimated to be 22 million cubic meters per year or slightly over 1,000 cubic meters per 1,000 population.

About two-thirds of the Industrial Roundwood Removals were converted into sawnwood with production somewhat steady at 1 million cubic meters (s) per year. During the review period plywood production had doubled to 60,000 cubic meters in 1969. Particleboard output ranged mostly between 8,000 to 15,000 cubic meters per year with no particular growth trend. Fiberboard was first produced in 1965 and thereafter at a rate of 10,000 cubic meters per year. Pulp production had increased about threefold during the 1960's, reaching 90,000 metric tons in 1969. However, 60 percent of the fiber source was bagasse. Paper production was generally about double domestic pulp supply with the deficits made up by waste papers and imported pulp.

Over the survey period roundwood exports per year decreased from some 90,000 cubic meters (r) to about 50,000 cubic meters (r). During 1960-1961 there was no reported export of sawnwood but from 1962 to 1969, trade jumped from 33,000 cubic meters (s) per year to 150,000 cubic meters (s).

Imports of roundwood, sawnwood, and panel products were negligible, only occasionally amounting to more than a few hundred cubic meters. Paper products, though, were a major import commodity with annual needs of 60,000 to 70,000 tons. Combined 1969 production and paper imports for that year shows an apparent consumption of only 12.7 tons per 1,000 population.

Nigeria (table 5)

Industrial Roundwood Removals during 1960-1962 were a little over 1 million cubic meters (r) per year but in the latter half of the decade, this increased to about 2 million cubic meters (r) per year. Fuelwood fellings were some 28 million cubic meters (r) in 1960 and almost doubled by 1969. This reflects population growth as per capita consumption was about 0.85 cubic meters per year throughout the decade.

Sawnwood output was erratic. This was generally close to 300,000 cubic meters (s) per year from 1960 to 1967 with a sharp increase to 500,000 cubic meters (s) in 1969. Plywood production was quite steady at 20,000 to 30,000 cubic meters per year. Veneer manufacture was first recorded for 1966 and this had held at 23,000 cubic meters per year.

Roundwood exports reached a peak of 764,000 cubic meters (r) in 1964. Thereafter there is a drop in shipments to about 350,000 cubic meters (r) in 1969. Sawnwood exports were also highest in 1964 (87,000 cubic meters (s)) and then a drop to almost nil in 1969. Plywood exports per year for 1961-1966 was between 19,000 and 24,000 cubic meters. In 1969 this dropped by almost 50 percent.

Imports of forest products varied considerably for each of the reported commodities. Entry of roundwood and sawnwood was highest in 1962-1963 with very small or no imports in the other years. Plywood imports per year during 1960-1964 were 5,000 cubic meters with little or no trade thereafter. Imports of particleboard and fiberboard were also irregular with maximums of 5,000 cubic meters and 5,000 tons respectively. Paper imports were more uniform with a yearly trade of 17,000 to 24,000 tons during 1961-1964 and 31,000 to 37,000 tons during 1965-1969. Apparent consumption at the end of the decade was about 0.5 tons per 1,000 population.

Gabon (table 6)

Industrial Roundwood Removals were at a high of about 1.8 million cubic meters (r) during 1960 and 1961. This dropped to 1.3 million in 1965 with a gradual increase back to the original high. Fuelwood demands were about 40 to 50 percent of the total roundwood removals.

Sawnwood production had a reported low of 6,000 cubic meters (s) in 1961 but there was steady increase thereafter to about 50,000 cubic meters (s) in 1969. Plywood manufacture was fairly irregular. A maximum of 89,000 cubic meters was reached in 1965 and this went down to 70,000 to 75,000 cubic meters during 1968-1969. Veneer output was very sporadic with a high of 20,000 cubic meters per year during 1964-1967 and small irregular amounts in other years.

Much of the Industrial Roundwood Removals were exported with volumes mostly around 1 million cubic meters (r) per year with a peak of 1.6 million in 1969. Sawnwood exports were developing over the decade. Some 6,000 to 12,000 cubic meters (s) were shipped per year during 1961-1965 with strong increases to 20,000 to 30,000 cubic meters during 1966-1969. Most of the veneer production was exported while about 10 to 15 percent of the plywood output was held for domestic use.

Imports of sawnwood and panel products were very small and irregular, no item amounting to much more than 100 cubic meters. Paper product imports were first recorded for 1965 (500 tons). In 1968 and 1969 this came to 800 tons or an apparent consumption of less than 2 tons per 1,000 population.

Philippines (table 7)

The Industrial Roundwood Removals show a continuous upward trend starting at some 6 million cubic meters (r) and ending at about 12 million cubic meters (r). In the Yearbook of Forest Products, the recorded fuelwood consumption for 1969 was some 300,000 cubic meters (r). In another FAO document, fuelwood use in the Philippines was estimated to be 500 cubic meters (r) per 1,000 population or about 18 million cubic meters (r) cut for 1969 use.

