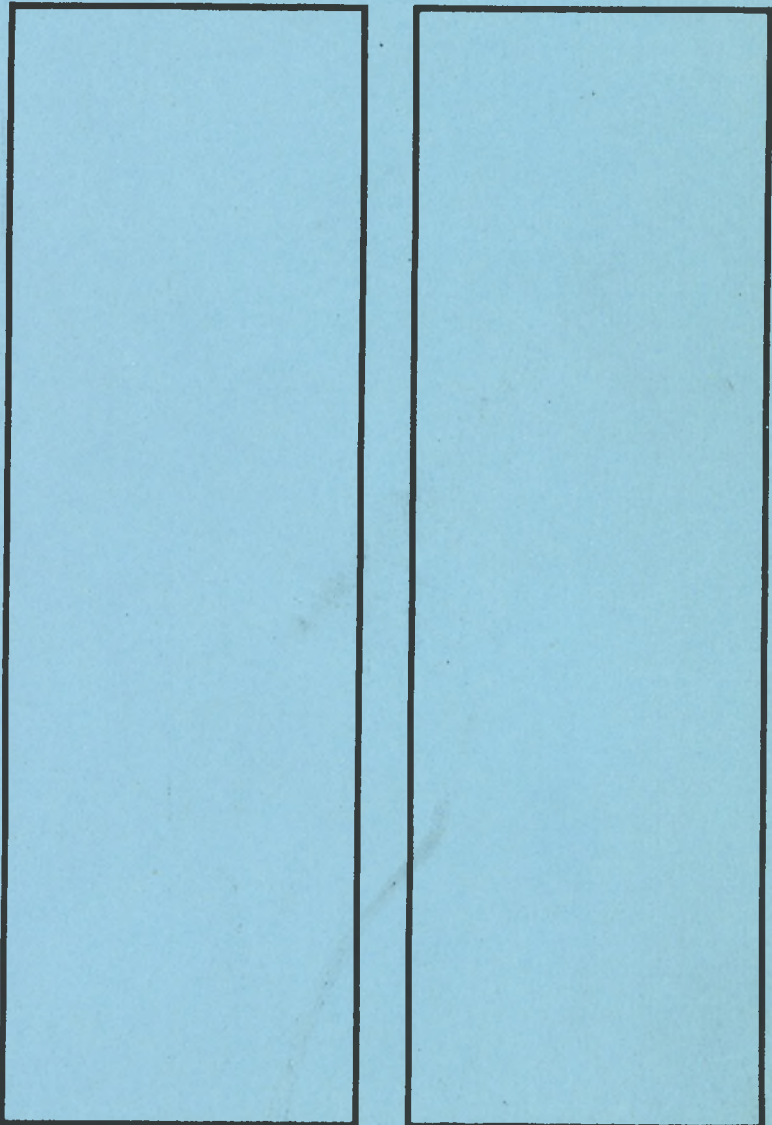


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# FACTORS INFLUENCING THE UTILIZATION OF TROPICAL WOOD SPECIES



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Introduction

Authority

The investigation reported herein was made under a Participating Agency Service Agreement between the Agency for International Development and the Forest Service, U.S. Department of Agriculture. The PASA Control No. is TA(AJ)2-73. The PASA was approved for AID on November 29, 1972, and for the Department of Agriculture on December 13, 1972. William H. Littlewood, Associate Director, Office of Science and Technology, Technical Assistance Bureau, AID, Department of State, served as the project monitor for AID.

Background

Tropical woods have long been important in commerce. Many European countries have imported woods from tropical countries under their sphere of influence and these have been important raw materials for their industries. The history of importation of tropical species into the United States is more recent. Such imports are growing and predictions indicate that the demand will increase both because of the special characteristics of such species and as a supplement to domestic supplies.

The Agency for International Development has, over an extended period, been concerned with the deleterious practice, in many tropical countries, of concentrating on a relatively limited number of species for exploitation. Such limited exploitation not only limits the resource base from which developing countries can enter into international commerce, but it also limits the possibilities for furnishing the amenities to their own populations. An expanded resource base could, in addition, reduce the necessity

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<sup>1</sup>Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

for imports and thus ease the problems of balances of trade for the tropical countries. For example, if newsprint is imported, establishment of newsprint manufacture from their own resources would be helpful.

Of at least equal importance is the potential impact on the nature of the forest resource. That is, long-term dependence on a few "preferred" species has the potential for their eventual depletion or near depletion. One avenue for reducing this threat is to reduce dependence on the "preferred" species through exploitation of a broader range of woods.

Recognizing these problems, the Agency for International Development asked the Forest Service, in 1962, to look at this problem in Latin America, with emphasis on the Amazon area--probably the greatest, relatively untapped forest resource in the world. This was followed, in 1965, by a second review, to update the earlier information. This resulted in recommendations, contained in the report "Projected AID Research Program on Improved Forest Products Utilization in Latin America," for establishment of research programs in several locations. In large part, the recommendations were based on the concept that one of the principal deterrents to increased utilization was a lack of knowledge of many species in the resource and thus of their potential for utilization.

The proposals for Latin America were never implemented but, in 1971, a new proposal was developed, along the same lines, to cover the three principal tropical areas of the world--Latin America, Africa, and Southeast Asia. During the review of this proposal, questions were raised as to the basic concept. That is, is the lack of knowledge of their characteristics the primary deterrent to increased use of "secondary" species, or are there other factors which are equally important or perhaps more important?

To get at the answer to this question, the PASA mentioned earlier was established and the Forest Products Laboratory was given primary responsibility for the investigation.

As background, we might point out that heterogeneity of forests is not unique to tropical forests, nor is selectivity in species utilization. This point was mentioned in a secretariat note for the Seventh World Forestry Congress (3). It was pointed out that, in mixed hardwood stands in the United States, some 114 species form approximately 45 commercial groups. Of these, only 8 species and commercial groups constituting 35 percent of the growing stock have continuously high market value. Attempts to improve the marketability of the remaining 65 percent have failed to produce spectacular changes because they have failed in one or more of the marketing criteria. While heterogeneity may not be as great in the coniferous forests, the number of species in commerce is limited.

This, however, has been a constantly changing situation, with former "secondary" species becoming "primary," at least with respect to certain applications. A case in point is the relatively recent introduction of southern pine into the structural plywood field, although it had long been a prime lumber species. This development, however, did not come spontaneously but only after research had demonstrated the necessary technology and

favorable properties of the product. Thus, the acceptability of a species may well change with changing circumstances. We suggest that the degree and speed of development in the application of new species, at least in critical applications, will depend upon the availability of sound technical information.

### Objective

The objective of the investigation, as stated in the PASA, is "To survey the extent and significance of the current lack of knowledge of the properties of wood derived from secondary species of tropical woods to clarify whether lack of knowledge of the potential uses of secondary woods is a significant inhibitor to their utilization." Significance of the factor of lack of knowledge of characteristics must be related to other factors, so that an implicit part of the objective is to survey other factors influencing utilization of secondary species.

### Approach

The investigations involved two aspects--a review of available literature and on-the-ground consultation in selected countries. In connection with the latter, a number of countries were visited--Republic of the Philippines in Southeast Asia, Colombia in Latin America, and Ghana and Nigeria in Africa. In connection with the latter trip, visits were made to appropriate organizations in England and France and to the Forestry Department of the Food and Agriculture Organization in Rome.

### Sources of Information

The literature review and the overseas travel resulted in detailed reports. Information contained in these detailed reports has formed the basis for much of the analysis contained herein. Additional sources have been consulted and these are shown in the list of references.

