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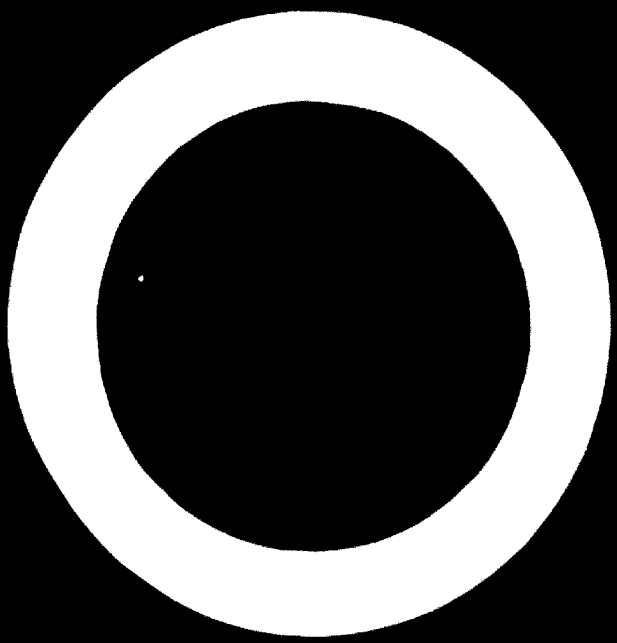
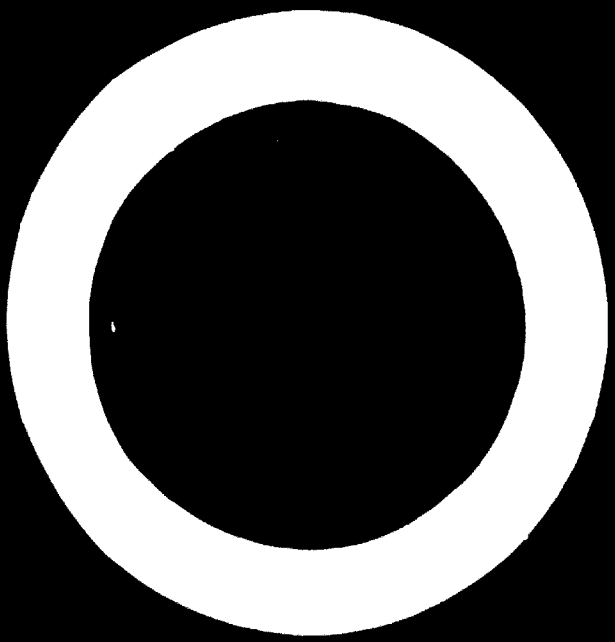
PRODUCTION OF PANELS FROM AGRICULTURAL RESIDUES

UNITED NATIONS





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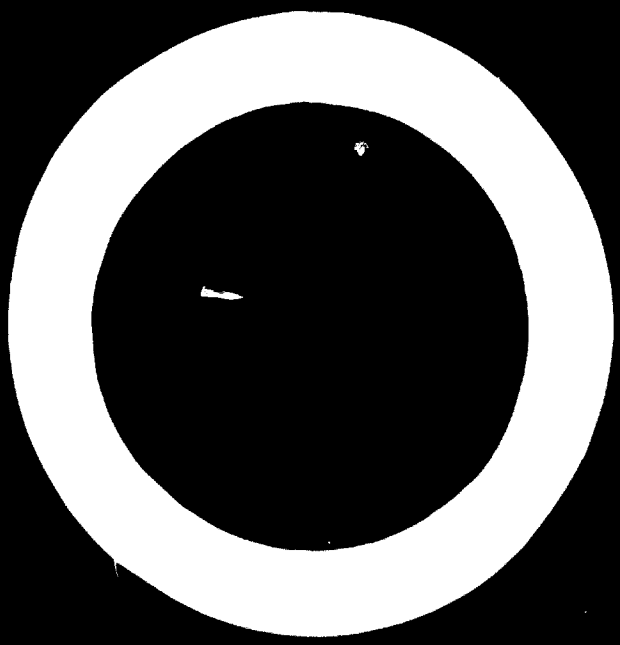