Sawnwood production had increased over the decade from about 1 million cubic meters (s) in 1960 to almost 1.6 million in 1969. This used about 25 percent of the Industrial Roundwood Removals. Plywood production was irregular and ranged from 208,000 cubic meters in 1964 to 410,000 cubic meters in 1968. Veneer output was first reported in 1964 and grew from 135,000 to about 250,000 cubic meters by 1969. Particleboard manufacture was minor and reached only 1,500 cubic meters during 1968 and 1969. Fiberboard growth was substantial. About 20,000 tons were produced in 1963 and increased to almost 50,000 tons in 1969. Pulp production as well as paper output has had considerable growth during the review period. Only 6,500 tons of pulp were produced in 1960 but this reached over 100,000 tons in 1969. Fifty percent of this was from fiber other than wood. Paper production increased more than threefold from 39,000 tons in 1960 to 140,000 tons in 1969.

The bulk of Industrial Roundwood Removals were exported in log form. There was a steady increase in this trade from about 3.8 million cubic meters (r) in 1960 to over 8.6 million in 1969. Sawnwood exports were irregular with a trade of 84,000 cubic meters in 1964 and almost double that volume in 1960 and 1969. Plywood exports also did not show a trend with a low of 134,000 cubic meters in 1964 and close to 200,000 cubic meters most other years. Veneer exports were only 49,000 cubic meters in 1961, but by the end of the decade the trade jumped to 213,000 cubic meters.

Imports of all forest products were small and erratic except for paper. Paper trade showed a general increase and reached 140,000 tons in 1969. Combined domestic production and imports gave an apparent consumption of 8 tons per 1,000 population.

Malaysia--West Malaysia (table 8)

Industrial Roundwood Removals showed a continuing increase and more than doubled during the decade from 2.3 million cubic meters (r) in 1960 to 5.4 million in 1969. Fuelwood removals were fairly constant at about 500,000 to 600,000 cubic meters (r) per year or an apparent consumption of 72 cubic meters per 1,000 population. This is much less than the 500 cubic meters per 1,000 population given in other FAO documentation for this area.

Sawnwood production in 1960 was 1 million cubic meters (s) and this about doubled to 2.1 million by 1969. Plywood production during this period was more spectacular. Output was only 2,000 cubic meters in 1960 with only slight increases the following few years. In 1965 production doubled, during 1966-1967 it doubled again, and again doubled in 1968, and reached 143,000 cubic meters in 1969. Particleboard was first reported in 1965 with a manufacture of only 600 cubic meters. It increased somewhat to 1,000 cubic meters by 1969. Pulp and paper output during most of the period amounted to only a few tons and was based on fiber other than wood (rice straw).

Roundwood exports in 1961-1962 were only a few thousand cubic meters but thereafter, trade increased rapidly to 1.9 million cubic meters in 1969. Sawnwood exports also showed a substantial growth from 352,000 cubic meters (s) in 1961 to 877,000 in 1969. At the end of the decade 40 percent of the production was shipped abroad. Though not shown under production in table 8, a few thousand cubic meters of veneer were manufactured and shipped towards the end of the decade. A small volume of particleboard was exported during 1966-1968.

Roundwood imports were about 50,000 cubic meters (r) per year for 1961-1963 with little or no trade thereafter. Sawnwood imports were about 20,000 cubic meters (s) per year in the early 1960's but then dropped to only a few thousand cubic meters per year during 1964-1969. Panel products showed similar trend and were about the same magnitude. Paper imports were irregular with a low of 36,000 tons in 1964 and 104,000 tons in 1969 or an apparent consumption of about 12 tons per 1,000 population.

Malaysia--Sabah (table 9)

Industrial Roundwood Removals almost tripled from 2.2 million cubic meters (r) in 1960 to about 6.2 million in 1969. Reported fuelwood removals showed only 36,000 cubic meters (r) in 1969 or 60 cubic meters (r) per 1,000 population, considerably less than the 500 cubic meters (r) already indicated for the region.

Sawnwood production during the 1960-1965 period varied from 50,000 to 80,000 cubic meters (s) per year. By 1969 this reached 136,000 cubic meters (s). Plywood manufacture was first reported for 1965 with an output of only 300 cubic meters. In 1969 production reached 6,000 cubic meters. For the same period veneer production grew from 6,000 to 17,000 cubic meters.

The bulk of the Industrial Roundwood Removals were exported in log form. In 1961, 2.2 million cubic meters (r) were shipped overseas and this developed to 6.2 million by 1969. Only a moderate portion of the sawnwood production was exported. Shipments were irregular and varied from 3,000 cubic meters (s) to 17,000 cubic meters (s) per year. Plywood exports were also irregular and minimal with only 5,000 cubic meters in trade during 1968 and 1969. (The table shows an export of 7,000 cu. m. of veneer in 1963 but no production was reported for that year.)