Particular attention was given to the results of a survey of markets for Vietnam timber products, a project sponsored also by AID. The report on this project (15) reflects on-the-ground surveys of market prospects in Japan, Taiwan, Korea, and Singapore and, to a degree, reflects concern for the use of secondary species.

### The Setting

#### Demand Prospects

In a review of market prospects for Vietnam timber products, Hutchison et al. (15) gave some figures indicating prospective demand for industrial wood. This demand has been steadily rising, on a worldwide basis, with consumption climbing from 726 million cubic meters in 1950 to

1,166 million cubic meters in 1967, with an estimated demand in 1985 of 1,995 million cubic meters--nearly a threefold increase over 1950.

The demand for tropical hardwoods shows prospects of an even greater percentage increase. Thus, Hutchison quotes consumption of tropical hardwoods, worldwide, rising from 38.6 million cubic meters in 1955 to 71.3 million cubic meters in 1968, with projected rise to 152.0 million cubic meters in 1985, a fourfold increase in 30 years.

This greater increase in demand for tropical hardwoods as compared to that for all wood reflects an increasing dependence on tropical hardwoods resulting from a diminishing supply of Temperate Zone woods. This suggests, in turn, an increasing impact on the tropical forest resource and the necessity for more efficient use of this resource.

### Supply Prospects

Information on supply prospects is limited and of doubtful accuracy. Pringle (20) gives some estimates of the world's forest resources, but cautions that they "should only be viewed as broad indications of magnitude." There are still vast forest areas which have not been surveyed or inventoried and only educated guesses can be made. Second, there is constant change, with reductions through exploitation and increases by growth and regeneration.

Nevertheless, it is of interest to note that the three regions of South America, Africa, and Asia, taken together, include about 75 percent of the world's broad-leaved forests and more than 50 percent of the forested area of the world. The importance of Latin America may be noted from Pringle's estimate that it contains about one-third of the world's broad-leaved forest resource.

Unfortunately, the magnitude of the forest resource is of only limited value in predicting prospective supply. Lack of accessibility, small sizes, and other factors affect the proportion of the resource which can be used and thus make most estimates of doubtful value.

We do not, therefore, find it possible to make meaningful comparisons of demand and supply. The prospects of heavy increases in demand for tropical hardwoods, however, certainly indicate a need for broadening the resource and for more efficient use of the logs extracted from the forest.

### Species Use

The number of species in the tropical forests number into many thousands. For example, Salvosa (22) states that there are, in the Philippines, some 3,879 species, of which 3,574 are indigenous and 305 introduced. Koeppen and Hutchison (17) report that there are about 1,000 species in Africa, with about 450 (one authority says 560) in Nigeria and from 200 to 250 species in Ghana which grow to "commercial" size (i.e., above 1 foot in diameter). Koeppen (16) reports that there are, in Colombia, more than

500 species of commercial size. Chudnoff (7) reports more than 400 species in Surinam and suggests, from his review, that there may be as many as 2,500 species in Peru alone. He indicates, as well, that there may be on the order of 1,400 species in the various areas of Malaysia.

The tropical hardwood forests are, thus, rich in variety. Only a minor fraction of this variety, however, finds its way into commerce. For example, Chudnoff (7) reports that the Surinam Forest Service classified 29 species as being readily available in quantity. However, 90 percent of roundwood exports were in two species, 95 percent of sawnwood exports were in three species, and 97 percent of hewn timber export was in a single species, and all of the plywood production and trade was in a single species.

The situation is similar for other countries. Again, from Chudnoff's review, log exports from Nigeria (1960) were made up almost totally of 25 species, of which only six accounted for 90 percent. The situation in lumber export was much the same, with the same 25 species making up 94 percent of the trade with only five species accounting for 70 percent. In Gabon five species account for 97 percent of the trade. In the Philippines, less than 100 species (out of some 3,800) are considered to be commercial. In West Malaysia, almost 90 percent of the trade was in three species and two species groupings; in Sabah, some 95 percent of trade was in five groupings of 39 species; and in Sarawak, 80 percent of export volume was in three species, two groupings of Shorea and one grouping of Dipterocarpus.

For Africa as a whole, Erfurth (10) reports that in 1970 the number of commercial wood species was 33; he classifies as "commercial" those with exports of more than 5,000 cubic meters. It is significant that he reports that the number of "commercial" species increased from 20 to 33 between 1951 and 1970. His data indicate that some 10 species accounted for about 80 percent of export, with only two accounting for nearly one-half. To compare with Chudnoff's figures, 25 species, in 1970, accounted for all but about 4 percent of export, with 6 species accounting for about 70 percent. Thus, the general situation is much the same.

Concern for the potential impact of this selectivity on continuing availability of "primary" species from the tropical forest resource seems to be indicated by worldwide activity to increase the utilization of presently under-utilized species. In part, this may reflect a concern for development of commerce in the tropical countries. In part, too, it undoubtedly reflects concern for depletion of the preferred species in the forests, although little specific comment on this point was found in the literature.

The World Consultation on the Use of Wood in Housing (1) pointed to the underutilization of some species as a factor inhibiting the provision of adequate housing for the populations of the developing countries. The Consultation stresses the fact that many of the lesser known species were perfectly suitable for building materials and urged governments to encourage their use.

However, a joint European-Ivory Coast meeting in 1972 reports that certain species are now practically exhausted (2). They cite, as examples,

assamela (Pericopsis elata) and sipo (Entandrophragma utile) which have previously been in heavy demand. Koeppen and Hutchison (17) report that the Ghana Timber Marketing Board has virtually banned exports of logs of utile (Entandrophragma utile), afrormosia (Pericopsis elata), mansonina (Mansonia altissima), and African walnut (Lovoa trichilioides). P. elata is known as assemela in the Ivory Coast and afrormosia in Ghana; E. utile is known as sipo in the Ivory Coast and as utile in Ghana.

#### Factors Influencing Species Selection

That there is a strong bias in favor of exploitation of a minor fraction of tropical species is clear from the foregoing. Let us now examine some of the more important factors which have led to this situation. Various sources of information on this point emphasize various factors. While there is no unanimity, there do seem to be some patterns. A brief review suggests some of the more important factors which should be considered.

Erfurth in his review of the situation in Africa (10) does not attempt to outline the factors involved. However, he does comment that the term "lesser known" implies that basic knowledge on the qualitative as well as the supply aspects of individual and/or groups of species must be available to obtain better market acceptance. He outlines in detail the aspects of knowledge which are needed.

Koeppen and Hutchison (17) suggest five factors which have deterred the more complete utilization of African hardwood timber. These include lack of interest on the part of consumers and conservatism on the part of timber agents; lack of necessity on the part of those producing logs; prior development of the African industry around large logs; lack of complete and accurate resource statistics; absence of pressure from log exporting countries to encourage or force more complete utilization.

Hutchison et al. (15) do not specifically treat this subject with respect to Vietnam, but do comment, in discussing the imbalance in species utilization, that "much of the lack of popularity of many of the other species can be attributed to inadequate information, market preferences, and other factors which have no particular relation to the qualities of these species." Later, they comment "An overriding factor in the unbalanced utilization of Southeast Asia's hardwood timber has been the incompleteness of the information about the resource. Data on timber volumes have been sparse, but more important has been the shortages in the information about strength, density, color, texture, etc., of many timber species."

Freas (11), in reviewing the situation in the Philippines, suggests a number of factors. These include number of species; inability to readily identify trees; abundance and dispersion of species; inventory practices; industry practices; governmental control; and knowledge of properties.