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA

PRODUCTION OF PANELS FROM AGRICULTURAL RESIDUES

Report
of the Expert Working Group Meeting
Vienna, 14–18 December 1970

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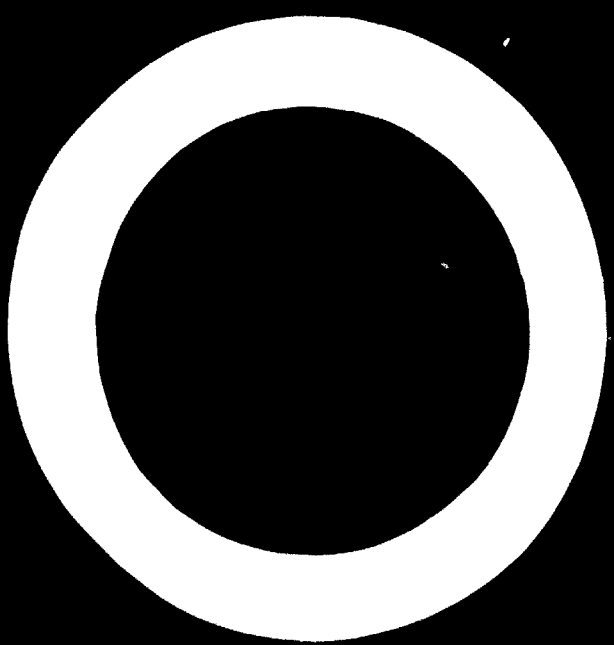


Introduction

1. Many developing countries, though not self-sufficient in wood and wood products, have great quantities of agricultural residues and non-wood fibrous materials which more often than not they fail to utilize. In order to assist these countries in finding substitutes for wood-based products, thereby reducing the need to import this vital commodity, UNIDO convened an Expert Group Meeting on the Production of Panels from Agricultural Residues, which met in the Neue Hofburg in Vienna from 14 to 18 December 1970.

Terms of reference

2. The terms of reference of the Group were as follows:

(a) To compile the results of experience acquired in the use of agricultural residues and non-wood fibrous materials in the production of panels, indicating which materials have been found suitable and which have not;

(b) To outline the research that must be carried out on certain potential raw materials common to the developing countries in order to determine their suitability for use in the production of panels;

(c) To investigate the economic and technological aspects of producing various types of panels from these materials, and highlight the prerequisites to ensure the viability of such industries in the developing countries;

(d) To formulate, in recommendations to be included in the report of the meeting, all the measures the developing countries must take to make fuller use of their potential raw materials as substitutes for imported wood-based panels.

Organization of the meeting

3. The meeting was organized by the United Nations Industrial Development Organization (UNIDO) and was intended to bring together participants from developing and developed countries at UNIDO's expense. The experts invited were either closely associated with research on these problems or managers of plants producing panels from agricultural residues and non-wood fibrous materials. Observers who met these qualifications also attended and actively participated in the meeting.

4. On behalf of Mr. I. H. Abdel-Rahman, Executive Director of UNIDO, the meeting was opened by Mr. E. G. Rothblum, Assistant Director of the Industrial Technology Division, whose statement is attached to this report as annex 1. Mr. W. Moreira-Dias, Officer-in-Charge of the Light Industries Section, gave an address of welcome.

5. *Attendance.* The meeting was attended by seventeen experts from the following countries: Austria, Belgium, Cuba, Czechoslovakia, Egypt, Federal Republic of Germany, France, Iran, Norway, Peru, Poland, Thailand and the United Kingdom. Twenty-four observers came from Austria, Belgium, Federal Republic of Germany, France, Iraq, Morocco, the Netherlands, Norway, Saudi Arabia and Sweden. A list of the participants and observers is given in annex 2.