Imports of Industrial Roundwood were irregular with a peak trade of 40,000 cubic meters (r) in 1963 but this dropped to only 9,000 cubic meters (r) in 1969. Sawnwood imports also varied considerably from a low of 3,000 cubic meters (s) in 1960 to a high of 28,000 cubic meters (s) in 1968. Panel products were imported sporadically and only in very small quantities. Paper imports were only 400 to 600 tons per year during 1961-1963 and then increased to 2,000 tons by 1969 for an apparent consumption of 2.8 tons per 1,000 population.

Malaysia--Sarawak (table 10)

The harvest of Industrial Roundwood showed a continuing increase from 1.2 million cubic meters (r) in 1960 to 4.3 million in 1969. Fuelwood removals were irregular with about 28,000 cubic meters (r) reported for 1969 or only 30 cubic meters (r) per 1,000 population. Again this is considerably less then that suggested for the region; i.e., 500 to 900 cubic meters (r) per 1,000 population.

Sawnwood production showed a continuing but irregular growth over the decade from 270,000 to 280,000 cubic meters (s) in 1960-1962 to about 600,000 cubic meters (s) during 1968-1969. Plywood and veneer manufacture was reported only for 1968-1969 with an output of 20,000 cubic meters per year. There was no other primary processing.

Export of Industrial Roundwood Removals was 500,000 cubic meters (r) in 1960 but by 1969 this increased almost sixfold to 3.1 million cubic meters (r). At the end of the decade about 70 percent of these fellings were shipped as is. Sawnwood exports were irregular and ranged from 184,000 cubic meters (s) for 1962 to 311,000 cubic meters (S) for 1968. Plywood exports were first reported for 1965 with a trade of only 300 cubic meters, however, this jumped to almost 15,000 cubic meters by 1969. Veneer export was erratic with a low of 3,000 cubic meters in 1969 to a high of 13,000 cubic meters in 1963 (only the 1968-1969 production and export figures for plywood and veneer appear to be compatible).

Imports of all forest products categories were irregular and in small quantities. Sawnwood and plywood imports rarely were much above 1,000 cubic meters per year. Fiberboard and paper imports had about the same yearly tonnage that ranged from 1,000 to 3,000. The apparent consumption of paper is 3.2 tons per 1,000 population.

Interpretation

For the decade 1960-1969, the greatest increase in Industrial Roundwood Removals took place in the Southeast Asia countries. By 1969 there were 11.7 million cubic meters (r) removals in the Philippines and 15.9 million cubic meters (r) in Malaysia. There was little or no growth in West Africa and Tropical America. Quantities removed were also much less: 0.1 million cubic meters (r) in Surinam, 0.6 million in Peru, 3.2 million in Colombia, 1.9 million in Nigeria, and 1.8 million in Gabon.

Fuelwood removals were substantial in each country but comparison and interpretation of the data is difficult because of inconsistencies in collecting and recording the statistics.

In Southeast Asia much of the Industrial Roundwood Removals were shipped to foreign markets without further processing. However, in West Malaysia there has been a high development of primary processing so that by 1969 only 35 percent of the log harvest was exported as is. Elsewhere the value was 75 percent for the Philippines, 87 percent for Gabon, and only 1 percent for Colombia.

Emphasis on primary processing is developing in the Philippines and rather high volumes of commodities were exported in 1969--sawnwood, plywood, and veneer equivalent to 1.2 million cubic meters of roundwood. Prior to the civil conflict in Nigeria, sawnwood and plywood equivalents to 200,000 cubic meters of roundwood were exported. This trade also developed rapidly in Colombia where exports of lumber were equivalent to 270,000 cubic meters of roundwood in 1969.

For all the countries, the most important forest product import was paper. Apparent consumption varied considerably per 1,000 population: 0.5 tons in Nigeria, 3 tons in Sabah, 12 tons in Colombia, and 21 tons in Surinam.

Finally, for a touch of perspective, the combined Industrial Roundwood Removals for all seven countries under review was about 35 million cubic meters (r) in 1969. This is 10 percent of comparable fellings made in the United States that year. Paper consumption for the same year was 260 tons per 1,000 population.

SUMMARY

For convenient reference, the interpretive statements prepared for each section in the text are again given here:

Flora

There is a considerable tree flora literature pertaining to the seven review countries. Some areas, though have been more intensively studied than others. This section cites references where taxonomic and dendrological descriptions are given for thousands of species. Explorers have covered, quite well, some of the most remote regions. Perhaps least known is the "Amazonas" sectors of Colombia and Peru. Nevertheless, in none of these countries should there be an anticipation of discovery of large tracts of land supporting sequoia-like trees, hitherto unknown, with ambrosial wood properties. Botanically, the forest resource has been well assayed.