Koeppen (16), with relation to Colombia, suggests that five factors are most important. These include lack of a complete forest inventory; lack of capital; lack of a good transportation system; lack of technological information; and lack of a system to accumulate low-volume species.



Cliff (8) reviewed a large number of reports available in the AID reference center. In summing up his review, he outlines a number of points needing consideration. Briefed down, these include additional research on technological properties; strengthening forestry administrative and research institutions; diversification and integration of forest industries; more realistic forest policies with regard to concessions to induce investment in forest enterprises; development of access; cooperation with importing countries to find markets; adequate capital; strengthening of ties with manufacturers and exporters, as well as with dealers in the importing countries; and others. It is interesting to note his comment that "The one measure to improve utilization of unused or little-used species most frequently recommended in the literature reviewed is to increase research on the physical and other properties of the woods. In some cases this is expanded by pointing out the need for assembling, cataloging, and making existing information on wood properties available in readily usable form to forest managers and processors and traders of wood products."

A note prepared by the FAO secretariat for the 25th session of the committee on industry and natural resources of the Economic Commission for Asia and the Far East (9) comments on reasons for lagging development. The report states "The drive for forest development and export of forest products, however, has been accompanied by inadequate appraisal of the forest resources; by disparate conditions offered to concessionaires by insufficient attention to insuring sustained supply; by inadequate progress in establishing domestic processing facilities; and by inadequate exchange of experience in forest management, forest harvesting, marketing, and transport."

A secretariat note prepared for the Seventh World Forestry Congress (3) touches only briefly on this point. They mention the high degree of heterogeneity of the mixed tropical forests; frequently unfavorable physical, mechanical, and technological characteristics of the wood; and transport difficulties. They indicate that there are others, but do not list them.

We find, thus, an imposing array of factors considered to bear on the problem of disparity in the utilization of tropical hardwoods. The more important of these will be considered in detail in the following section.

### Review of Factors Affecting Utilization

#### Availability of Technical and Technological Information

There appears to be considerable disparity of opinion as to the effect of availability of technical and technological information on increased use of secondary species. It is unquestionably true that many tropical species have entered commerce (locally, internationally, or both) without benefit of laboratory evaluations. However, it is undoubtedly equally true that they gained prominence in commerce only as their ability to perform a function became known. This knowledge may initially have been based on experience gained from local use and then broadened by the experience in other markets. Thus, we may well say that there will be no utilization without knowledge, whether that knowledge be empirical or laboratory-generated. Certainly new species will come into use without laboratory

evaluations, but it may well be that laboratory data will point out the species which have greatest promise and whose use should be encouraged. In other words, better information may be expected to shorten the period required for general adoption. In any event, we found considerable indication that technical and technological information was considered important, as indicated in the following discussions. In some cases the thought seemed to come out that such data were not needed. In many cases, however, the real thought was that availability of the information was not a problem because much had already been collected. A review of information on this point follows.

Cliff (8) cites numerous recommendations for acquisition of additional knowledge on species properties. As noted earlier, this was the most frequent recommendation that he found in his review, sometimes accompanied by the suggestion that available information be assembled and disseminated. Cliff cites also references to inadequacies in available data including inadequate coverage of species, lack of standardization of collection and testing procedures, confusion about identification, etc. Some references recommended international standardization and coordination of data collection and recording. Many of Cliff's references which recognized the need for more information on wood properties placed priority on the strengthening of forestry institutions as the most essential first step.

Koepfen and Hutchison (17), after reviewing a number of factors related to Ghana and Nigeria, say that "Under these circumstances, it is difficult to argue that lack of technical and technological knowledge has been a critical factor in the species problem. Nor can it be said that the situation would have been much different today if all the information had been available. However, this conclusion is hardly relevant to the future as some very important changes are taking place." They note that, in the organizations they visited in Europe, there appears to be the feeling that adequate information is available. In Nigeria and Ghana, however, discussions indicate a definite need for more data. They point out that, with the prospects for a more favorable market, there is a need for additional information and point out the sparseness of information on some species.

Hutchison et al (15), in discussing the situation in Vietnam, comment on lack of data but state "It cannot be proven that the lack of a catalog of species properties has prevented the use of any species but the spottiness of the data has played some part in the failure to develop systematic programs to develop the tropical forests. One of the most constructive steps that could be taken would be to establish an international program to gather such data and to follow that with an effort to publicize the lesser known species and their attributes. In the absence of an overall attack on the problem, improvements in utilization will continue to come in a piecemeal fashion."

Freas, Kukachka, and Landt (12), in reporting on a survey of several countries in Latin America, commented that "Throughout the trip, we found agreement that the greatest deterrent to increased utilization of the Latin American resource was the lack of knowledge of the resource, in terms of both quantity and properties (i.e., of both available volumes of various

timber species and the properties of the wood of each species)." Recognizing the validity of the old proverb about leading a horse to water, they said "It is axiomatic that a full library of fundamental information on properties of forest tree species will not insure utilization either of the information or of the forest resource itself."

Koeppen (16) concludes that a lack of knowledge of the characteristics of Colombian woods restricts the base of industrial supply and results in over-utilization of the preferred species. He cites one manager, whose plant was running at only 50 percent of capacity, who felt that he could operate at closer to capacity if he had additional knowledge of the properties of a greater range of species.

Chudnoff (7) points out that, for some areas, high trade volumes are in five or six species even though there is substantial literature on the characteristics of other species. He contrasts this with Peru, also with commerce in only a few species but where there is very little technical literature. The inference is that availability of information has had little effect on introduction of new species. After further discussion, he states "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 major deterrent to the successful promotion of tropical wood."

In a private conversation, K. D. Menon, Deputy Director General of Forests for West Malaysia, stated to one of the authors that lack of knowledge of characteristics was not a problem in his country, since they had already evaluated a broad range of characteristics on more than 200 of their species. He stated that they hoped soon to publish this information. Mr. Menon indicated several problems militating against the use of additional species. These include: many species occur in the forest in small numbers and thus it is difficult to get an adequate supply; users are accustomed to a certain set of species and are reluctant to try new ones; loggers have difficulty in recognizing some species in the forest; identification of some species in lumber or veneer form is difficult; and loggers are hesitant to cut species without an assured good price. He felt also that they would be better able to introduce new species into the international market if they had some successful local use which could be cited.

In a similar private conversation, Salvador Quiroz, Director General, Forestry and Wildlife Service, Honduras, indicated that lack of technical data was secondary. He felt that a better approach was to select species appreciated by the natives and try them in manufacturing plants.

In correspondence, the Director General of the Centre Technique Forestier Tropical commented on the question of the degree to which a lack of technical and technological knowledge is an obstacle to use of secondary species. He felt that this lack was not an obstacle, pointing out that his organization had data on more than 900 tropical species and that, for Africa, the majority of the species have been studied by research organizations. It was his opinion that the increased use of tropical species is more a function of economics than of technical information. He adds, however, that favorable technical information could aid in the growth of use.

In discussing similar questions by letter, Dr. A. C. Sekhar, Director of Forest Products Research of the Forest Research Institute and Colleges, India, expresses the opinion that there should be "increased support to research projects leading to as much information as possible on tropical species." He points out the need for such projects to include activities leading to improvements in utilization technology. He feels that, regardless of the importance of other factors in limiting the utilization of secondary species, continuous exploration into the properties of hitherto under-utilized species continues to be of importance.

At this point it might be desirable to review, in at least a qualitative way, the availability of technical and technological data.

Chudnoff (7) cites numerous sources of data on a fair number of species in the countries he studied, except for Peru. Kukachka (18) has assembled information on physical and mechanical and other properties of more than 100 tropical species of interest to U.S. importers and users. Bolza and Keating of Australia (5) have summarized information on some 700 African species. P. Sallenave (21) has published physical and mechanical properties from nearly 1,900 tests of more than 900 species in three volumes. In the third volume (the second supplement to his original work), he outlines methods for converting data from the American (ASTM) methods of test to permit comparison with results derived from the French (AFNOR) methods of test.

At a meeting on the occasion of the 50th anniversary of the Centre Technique Forestier Tropical in France, attended by representatives of a number of European laboratories, the suggestion was made that there should be a central clearing house in which the results of tests on tropical timbers carried out by various responsible laboratories could be circulated to all others in the European group. This suggestion was agreed to and the CTFT undertook responsibility for this task. In order to provide a suitable limitation, it was agreed that the operation should be limited to nine European laboratories well known for their work in tropical woods. An Australian laboratory later joined in the effort.

As a first step, the CTFT assembled information on species studied, together with an indication of the types of evaluations made. The first published result of this work was a report (6) listing the species studied by ten laboratories, together with an indication of the evaluations made. This publication covers 732 species.

It must be concluded that there is a substantial volume of information on tropical woods, secondary as well as primary. One must conclude also that it is widely scattered in the literature and that the adequacy of the data varies widely based as it is on samples ranging as low as a few planks--hardly representative of a species. The data are, moreover, derived from several methods of evaluation, giving results not always comparable.

Recognizing these problems, Section 41 (Forest Products) (now Division 5) of the International Union of Forestry Research Organizations (IUFRO) convened a meeting at the Federal Research Organization for Forestry and

Forest Products, Hamburg-Lohbrügge, West Germany, in November 1970. As a result of this conference (13), a project group on tropical woods was organized in IUFRO Division 5. The primary purpose of the group is to locate, assemble, and disseminate information (published and unpublished) on tropical woods as a base for their more efficient utilization. The group recognized the effort already under way at the Centre Technique Forestier Tropical, but they recognized also that this effort was limited to a few laboratories and they considered it desirable to expand the effort to a worldwide basis.

At a recent meeting on Properties, Uses, and Marketing of Tropical Timbers, sponsored by FAO and the German Foundation for Developing Countries in Berlin, West Germany, in late June and early July, 1973, the importance of developing a broader species base was recognized. The importance of a thorough knowledge of species characteristics as related to end uses was discussed in several sections. While no report on this meeting is as yet available, it was clear that such information, developed both in the laboratory and in industry, was vital to intelligent use.

The World Consultation on the Use of Wood in Housing (1), at one point in the summary of the proceedings, stated that "...knowledge of the characteristics of underutilized species, including those requiring essential but cheap and simple treatment, was vital to their efficient utilization." At various points throughout the report of the Consultation, reference was made to the need for additional research on secondary species. For example, in the report of the section on supply of wood materials for housing, it states "More effective dissemination and application of available information on research results and technical methodologies were needed to hasten development." And, as well, "Much of the tropical wood supply is represented by tree species not yet adequately known on timber markets and there is need for forest products research laboratories to undertake more research on the properties of these species and especially on their utilization in housing construction, although it is acknowledged that a vast amount of information exists in this regard." The section dealing with promotion of the use of wood in housing urged interested countries directly or through international agencies to coordinate information on the characteristics of tropical woods to prevent duplication of research and to determine areas in which further work must be undertaken.

The Organization for Tropical Studies, Inc., is a consortium of 25 institutions, representing some 34 campuses, with teaching and research facilities in Costa Rica. While it covers a wide variety of sciences, forestry has figured prominently since the inception of OTS. Dr. Stephen Preston, former Executive Director of OTS, in describing the organization and its activities (19) states that establishment of data banks on a variety of subjects including wood science and technology is envisioned.

A review of the proceedings at the most recent World Forestry Congress (3) indicates that the technological properties of many tropical timbers are still insufficiently known and encourages strengthening of research and research institutions in the developing countries, particularly stressing

the need for training of researchers in these countries. They mention the need for making such research practical and market-oriented, with emphasis on improvements in processing, recovery, and application of forest products. The need for a system of retrieval of the tremendous volume of literature on forestry research was emphasized.

In summary, while it cannot be concluded that lack of information on species characteristics is a primary deterrent to the utilization of additional species, such utilization will not take place, at least in an efficient way, until the information is available. It must be concluded, also, that substantial volumes of data are available. They are, however, scattered and variable in quality. An assembly of such information could play a vital role in promoting the use of secondary species and, as well, point out the gaps as a base for developing research programs.

### Forestry Institutions

One of the factors noted by Cliff (8) in his review was the need for strengthening forestry institutions. As a matter of fact, he classified under this broad heading some 180 comments or recommendations relating to some aspect of this subject. These covered a wide range of subject matter-- development or improvement of forest policy and forestry laws; improved organization and administration of forestry activities, including improved education and training of personnel, improved funding, improved personnel management and working conditions, and a higher proportion of technical staff; forestry assistance; greater government support and lessened political interference; and better administration of timber sales and concessions, including better enforcement of contracts, control of illegal logging, and improvement in concession agreements.

He comments, with relation to this, that "obviously without an organization of trained people with adequate funds to protect and manage the forests, promote their greater use, make and administer sales and concessions and conduct necessary research, little progress can be expected in attaining more efficient and complete use of the forest resource." In other words, there will be no realization of the potential of a forest resource without a competent, well funded, progressive organization to generate the actions needed to transform a resource into useful products.

### Forest Inventories

A perusal of the reviews developed during this investigation brings out clearly the effect that inadequate inventories of the forest resource have on utilization. While inventories are available in some areas, they are not always adequate.

Freas (11), for example, points out that, in the Philippines, inventory practices of the Bureau of Forestry concentrate on the primary species with

others classified under "miscellaneous." The Forest Products Research and Industries Development Commission (FORPRIDECOM) of the Philippines commented that, when their research points to the utility of a particular species, this frequently results in the question, "Where can we get it?" and they are unable to respond because of a lack of detailed inventory information. Discussions with the Bureau of Forestry indicated a recognition of this problem and an intention to revise their procedures. At least one company indicated a desire to institute an inventory on their own concession; they lacked, however, the expertise to undertake it and indicated a desire to have their staff trained by the Philippine Government.

Koepfen (16) reports that only 20 percent of the forested area of Colombia has been inventoried and that, thus, the potential timber supply is not known. Long-range forestry planning is stifled by this lack of resource data and it also hampers industrial development. Koepfen reports that this results, in large part, from lack of financing of the Institute for Development of Renewable Natural Resources (INDERENA).

Koepfen and Hutchison (17) classify the lack of complete and accurate resource statistics as one of five principal factors hindering forest development in Nigeria and Ghana. They point out that, while some areas have had 100 percent inventories, these have been in the nature of "timber sale cruises" and the data are not sufficient for management planning. Ghana has a reasonably accurate inventory of its reserves, but only for "important" species. They comment that most African countries with a timber resource are completely lacking in or have insufficient data regarding growing stock and its composition to do proper utilization and management planning.

Cliff (8) in his review of information available in AID does not comment specifically on this point. He does mention that 26 out of the 135 reports he reviewed made mention of forest inventories and management plans.

Hutchison et al. (15) consider that lack of resource information has been a real factor in Southeast Asia. Specifically, they state "An overriding factor in the unbalanced utilization of Southeast Asia's hardwood timber has been the incompleteness of the information about the resource." In this connection, they are concerned not only with data on timber volumes but also with data on species characteristics.