Commercial Species

Except for Peru, each country has been developing an extensive literature on the characteristics and properties of their "commercial" timbers. The number of species described in detail ranges from about 50 in Surinam and Nigeria to almost 1,000 for West Malaysia. But for each area some 90 percent or more of the trade volume is in only five or six species or species groupings. This is about the same number of species making up the main commerce in Peruvian timbers where there is little technical literature.

Forest Enumeration

In the "High Forests" of the wet tropics, timber volumes are substantial, generally running from 150 to 200 cubic meters per hectare. On good sites in the Philippines this may reach 250 cubic meters and more. Exploitable volume may be as low as 10 to 20 cubic meters per hectare in some areas of South America to as much as 10 times this volume in West Africa and Southeast Asia. Though forest heterogeneity is typical in all of the review countries (where many hundreds of woody plants have been described), some dozen or so species commonly may make up 50 percent of the stand volumes. But it is also not unusual to require a gathering of 50 species per hectare to accumulate one-half of the timber volume. Stand "purity," however, is most highly developed in the Philippines where 90 percent of

the volume may be in dipterocarps. Much of the wood-use patterns and exploitation trends would be almost self-explanatory if we had a better documentation of the forest inventory. These quantitative measurements together with species enumerations would more clearly indicate the rationalization behind current harvest practices.

Forest Management--Silviculture

Though techniques are now known for obtaining regeneration of desired species for certain tropical forest types under favorable growth conditions, often they are not applied for economic or other reasons. For most tropical forests, where a highly complex mix of many species make up the stand, there is no system for perpetuating species of choice. Often then, as an alternative, plantations are established with a preference for fast-growing exotics. Present use of these natural mixed forests is exploitive and "loggers choice" is the common expediency. Use of other than the more gregarious timber species then is a "one shot" harvest for there is little chance of regeneration. An understanding of this is fundamental to planning of tropical woods research programs.

Characteristics of "Primary" Species

A review of the characteristics of the "primary species" shows a remarkable spread of properties. The various woods include those with very attractive figures and colors and others quite bland in feature; very light and structurally weak timbers and heavy strong timbers; woods that have little in place movement, dry rapidly, and with no warp or checking, and others with high movement, slow and difficult to dry, and prone to collapse, warp, etc.; woods that are easy to machine and others that gum the cutters, dull the tools, and tend to chipped and torn grain; and there are woods that are highly durable, not attacked by borers or termites, and resist marine borer activity, and others that are highly perishable and vulnerable to insect attack both in the green logs and finished lumber. The only feature common to all these woods are the large sizes of the trees and their relatively frequent occurrent in the forest. At best many of these would be considered rare in a temperate zone forest. Also though air-dry densities for the woods under survey range from 24 to 78 pounds per cubic foot, all except four species have weights about equal to white oak and sugar maple or less.

Roundwood Removals, Production, and Trade

For the decade 1960-1969, the greatest increase in Industrial Roundwood Removals took place in the Southeast Asia countries. By 1969 there were 11.7 million cubic meters (r) removals in the Philippines and 15.9 million cubic meters (r) in Malaysia. There was little or no growth in West Africa and Tropical America. Quantities cut were also much less: 0.1 million cubic meters (r) in Surinam, 0.6 million in Peru, 3.2 million in Colombia, 1.9 million in Nigeria, and 1.8 million in Gabon.

Fuelwood removals were substantial in each country but comparison and interpretation of the data is difficult because of inconsistencies in collecting and recording the statistics.

In Southeast Asia much of the Industrial Roundwood Removals were shipped to foreign markets without further processing. However, in West Malaysia there has been a high development of primary processing so that by 1969 only 35 percent of the log harvest was exported as is. Elsewhere the value was 75 percent for the Philippines, 87 percent for Gabon, and only 1 percent for Colombia.

Emphasis on primary processing is developing in the Philippines and rather high volumes of commodities were exported in 1969--sawnwood plywood, and veneer equivalent to 1.2 million cubic meters of roundwood. Prior to the civil conflict in Nigeria, sawnwood and plywood equivalents to 200,000 cubic meters of roundwood were exported. This trade also developed rapidly in Colombia where exports of lumber were equivalent to 270,000 cubic meters of roundwood in 1969.

For all the countries, the most important forest product import was paper. Apparent consumption varied considerably per 1,000 population: 0.5 tons in Nigeria, 3 tons in Sabah, 12 tons in Colombia, and 21 tons in Surinam.

Finally, for a touch of perspective, the combined Industrial Roundwood Removals for all seven countries under review was about 35 million cubic meters (r) in 1969. This is 10 percent of comparable fellings made in the United States that year. Paper consumption for the same year was 260 tons per 1,000 population.

Throughout the areas studied, choice of species for exploitation can be related to available supplies and intensity of demand. In the Colombian highlands surrounding Bogotá, in the coastal and mountain areas of Peru, in the populated centers of Western Nigeria, and in the heavily settled areas of Malaysia, the forests have been intensively used and overused for generations to meet domestic needs.