Chudnoff (7), in discussing "Forest Enumeration," cites a number of surveys in the countries he studied. However, he says "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."

Thus, we are forced to conclude that lack of resource data, particularly with respect to "secondary" species is a serious deterrent to expansion of the number of species which reach the market place. It appears to some, at

least, to be a primary deterrent. Certainly an entrepreneur is unlikely to undertake an enterprise dependent on a species or group of species of which he cannot be assured an adequate and continuing supply.

### Heterogeneity of the Forests

Great heterogeneity in the species composition of the tropical forests is a fact of life which must be recognized. Various sources (10, 16, 17) refer to the large number of species to be found in a single tract. Chudnoff (7) sums this up by pointing out that some dozen or so species may make up 50 percent of stand volumes. But, he comments, it is not unusual to require a gathering of 50 species per hectare to accumulate one-half of the timber volume.

The degree of heterogeneity varies greatly. In the Philippines, for instance, stand "purity" is exemplified by as much as 90 percent of the volume being in species of the dipterocarps, mostly of the Philippine mahogany type.

That this creates problems in utilization goes without saying. A logger certainly will hesitate to remove "secondary" species when he realizes only minor volumes of timber and must accumulate them over a period to get marketable amounts.

One approach to this problem which has been suggested is to "group" species of like characteristics which can be sold together for a common use. This concept has been proposed by Erfurth (10) and is being considered by others, as mentioned by Koeppen (16) and Koeppen and Hutchison (17). The previously mentioned review of the Seventh World Forestry Congress (3) suggests that "appropriate grouping of species for conversion into construction materials is an important way toward the greater acceptance of lesser used woods in the building and construction market...." This has long been done for such closely related species as those going into the Philippine mahogany group, but has not yet been developed to the point where "primary" and "secondary" species can be grouped together.

It must be pointed out here that development of a "grouping" concept will not be feasible without adequate knowledge of species characteristics. Such information is vital whether it comes from experience or from the laboratory.

To a degree, the effects of heterogeneity can be minimized through the use of mixed species in the manufacture of pulp and paper, fiberboard, and perhaps particleboard. This possibility is suggested in a number of the references by Cliff (8). Some pulp is already manufactured in the Philippines (11) and it appears that a wide variety of species can be utilized, with appropriate limitations on density. The Economic Commission for Asia and the Far East (9) is promoting development in this field. The Seventh World Forestry Congress review (3) considers as a "main goal" the development of species-tolerant processes in which the identity of individual



species is to a large degree lost, as, for example, through pulping or production of composite wood products. In addition, they cite an example in which "run of the bush" material from a tropical rain forest was successfully converted into laminates for the urban housing market.

### Botanical Knowledge

Ability to identify trees in the forest is an important factor from several standpoints. A researcher evaluating the utilization-related characteristics of a species must have assurance that the sample with which he is working is from a particular species or at least of a particular genus. Inventories of the forest resource depend on ability to identify the trees in the area being surveyed. And, finally, the loggers must be able to identify the species to be cut if they are operating on a selective basis.

Chudnoff, in his review of selected countries (7), reports substantial literature on the flora of the countries, with taxonomic and dendrological information given for thousands of species. He points out that the areas most poorly known are those of the Amazon region in South America.

Although Chudnoff reported a considerable literature on the flora of Colombia (he says it is somewhat fragmented), Koeppen (16) considers that the tree species of Colombia are not well known. As a case in point, he cites the publication "Maderas Colombianas" (Colombian Woods), in which 13 of the 69 botanical names are in question. He points out also that, in the course of a PL-480 project in Peru, ten new species have been described.

Both Chudnoff (7) and Koeppen and Hutchison (17) feel that botanical knowledge is good for Africa, botanical studies having been made over a period of several centuries. They feel, moreover, that local botanists are well trained in taxonomy.

Chudnoff (7) reports extensive botanical literature for the several areas of Malaysia as well as for the Philippines. However, Freas (11) reports that an informational note prepared by a FORPRIDECOM staff member for his visit states that only about 7 percent of Philippine trees can be identified to species. Specifically, the note, in commenting that only 264 species are considered important, says "If the 264 species are considered botanically well known, it is safe to say that only 7.4% of our tree species can be identified with certainty. The remaining 92.6% are perhaps identifiable down to the genus or family level, but hardly according to species." In view of the compilation of species names by Salvosa (22), this is somewhat difficult to understand, but perhaps it refers to species which can be readily identified in the forest. It is perhaps this which led the Filipinos to suggest the need for a dendrology manual for field use.

The importance of this factor is difficult to gauge. It would appear that botanical data are available for most areas to some degree of completeness and one might assume that probably if information is available it would cover the species most likely to be of interest. Nevertheless, better manuals for field identification appear to be needed.

### Tradition

The term "tradition" is here used to indicate not only traditional preferences within the lesser developed countries, but also the "traditions" or preferences which have grown up in the market over a long period which, in turn, has affected the range of species traditionally exploited from the tropical forests.

Koeppen and Hutchison (17) point out that the native peoples of West Africa tend to look with disfavor on wooden homes, considering wood as a short-lived material suitable only for temporary quarters. Koeppen (16) reports a substantial preference in Colombia for a few species for furniture and for decorative purposes. While he does not mention it, there is believed to be a market preference all through Latin America for homes built of masonry, probably for reasons similar to those reported for Africa.

In part, such attitudes result from improper use--poor manufacture, improper drying, and the like. It is reported that some effort is contemplated in Africa to build middle-class homes of wood and to use wood in public housing to reduce the image of wood as a "poor man's home."

The attitudes of importers, traders, and users appear to have been conditioned by a plentiful supply of the preferred species. Thus, they have little incentive to try something new if they don't have to. This attitude, of course, reflects back on the producers who will restrict their efforts to marketable species. It is, however, clear that this situation is changing and that their attitude must change.

### Industrial Practices

Industrial practices, insofar as they relate to use of secondary species, seem to be related to two things. First, a reluctance to try new species if they don't have to and, second, the possible disruption of production.

Freas (11), for example, reports on a plywood plant in the Philippines which makes a great deal of overlaid plywood, all of Philippine mahogany, with a variety of printed patterns. The company in response to a question as to why they did not reserve Philippine mahogany for unoverlaid panels and use other species for the faces of overlaid panels expressed the opinion that this would cause too much disruption in their processing.

Other sources of information do not seem to discuss this aspect. It is likely, however, that similar situations exist elsewhere. It is unlikely that a change in attitude will occur until the supply situation truly becomes acute.

### Forest Management--Silviculture

A variety of management practices are used in the various areas. Several of these are summarized by Chudnoff (7). He points out that although some techniques are known for obtaining regeneration of desired species, often they are not applied for economic or other reasons. For highly complex tropical forests, there is no system for perpetuating species of choice.

Koeppen and Hutchison (17) reflect this same feeling when they state that "many foresters despair of being able to perpetuate the high forest with its most complex array of ecological and silvicultural problems." They describe efforts in Nigeria and Ghana with selective cutting. This has been only partially successful in that in many cases fairly heavy partial cuts have created such big breaks in the tree canopy that vines and light-loving weed tree species have taken over, excluding the desirable trees.

In the Philippines, only selective cutting is practiced (11), with the objective of cutting not more than 40 percent of volume, leaving 60 percent for reproduction and to grow to larger size. Clear-cutting is permitted in only a limited number of circumstances, as in road construction, at landings, and along cableways.