As timbers with prime attributes were exhausted, the less desirable species quickly became of first rank. Skimming continued until the forests were devastated and even the most refractory material then assumed primary importance. Under this circumstance, wood from eucalypt plantations became very attractive, not because of desirable physical, mechanical, or other properties, but because the trees were adaptable to harsh growth conditions and could yield high volumes.

In the same countries but in areas where population pressures on rich forest stands have been light, fellings are still highly selective both for internal and foreign markets.

Somewhat similar parallels in timber exploitation have been experienced in the United States. East and west coast hemlock, beech, red gum, and pecan hickory were pariahs of the forest. Neither technological advances in processing nor more precise characterization of wood properties finally brought these species to the marketplace. Rather they became attractive alternatives because their timbers were abundant in large sizes while the "prime" woods were becoming scarce and small in girth.

From this it would be wrong to conclude that a good documentation of species characteristics would be of little value in processing or selection of an optimum end-use. What is incorrect is to assume that the lack of technical data is the deterrent to the successful promotion of tropical wood.

It may be more important to recognize:

1. Most woods are available only in small volumes gathered over large areas.

2. Complex stand heterogeneity.

3. Preponderance of high-density species.

4. Difficult and costly silvicultural systems do not assure regeneration and maintenance of desired species.

To avoid these problems, some tropical forest managers are clearing off the natural growth in order to establish plantations of short-rotation fast-growing "utility" species. But the high volumes of timber already in place are wasted for lack of nonspecies oriented processing systems.

Research to develop such systems can make the total "xylem pool" available for processing and supply to world markets. It could encourage formation of large conversion centers in parts of the world where timber growth can be most dynamic and it can bring economic advancement to people that are now hardly meeting their basic needs.

Table 1.--Publication classification Forestry Abstracts 1951-1970

Country	Environment 1	Silviculture 2	Harvesting 3	Forest injuries 4	Mensuration 5	Management 6	Marketing 7	Forest products 8	National view 9	Total
Surinam	21	1	1	--	9	1	--	12	9	54
Peru	21	3	--	1	1	1	3	4	10	44
Colombia	28	4	--	1	1	2	1	12	28	77
Nigeria	80	30	2	3	8	9	11	14	57	214
Gabon	21	3	5	--	1	1	--	1	2	34
Philippines	17	22	13	2	5	4	1	41	33	138
Malaysia	122	31	7	3	31	3	7	64	99	367
West Malaysia	70	24	2	2	19	2	4	47	67	237
Sabah--Sarawak	52	7	5	1	12	1	3	17	32	130
Total.....	310	94	28	10	56	21	23	148	238	928

Table 2.—Surinam: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	242	250	243	251	275	282	283	244	255	237
Industrial (1,000 cu. m. (r))	210	219	211	226	250	261	264	229	246	220
Fuelwood (1,000 cu. m. (r))	32	31	32	25	25	21	19	15	9	17
Production										
Sawnwood (1,000 cu. m. (s))	34	55	36	42	47	42	56	53	57	64
Plywood (1,000 cu. m.)	15	15	17	19	18	16	13	16	18	19
Particleboard (1,000 cu. m.)	9	17	19	21	24	20	24	13	10	20
Export										
Roundwood (1,000 cu. m. (r))	--	19	21	21	11	23	28	21	21	22
Sawnwood (1,000 cu. m.)	--	2.4	3.2	3.3	4.7	5.3	6.7	7.3	4.9	6.1
Plywood (1,000 cu. m.)	--	13.7	13.7	16.3	15.1	13.3	11.6	12.4	13.7	14.4
Particleboard (1,000 cu. m.)	--	14.8	16.4	20.0	22.4	18.3	19.5	10.2	10.4	17.0
Import										
Roundwood (1,000 cu. m. (r))	--	15	16	11	8	12	6	22	14	14
Sawnwood (1,000 cu. m. (s))	--	--	--	--	--	--	--	--	.6	.6
Fiberboard (1,000 metric tons)	--	.5	.4	.6	.4	.3	.5	.5	.5	.5
Paper (1,000 metric tons)	--	1.3	1.5	1.6	1.6	1.2	2.5	4.1	7.9	7.9

Table 3.--Peru: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	4,649	4,549	4,610	3,024	2,931	2,931	2,931	3,334	3,227	3,227
Industrial (1,000 cu. m. (r))	689	510	490	552	431	431	431	734	577	577
Fuelwood (1,000 cu. m. (r))	3,960	4,039	4,120	2,472	2,500	2,500	2,500	2,600	2,650	2,650
Production										
Sawnwood (1,000 cu. m. (s))	102	121	149	159	236	236	236	310	239	239
Plywood (1,000 cu. m.)	--	--	--	--	7	7	7	12	12	12
Particleboard (1,000 cu. m.)	--	--	--	2	4	4	4	5	9	8
Pulp (1,000 metric tons)	30	27	26	42	43	43	43	43	42	73
Paper (1,000 metric tons)	40	56	53	62	67	67	67	90	88	95
Export										
Roundwood (1,000 cu. m. (r))	--	0.1	0.1	1.0	1.0	1.0	--	--	0.3	0.3
Sawnwood (1,000 cu. m.)	--	3.4	5.3	4.5	7.1	7.1	5.5	2.1	2.7	2.7
Import										
Roundwood (1,000 cu. m. (r))	--	.1	.1	.2	2.1	2.1	--	3.5	1.7	1.7
Sawnwood (1,000 cu. m. (s))	--	66	90	93	87	87	88	96	44	44
Plywood (1,000 cu. m.)	--	4.1	3.9	5.2	3.4	3.4	5.6	3.2	.1	.1
Particleboard (1,000 cu. m.)	--	--	--	--	--	--	.2	.1	.8	.8
Fiberboard (1,000 metric tons)	--	1.9	3.3	2.7	2.7	2.7	1.3	1.1	--	--
Paper (1,000 metric tons)	--	40	40	42	41	41	56	60	64	64

Table 4.--Colombia: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	12,662	25,330	25,330	25,330	25,330	24,790	24,790	24,940	25,040	25,235
Industrial (1,000 cu. m. (r))	3,440	3,130	3,130	3,130	3,130	2,790	2,790	2,940	3,040	3,235
Fuelwood (1,000 cu. m. (r)	9,219	22,200	22,200	22,200	22,200	22,000	22,000	22,000	22,000	22,000
Production										
Sawnwood (1,000 cu. m. (s))	641	1,044	1,044	1,044	990	985	925	1,025	1,060	1,167
Plywood (1,000 cu. m.)	24	30	30	30	30	54	48	50	60	60
Particleboard (1,000 cu. m.)	8	9	9	12	15	17	15	7	12	13
Fiberboard (1,000 metric tons)	--	--	--	--	--	10	12	10	10	10
Pulp (1,000 metric tons)	34	50	31	41	43	53	71	88	85	90
Paper (1,000 metric tons)	74	77	95	105	115	132	150	165	177	185
Export										
Roundwood (1,000 cu. m. (r))	—	86	85	93	60	88	89	42	42	50
Sawnwood (1,000 cu. m. (s))	--	--	33	49	83	44	47	55	104	150
Import										
Roundwood (1,000 cu. m. (r))	--	0.7	0.6	0.2	1.6	--	--	—	--	—
Sawnwood (1,000 cu. m. (s))	—	--	--	--	.5	--	1.9	2.1	--	0.9
Plywood (1,000 cu. m.)	--	--	--	--	--	--	--	--	0.1	.4
Particleboard (1,000 cu. m.)	—	.5	.5	.5	.5	--	--	--	.6	.6
Paper (1,000 metric tons)	--	79	74	56	56	54	83	78	73	67

Table 5.--Nigeria: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	29,871	30,250	30,241	30,717	31,454	49,376	50,841	52,244	53,492	55,235
Industrial (1,000 cu. m. (r))	1,371	1,450	1,241	1,717	1,954	2,006	2,051	1,994	1,732	1,920
Fuelwood (1,000 cu. m. (r))	28,500	28,800	29,000	29,000	29,500	47,370	48,790	50,250	51,760	53,315
Production										
Sawnwood (1,000 cu. m. (s))	297	330	260	260	320	293	320	340	425	500
Plywood (1,000 cu. m.)	20	20	26	26	34	21	31	20	24	28
Veneer (1,000 cu. m.)	--	--	--	--	--	--	23	23	23	23
Export										
Roundwood (1,000 cu. m. (r))	--	475	459	673	764	585	560	323	313	325
Sawnwood (1,000 cu. m. (s))	--	62	66	77	87	82	74	52	60	2
Plywood (1,000 cu. m.)	--	19	23	21	22	24	21	15	17	12
Import										
Roundwood (1,000 cu. m. (r))	--	--	2.4	3.0	2.2	0.6	0.1	--	--	--
Sawnwood (1,000 cu. m. (s))	--	--	34	34	--	1.1	--	0.3	--	--
Plywood (1,000 cu. m.)	5.0	5.0	5.6	4.6	5.0	2.5	--	1.2	--	--
Particleboard (1,000 cu. m.)	--	--	--	2.0	3.1	5.4	1.7	1.6	0.2	2.3
Fiberboard (1,000 metric tons)	--	5.2	4.7	2.7	2.0	2.4	3.9	2.5	--	3.7
Paper (1,000 metric tons)	--	18	17	21	24	33	37	33	36	31