Cliff (8), in his review, comments that "To make things worse, there has been very little progress in developing sound silvicultural systems to insure regeneration of the preferred species in tropical forests." While he does not go into specifics on this point, he indicates that some 32 of the references he examined (out of 135) dealt with the need for research on various aspects, including silviculture.

The Seventh World Forestry Congress (3) comments on the dangers to the tropical forests from a variety of factors including shifting agriculture and failure to regenerate stands. In consequence, one of the recommendations is to accelerate research in natural regeneration. They urge organization of a worldwide meeting to explore the problems involved.

We believe that it may fairly be said that knowledge of silviculture and management in tropical forests is not well understood. Improvements in such systems could have an effect on extending the resource, both as to primary and secondary species.

### Government Controls

From our review, it would appear that controls exercised by government agencies can have both beneficial and adverse effects.

In the Philippines, for instance, Freas (11) reports that the Bureau of Forestry exercises close control over exploitation of the forest. By limiting the proportion of the stand which may be cut, they are seeking to insure that there will be a continuing resource, as indicated earlier, by

leaving trees for reproduction and delaying cutting to allow the smaller trees to grow to more marketable size. On the other hand, they impose a minimum size for cutting and restrict the volumes which can be removed from a concession. Undoubtedly some of the "secondary" species will be below the minimum size and this could inhibit their exploitation. Limitations of volumes to be removed would tend to discourage removal of secondary species in the sense that the concessionaire would prefer to remove only species on which he could get the greatest return.

Koeppen (16) reports that, in Colombia, governmental control is relatively light. The one exception mentioned was that the granting of a concession required up to 3 or 4 years.

Ghana is exercising increasing control over the use of the forest resource through the Ghana Timber Marketing Board (17). It has been felt that, in the past, individual timber producers with strong ties to buyers have not secured the best possible return to Ghana nor a broad enough use of species. Thus, they have instituted a number of requirements to remedy this situation. For example, direct negotiations between buyer and producer are no longer permitted. Rather, all export sales of logs and manufactured products must be handled through licensed agents who become, in effect, agents of the Board. In order to encourage greater species diversification, the Board has virtually eliminated the export of logs of four primary species and restricted the shipments of any one species in a given month. They are, in addition, taking steps to encourage more local processing and thus to reduce log exports. Similar steps are being taken in the Philippines where it is expected that log exports will be virtually eliminated by the end of 1975.

### Marketing Strategies

As noted elsewhere, export markets are tuned to the use of a relatively few preferred species. If secondary species are to find increasing acceptance in the market, sound marketing strategies are essential.

Hutchison et al. (15) discuss this point at length. They point out that it is an extremely difficult problem to develop a permanent forestry enterprise. Ability to market timber from Vietnam, in addition, depends on reduction of overcutting, reduced dependence on a few species, development of sound forestry programs, and reduced concentration on log exports. They conclude that prospects are good if the Republic of Viet Nam will take the proper steps.

Koeppen and Hutchison (17) review the situation in Ghana and Nigeria. It is clear that marketing problems exist here. They review some of the steps that have already been taken to improve the marketing situation.

The meeting on Processing, Uses, and Marketing of Tropical Timber (Berlin, 1973), already referred to, devoted two sessions to promotion and marketing needs, with special reference to secondary species. They conclude that

marketing investigations play a particularly important role in providing links between resource use, wood processing, and market requirements, and consequently have to be initiated at an early stage of development planning.

Much of the problem results from a lack of interest on the part of consumers, importers, agents, and producers in introducing new species. That is, they are comfortable with the current situation and probably will not change except in response to a changing supply situation. It might be pointed out, however, that development of a "grouping" concept will not be feasible without adequate knowledge of individual species characteristics. Such information is vital whether it comes from experience or from the laboratory.

We conclude that development of marketing strategy is an extremely important factor in promoting the use of secondary species. While steps are being taken in developing such strategies, it would appear that they are in need of additional development.

#### Transportation

Koeppen (16) reports that lack of a good transportation system has an adverse effect on utilization in Colombia. In part, this results from difficult terrain ranging from high, rugged mountains to swampy lowlands, both of which make road building difficult and expensive. What is apparently a low price for wood makes the matter of high road-building costs an important factor. Major manufacturing centers are at considerable distances from existing forests, again complicating the problem. That lack of adequate transportation is a problem elsewhere is indicated by Cliff's review (8) where some 24 references (out of 135 examined) dealt with transportation problems, mostly roads.

Cliff did not go into detail on this priority, but he did comment that inadequate transportation facilities can compound the effect of other factors. In most tropical countries, logging has started along water causes because, typically, logs are floated to shipside or to a manufacturing plant on a navigable waterway. Where this is the only means of transport, only logs that are light enough to float and which have other desirable properties will be harvested. Those which will not float, even though they have desirable properties, thus will not find a significant place in commerce. Exceptions, of course, are the so-called "luxury woods" which have sufficient value to justify logging individual trees by arduous ground methods or a combination of land transport and barging to a shipping or manufacturing point. Thus, transportation facilities, or lack of them, may be a factor of importance in affecting the utilization of additional tropical species.

### Development of Local Processing Industries

In a section devoted to developing a marketing strategy for Vietnam, Hutchison et al. (15) point out that there may be no particular trick in selling timber, but skill and patience will be required to develop a permanent, stable forestry enterprise that continues to contribute substantially to the income and welfare of Vietnam. They point out that failure of tropical countries to benefit as much from the forest as they might is based in part on heavy concentration on log exports. In other words, internal forestry-connected industries are needed to attain full benefit.

Many of the sources researched by Cliff (8) touched on this point in one way or another. A large number pointed toward expansion, diversification, and integration of forest industries as important steps in the improved utilization of tropical woods. Specific products were the subject of a number of recommendations, with heavy emphasis on pulp and paper and panel products such as hardboard, particleboard, and plywood.

An industry complex making a variety of products could be expected to utilize a greater range of species than would an industry making a single product. Thus, species heterogeneity would be less of a problem. It would be still less of a problem in applications which are tolerant of species. This has been discussed earlier under "Heterogeneity of the Forests" which quotes the Seventh World Forestry Congress as recommending as a "main goal" the development of species-tolerant processes. Pulp mills already use a mixture of species, with only the very dense species excluded. A similar possibility would seem to exist for particleboard and other panel products such as hardboard and fiberboard.

Whatever the application, species tolerant or not, successful local experience in making and using a product can only be a plus in introducing it to the export market, as well as in expanding local employment, improving foreign exchange positions, and obtaining more use of native timber. It would appear to us that an increasing degree of local development must occur if the trend toward discouraging log export continues to a considerable degree.

### Technology Transfer

Success in establishment or expansion of local industry will depend upon application of good technology in manufacture. That this is being done in some instances is evident from the existence of pulp and paper mills, sawmills, and veneer and plywood plants in developing countries.

As already mentioned, lack of proper manufacture, improper seasoning, and lack of preservative treatment are factors which have led to lack of acceptance of wood houses in some areas. Inadequate seasoning of the wood has led to lack of acceptance of furniture manufactured in some Central American countries. In many cases, these problems could be overcome by

application of technology well known in developed countries. Thus, it would appear that technology transfer could play an important role in improving utilization of wood generally and in improving the acceptance of secondary species.

Care is needed, however, in transferring technology to be sure that it fits the local conditions. Koeppen, for example, reports on a case in Colombia where American equipment was ill-suited to the timber sizes involved (16). Similarly, highly sophisticated equipment would be unsuitable where trained personnel are not available. In other words, the technology must be suited to local conditions of the timber resource, level of training of the work force, and limitations of available capital.