Table 6.--Gabon: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	3,058	3,058	2,771	2,771	2,771	2,561	2,525	2,571	2,695	2,906
Industrial (1,000 cu. m. (r))	1,838	1,838	1,531	1,531	1,531	1,261	1,498	1,531	1,639	1,835
Fuelwood (1,000 cu. m. (r))	1,220	1,220	1,240	1,240	1,240	1,300	1,027	1,040	1,056	1,071
Production										
Sawnwood (1,000 cu. m. (s))	21	6	35	35	40	48	46	53	53	48
Plywood (1,000 cu. m.)	54	54	60	62	70	89	61	63	69	75
Veneer (1,000 cu. m.)	--	--	18	--	18	23	24	20	8	5
Export										
Roundwood (1,000 cu. m. (r))	--	1,225	1,067	1,157	1,313	1,225	1,198	1,180	1,294	1,592
Sawnwood (1,000 cu. m. (s))	--	6.7	12.2	12.3	5.6	5.5	19.4	25.8	29.5	21.3
Veneer (1,000 cu. m.)	--	16	15	20	22	20	26	20	10	5
Plywood (1,000 cu. m.)	--	54	58	59	64	51	51	54	60	66
Import										
Roundwood (1,000 cu. m. (r))	--	--	--	--	--	0.1	--	--	--	--
Sawnwood (1,000 cu. m. (s))	--	--	--	--	--	--	--	0.3	--	--
Veneer (1,000 cu. m.)	--	--	--	--	--	--	--	.1	--	0.1
Plywood (1,000 cu. m.)	--	--	--	--	--	--	0.1	--	0.1	--
Paper (1,000 metric tons)	--	--	--	--	--	.5	1.4	1.3	.8	.8

Table 7.--Philippines: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	20,191	20,723	21,506	22,874	24,142	24,896	24,427	27,594	28,735	29,949
Industrial (1,000 cu. m. (r))	6,038	6,597	6,772	7,668	8,910	8,700	7,625	10,184	11,337	11,732
Fuelwood (1,000 cu. m. (r))[1]	14,153	14,126	14,734	15,206	15,232	16,196	1,6802	17,410	17,398	18,217
Production										
Sawnwood (1,000 cu. m. (s))	1,000	1,041	958	1,138	1,220	1,250	1,172	1,299	1,142	1,596
Plywood (1,000 cu. m.)	287	230	280	354	208	270	319	285	410	309
Veneer (1,000 cu. m.)	--	--	--	--	135	185	244	225	267	247
Particleboard (1,000 cu. m.)	--	--	--	--	1.5	--	0.8	0.5	1.5	1.5
Fiberboard (1,000 metric tons)	7.1	--	--	19.1	18.9	27.6	25.1	51.0	46.1	47.5
Pulp (1,000 metric tons)	6.5	17.5	15	25	30	35	40	90	100	105
Paper (1,000 metric tons)	39	89	112	125	127	130	130	130	135	140
Export										
Roundwood (1,000 cu. m. (r))	--	3,776	3,952	6,521	6,140	6,700	5,882	6,648	7,511	8,649
Sawnwood (1,000 cu. m. (s))	--	191	123	115	84	116	112	104	102	168
Plywood (1,000 cu. m.)	--	149	173	245	134	198	234	235	254	195
Veneer (1,000 cu. m.)	--	49	74	124	99	179	195	178	220	213
Import										
Roundwood (1,000 cu. m. (r))	--	.1	.2	--	--	--	--	--	--	--
Sawnwood (1,000 cu. m. (s))	--	.3	.2	0.3	0.1	1.1	1.1	--	--	--
Plywood (1,000 cu. m.)	--	--	--	--	--	.1	.1	--	--	--
Fiberboard (1,000 metric tons)	0.2	--	.3	--	--	32.1	32.1	--	--	--
Paper (1,000 metric tons)	--	79	60	91	103	82	81	140	140	140

[1] Fuelwood estimated based on 500 cu. m. per 1,000 population.

Table 8.--Malaysia--West Malaysia: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	2,818	2,807	2,862	3,250	3,557	3,873	4,383	4,822	5,785	6,044
Industrial (1,000 cu. m. (r))	2,305	2,279	2,384	2,781	3,076	3,403	3,913	4,317	5,176	5,422
Fuelwood (1,000 cu. m. (r))	513	528	478	469	481	470	470	505	609	622
Production										
Sawnwood (1,000 cu. m. (s))	1,030	1,292	1,361	1,540	1,329	1,339	1,422	1,774	2,062	2,105
Plywood (1,000 cu. m.)	2	7	10	12	9	26	52	54	100	143
Particleboard (1,000 cu. m.)	--	--	--	--	--	0.6	0.6	0.5	1.8	1.1
Pulp (1,000 metric tons)	--	--	0.1	0.1	0.1	.1	.1	.3	.5	.6
Paper (1,000 metric tons)	0.2	0.2	.2	.2	.2	.2	.2	3.0	3.5	3.5
Export										
Roundwood (1,000 cu. m. (r))	--	8	4	63	889	1,056	1,431	1,493	1,770	1,894
Sawnwood (1,000 cu. m. (s))	--	352	416	507	488	475	489	583	888	877
Plywood (1,000 cu. m)	--	2.4	2.7	2.3	--	9.1	12.8	26.8	57.9	89.2
Veneer (1,000 cu. m.)	--	--	.1	--	--	2.2	5.4	1.9	4.8	2.9
Particleboard (1,000 cu. m.)	--	--	--	--	--	--	.2	.1	.2	--
Import										
Roundwood (1,000 cu. m. (r))	--	56	53	42	--	.2	.5	--	1.2	.2
Sawnwood (1,000 cu. m. (s))	16	18	19	20	1	5	5	4	2	3
Plywood (1,000 cu. m.)	16.0	15.8	21.1	10.8	8.9	3.8	1.8	2.3	1.6	1.8
Fiberboard (1,000 metric tons)	5.1	15.5	11.9	15.5	13.2	6.7	6.2	4.5	6.7	3.8
Paper (1,000 metric tons)	--	64	79	81	36	50	60	69	81	104