### Conclusion

We find it difficult, from our study of available information, to conclude that any one factor can be considered to be of primary importance in inhibiting the use of secondary species. Rather, there are a variety of factors, some of which seem to be more important than others. Some appear to be susceptible to efforts by AID.

### Availability of Species Characteristics

It was a question as to the importance of this factor which led to the investigation reported herein. We must conclude, from our study, that there is a considerable body of data on the technical and technological characteristics of a large number of tropical hardwood species. It is apparent, however, that it is scattered, is based on samples varying greatly in intensity, is sometimes based on samples of doubtful identity, and is not always comparable because of differences in methods of evaluation.

There are frequent suggestions, in references examined, for additional research. Perhaps as frequently, there are suggestions that available information be assembled, collated, and disseminated as a base for promotion, marketing, and use. Such an assembly of information would have both an immediate and a long-range effect. In the short term, it would make available to forest managers, producers, exporters, importers, and users a base of information for forest management and exploitation and for more efficient use. In the longer term, it would provide a base for research efforts by pointing out the gaps resulting from inadequate sampling, factors which have not been studied, and so on.

Efforts in this area are underway. For example, the Centre Technique Forestier Tropical, in France, is cooperating with a number of European laboratories (and an Australian laboratory) in assembling data from these organizations. In an effort to expand this to a more worldwide basis, Division 5 (Forest Products) of the International Union of Forestry Research Organizations has established a project group with a similar objective. Their efforts might well be supplemented to make the information available at an earlier date.

### Forest Resource Data

It was common, during our travels and our study of reports, to find comments deploring the lack of data on the forest resource. This was so common, in fact, that we must conclude that this must be an extremely important factor.

The degree of deficiency certainly must vary. In some cases, at least, reasonably good data exist for primary species, but information on currently less desirable species is limited or nonexistent. In other cases, it would appear that only fragmentary information, from limited areas, is available.

Some countries have organizations which are engaged in inventory work and which, with increased funding, a change in emphasis, or both, would be capable of improving their resource data. Others are almost totally lacking. The United Nations Development Program, as a part of pre-investment studies, has sponsored inventory work. As we understand it, this involved not only data collection, but training of technicians to carry on the work. We have not been able to identify what role AID has had in this area. Bolstering the efforts of the developing countries in evaluating their forest resources would be productive, but would be an expensive and time-consuming proposition and would have effect in the long term in promoting the use of secondary species. Training of technicians in inventory procedures, probably on a regional rather than a country-by-country basis, would undoubtedly be worthwhile, particularly if accompanied by the development of dendrology manuals, procedural manuals, and the like.

### Botanical Information

Botanical information on forest trees in the tropical countries varies widely. There is a substantial literature, but it appears, in some cases, inadequate to permit identification to species, but only to genera and sometimes only to family. It would appear, in any event, that transformation of this literature to a form suitable for field use by inventory technicians or loggers is lacking. Thus, although the flora of the Philippines is rather well known, personnel there suggested the desirability of preparing a dendrology manual for field use.

### Forest Management--Silviculture

Management systems for tropical forests seem to be in a state of flux. Various systems have been and are being tried, but optimum systems seem to be lacking. This is an extremely difficult area requiring long times to develop results.

### Industrial Practices

In more than one instance, industrial practice militated against the use of secondary species. In these cases, the companies are not motivated to try additional species because they feel that they have plenty of the



primary species and they resist potential disruption of their production process. To a degree, this probably represents an attitude which would be difficult to change except as a change is forced by supply problems, governmental control, or other factors.

#### Tradition

Local tradition in many areas discourages the use of wood in applications such as housing. This seems to stem from the short life expected from wood, based on past experience, and from the fact that non-wood homes are a symbol of prestige. The introduction of improved seasoning, preservative treatment, better construction practices, and the like can result in longer life and greater satisfaction. Construction of demonstration homes and public housing utilizing secondary species is planned in some areas to break down local bias-- a long-term approach.

#### Governmental Controls

As noted earlier, governmental controls may have both encouraging and discouraging aspects with respect to promotion of the use of secondary species. The trend, however, seems to be toward controlled exploitation of preferred species and encouragement of the use of secondary species at least on the local level.

#### Transportation Systems

Lack of adequate transport, mainly roads, appears to be a problem in some areas. We see no easy solution to this problem, and it is obviously not within the scope of studies we might propose.

#### Local Industries

Development of local industries can have considerable effect on the timber industry in developing countries. With relation to increased acceptance of secondary species, good experience with them in local use can be an important plus in promoting their use elsewhere. Suitably integrated industries may have an important effect in reducing the effects of heterogeneity either by routing species to a variety of products or by use in species-tolerant products.

#### Quality Standards

In the meeting on Properties, Uses, and Marketing of Tropical Timber (Berlin, 1973), attention was given to the matter of quality standards (grades) for wood and wood-based products. In this connection, it was noted that quality

standards should be more closely related to end use and that often the rules were adapted to individual requirements of the temperate countries, with inadequate attention to the needs of producing countries. The summary stressed the need for development of rules and standards to provide a common language between producer and user to assist the introduction of secondary species into world markets.

#### Technology Transfer

The introduction of improved technology can undoubtedly be a factor in improving the utilization of secondary species both for local use and for export. Care must be taken, however, to insure that the technology introduced is compatible with local conditions of the resource, labor skills, and capital availability.

#### Summary

In brief, several points stand out:

- There is a substantial amount of information dealing with the technical and technological characteristics of tropical species, including some secondary species.
- This information is widely scattered and facts on properties are not readily available to some who would use them.
- Available information varies in adequacy and thus some is of limited value.
- It seems apparent that gaps in knowledge of the utilization characteristics of tropical species still exist, although the extent of the deficiency in coverage and adequacy is not fully known.
- Additional research is needed to overcome this deficiency.
- Availability of information on utilization characteristics will not solve the problem of under-utilization by itself. Improving the availability of such information through assembly of current information and through research is but part of a total program which must include better timber inventories, promotion, more effective controls in the developing timber countries, and improvement in processing and use within the countries.

This suggests several immediate steps:

- Bring together existing information and make it generally available through an adequate retrieval system.
- Develop a model plan for conducting needed research.

--Develop means for enhancing the comparability of data from various sources.

Further in the future would be:

--Improve inventory practices to develop more complete information on the tropical forest resource.

--As gaps in existing information become apparent, and research needs develop, accelerate the research effort on technical and technological characteristics of tropical species with emphasis on enhancing the capabilities of developing countries, perhaps on a regional basis, to do the research themselves.

--Provide assistance in clarifying marketing problems and developing marketing strategies.

--Provide assistance in improving processing technology and application of wood-based products within the developing countries through technology transfer.

#### Recommendations

The following areas are suggested to the Agency for International Development or to other similar assistance organizations worldwide for consideration as to inclusion in their future programs.

(1) It seems apparent that there is available a great deal of information dealing with the technical and technological characteristics of tropical species, including some secondary species. It seems equally apparent that this information varies widely in adequacy, depending upon such factors as extent of sampling, adequacy of identification of sample material, and so on. Many sources have recommended assembly and dissemination of such information. The importance of such an assembly is suggested by the work in this regard already underway or planned by such prestigious organizations as national laboratories of Europe and Australia and the International Union of Forestry Research Organizations. The IUFRO group will shortly be circulating a questionnaire to go to all known institutes working on tropical woods. This is intended to search out available data, published and unpublished, together with information on the utility of the data with respect to the properties studied and the sample taken. Assembly of the data is likely to proceed slowly because progress must depend upon voluntary efforts by member institutions. The Centre Technique Forestier Tropical has already collected information on species tested by the cooperating institutions and the types of tests carried out. This information has been presented in the publication referred to earlier (6). They have also collected a great deal of information on test results and details of the evaluation procedures used. They are now reviewing this information to determine how best to handle it.