Table 9.--Malaysia--Sabah: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	2,235	2,691	2,854	3,500	3,617	4,217	6,029	5,716	5,936	6,220
Industrial (1,000 cu. m. (r))	2,160	2,623	2,796	3,458	3,588	4,162	5,979	5,680	5,900	6,184
Fuelwood (1,000 cu. m. (r))	75	68	58	42	32	55	50	36	36	36
Production										
Sawnwood (1,000 cu. m. (s))	79	67	59	51	61	81	136	124	93	136
Plywood (1,000 cu. m.)	--	--	--	--	--	0.3	1.4	2.7	3.8	6.2
Veneer (1,000 cu. m.)	--	--	--	--	6.4	7.6	10.5	12.1	11.8	17.2
Export										
Roundwood (1,000 cu. m. (r))	--	2,254	2,473	3,001	3,384	3,798	1,933	5,321	5,796	6,187
Sawnwood (1,000 cu. m. (s))	--	17	12	6	5	7	3	3	4	10
Plywood (1,000 cu. m.)	--	--	0.1	--	0.1	--	0.8	3.7	5.2	4.9
Veneer (1,000 cu. m.)	--	--	3.0	6.9	9.1	9.9	9.0	5.9	8.8	11.1
Import										
Roundwood (1,000 cu. m. (r))	--	11	23	40	34	17	12	8	12	9
Sawnwood (1,000 cu. m. (s))	3	9	9	17	18	15	11	20	28	14
Plywood (1,000 cu. m.)	.7	.7	1.0	.6	1.0	1.0	--	--	--	--
Veneer (1,000 cu. m.)	--	--	--	--	--	.1	--	--	--	--
Particleboard (1,000 cu. m.)	--	--	--	--	.2	--	--	--	--	--
Fiberboard (1,000 metric tons)	--	.1	.2	--	1.0	.9	--	--	--	--
Paper (1,000 metric tons)	--	.4	.5	.6	1.1	1.4	--	1.6	1.7	1.7

Table 10.--Malaysia--Sarawak: Roundwood removals, production, and trade--1960-1969

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Roundwood Removals										
Total (1,000 cu. m. (r))	1,206	1,268	1,426	1,769	1,909	2,390	3,063	3,678	4,310	4,321
Industrial (1,000 cu. m. (r))	1,172	1,202	1,376	1,731	1,876	2,358	3,038	3,650	4,281	4,293
Fuelwood (1,000 cu. m. (r))	34	66	50	38	33	32	25	28	29	28
Production										
Sawnwood (1,000 cu. m. (s))	283	273	270	330	400	425	450	675	605	570
Plywood and veneer (1,000 cu. m.)	--	--	--	--	--	--	--	--	18	20
Export										
Roundwood (1,000 cu. m. (r))	--	503	696	891	866	1,214	4,856	2,244	2,991	3,064
Sawnwood (1,000 cu. m. (s))	--	194	184	208	261	271	222	275	311	305
Plywood (1,000 cu. m.)	--	--	--	--	--	0.3	4.3	11.2	10.1	14.8
Veneer (1,000 cu. m.)	--	4.2	10.2	13.5	4.5	12.1	9.4	6.6	6.4	3.3
Import										
Roundwood (1,000 cu. m. (r))	--	--	--	--	--	--	--	--	1.6	.4
Sawnwood (1,000 cu. m. (s))	.3	.7	.2	.1	--	14.0	3.3	.9	.4	2.5
Plywood (1,000 cu. m.)	1.1	1.1	1.2	.7	.7	.8	1.4	1.1	1.4	1.6
Fiberboard (1,000 metric tons)	--	1.3	1.4	1.5	1.7	2.3	3.6	2.1	1.6	2.8
Paper (1,000 metric tons)	--	.7	.8	.8	3.9	2.5	1.8	1.7	2.3	3.0