In view of the expressed need for such a compilation, and in view of the worldwide nature of the compilation planned by IUFRO, we recommend that AID and others cooperate with IUFRO Division 5 in the assembly, collation, and dissemination of information on the technical and technological characteristics of tropical hardwoods (with emphasis on secondary species) in order to provide this information in a more expeditious manner than would occur without such assistance.

Careful coordination with IUFRO Division 5 and with the Centre Technique Forestier Tropical must be maintained in order to prevent duplication of effort, to assure fullest coverage of the world's literature, and to assure inclusion of all needed relevant information. Matters related to format, methods of presentation, languages of presentation, and the like will require consultation with the groups mentioned above, with the Food and Agriculture Organization of the United Nations, and perhaps with others. The results of such work would be presented in a series of volumes based on countries, sub-regions, or regions as may be determined.

The United Nations Development Program has, over a period of several years, considered the establishment of Tropical Timber Bureaus, with the primary purpose of promoting the use of tropical species, with offices in developed areas such as Europe and the United States. One of the functions of such Bureaus would be the assembly of technical information. Progress has been slow and there has been some indication that the concept may be dropped, at least for the time being. The status of the "data bank" activities of the Organization for Tropical Studies is not known. However, close coordination, with both the proposed Tropical Timber Bureaus and the Organization for Tropical Studies, must be maintained.

(2) The work proposed in the first recommendation will result in vast amounts of information which will pose difficulties in storage and retrieval. Accordingly, we recommend that, concurrently with the activities of assembly of information, AID or others undertake a study of the feasibility of electronic storage of such information to provide for its ready modification as new or additional information becomes available, and for ready preparation of new presentations of information as modifications become necessary. At the same time, consideration should be given to establishment of a central point which will undertake to store, modify, and disseminate such information on a continuing basis.

(3) It seems apparent that the work proposed in the first recommendation will uncover gaps and other deficiencies in available information and, perhaps, potentially useful species on which no information is available. This will undoubtedly lead to additional research. In order to insure that limited research personnel and funds are most efficiently used, it would be well to develop a suggested approach to research which could be used as a basis for research planning.

Therefore, we recommend that AID or similar technical assistance organizations undertake a study to develop a model plan of attack for use in planning research on tropical species. It might, for example, involve a series of screening tests to indicate a probable use or uses toward which more in-depth research would be directed. It seems apparent, for example, that a species whose most probable use would be for decorative paneling or for furniture would require a minimum of evaluation of strength properties, and that emphasis should be placed on such things as ease of cutting into veneer, machinability, and like characteristics.

Consultation will be required with organizations such as FAO and with selected research laboratories in both developed and developing countries and with industrial organizations. Erfurth of FAO, in a recent publication, has developed a list of characteristics of lesser known species which he suggests as a basis for evaluation aimed at comparability of data.

Increased use of secondary species on a species-by-species basis will undoubtedly continue. However, there is need for developments on a non-species-oriented base as well. There appear to be examples of success in the area of utilization as pulp and indications of success in the area of use as solid wood. With this background, we suggest that AID consider an in-depth review of the literature in this area to clarify the potential of this approach as a basis for future development. Special emphasis should be placed on methods for establishing the utility of a resource on an area, regional, or other basis. Such a review may, in addition, clarify research needs for improving the non-species approach to utilization.

(4) Already mentioned is the problem of differences in methods of evaluation, particularly in strength properties. Such differences make difficult the interpretation, comparison, and use of the data. Efforts to develop a single set of evaluation procedures have, to date, been fruitless. In any event, large volumes of data are already available based on differing methods of evaluation and a procedure for converting results from one system to another would be desirable.

Accordingly, we recommend that AID or others undertake a study to determine the feasibility of developing a procedure which would permit conversion or comparison of results based on different evaluation methods. Such a study could well be in two phases. The first phase would search for previous attempts to develop such a procedure and for existing data which might be used. For example, Sallenave of the Centre Technique Forestier Tropical presents factors for conversion of data from the American to the French system. If such a search proves fruitless or if existing data prove inadequate, a second phase could involve a study to provide the necessary data for development of needed factors.

(5) Repeatedly, the inadequacy of resource information has been cited as a factor inhibiting the use of secondary species. Our investigation has served only to reveal it as a problem but has not provided any measure of the degree

of the deficiency. Thus, although we recognize that the problem is important, we do not feel, with the present state of our knowledge, that we can make specific recommendations on this point.

However, we would suggest that AID or others consider the possibility of getting a fix on the magnitude of the problem and potential steps toward solution through consultations with such agencies as the United Nations Development Program (which has sponsored pre-investment resource surveys), FAO (which has served as the executive agency in carrying out such surveys), forestry consultants both here and abroad, and perhaps the forest services in selected countries. We would not presume to predict what steps might be taken after the problem is better evaluated, but it might well involve the establishment (probably on a regional basis) of ad hoc sessions to provide to country personnel training in resource survey techniques or it might involve the preparation of dendrology manuals for field use from botanical literature.

(6) The development of markets for secondary species will certainly require marketing investigations to outline the problems anticipated and to suggest solutions. Some activities in this regard are already under way, as indicated by the establishment of the Marketing Board in Ghana and the promotional proposals outlined by the conferences in the Ivory Coast and in Cameroon already mentioned. AID has sponsored a review of markets for Vietnam timber products in Japan, Korea, Taiwan, and Singapore.

We suggest that consideration be given to the establishment of marketing investigations in selected countries or, if more feasible, in selected regions. That already carried out in Vietnam might be considered as a pattern.

(7) Favorable technical characteristics will certainly have an influence in promoting the use of secondary species in the long term. Perhaps even more influential would be a record of successful use in one or more applications. In part, at least, prejudices against wood in general and against certain species appears to result from lack of application of even basic known technology. For example, prejudices against the use of wood in housing, previously mentioned, may be laid to inadequacy in seasoning, lack of preservative treatment, and the like. More recently, in Latin America difficulties in marketing locally made furniture were found in large part to be a result of inadequate control of moisture in the raw material and in the finished product.

It appears, therefore, that substantial progress could be made by introducing improved technology, probably even on a relatively unsophisticated level. It is suggested, therefore, that AID consider establishing a pilot project to determine the feasibility of improving processing and use of wood-based products in developing countries to promote the general acceptance of wood and to establish a performance record for selected secondary species. The ultimate goal would be to establish within the country a permanent technology-transfer group which could provide continuing assistance to processors,

manufacturers, and builders within the country. Such activities have been highly successful within the United States, as exemplified by the Agricultural Extension Service and by the forest products utilization groups within the State and Private Forestry organization of the Forest Service.

We would suggest that such a pilot project be established within a single country or, at most, in two or three neighboring countries. It should be developed in consultation with the country's forest service or a development organization. The first phase would involve consultation on the ground to ascertain interest in such activities, to survey the levels of technology in use and thus the opportunities for improvement, and the selection of target species for consideration. We consider it of the utmost importance that those involved view this as an "establishment" project and not one which would involve permanent assistance from the United States.

We would suggest that items 1 through 4 be considered for implementation in the relatively immediate future, with the others to be considered in the longer range.

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