6. *Election of officers.* Mr. Mohamed H. Tantawi, Director and General Manager, Société des Sucreries et de Distillerie d'Egypte, Cairo, Egypt, was elected Chairman; Mr. Torsten J. Mosesson, Director, Tomo Trading Co. Ltd, Uxbridge, United Kingdom, was elected Vice-Chairman; and Mr. Arnost Travnik, Lecturer, Lignoprojekt, Bratislava, Czechoslovakia, was elected Rapporteur. Mr. Antoine V. Bassili of the Light Industries Section of the Industrial Technology Division of UNIDO served as Secretary to the meeting.

Adoption of the agenda

7. The work programme and agenda, which are presented in annex 3, were unanimously adopted. The Group decided to change the title of the meeting from "Expert Working Group Meeting on Production of Panels from Agricultural Wastes" to "Expert Working Group Meeting on Production of Panels from Agricultural Residues" as it was felt that the word "wastes" could be interpreted as being pejorative, thus possibly evoking consumer resistance to panels manufactured from these materials. The Group stressed that the quality of the product was the only valid criterion for selecting a panel for a given end use, and that those who are concerned with specifications should not be influenced by the raw material used in the manufacturing process.

Documentation and working languages

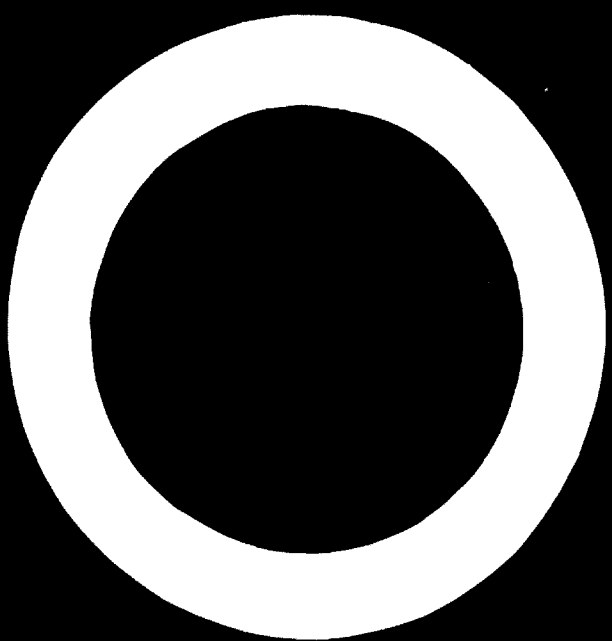
8. Twelve documents dealing with topics related to the agenda items had been commissioned by UNIDO and were distributed to the participants. In addition, two documents were submitted by participants and distributed during the meetings. A list of documents is attached to this report as annex 4. Although the documents were distributed only in the languages in which they had been written (English and French), summaries were made available to participants in English, French and Spanish.[1] English, French and Spanish were the official working languages of the meeting.

[1] A limited number of copies of these documents are available upon request in the language in which they were presented. Summaries in English, French or Spanish are also available.

Adoption of the report

9. At its closing session, on 18 December 1970, the Group unanimously approved the draft report of the discussions that had taken place. The recommendations formulated and variously amended by the experts were carefully considered and unanimously approved. (The recommendations are presented in chapter 7.)

10. In adopting the report, the Group recommended that UNIDO make it available to the following bodies in developing countries, over and above its normal channels of distribution: industrial development corporations and banks, industrial research and building research institutes, and chambers of industry. It was considered that this would materially assist in the establishment of industries producing panels from agricultural residues and increase the consumption of these panels. It was also felt that this step would encourage the Governments, industries, institutions and individuals concerned to implement the recommendations.



Chapter 1

HISTORICAL OUTLINE OF PAST RESEARCH

11. The Group considered two papers on past research and experiences in producing panels from agricultural wastes. These were: "Historical outline of past research on the production of boards from agricultural wastes and future trends" (ID/WG.83/2), by Mr. A. E. Chittenden; and "Some experiences in research and manufacture of panels from agricultural wastes and non-wood fibrous raw materials in Czechoslovakia" (ID/WG.83/CR2), by Mr. K. Eisner and Mr. A. Travnik. Historically, it was pointed out, progress towards the increasing use of agricultural residues in developing countries has been very slow, even in countries with insufficient timber for domestic needs.

12. It is also apparent that only a relatively low proportion of materials that have been tested have been utilized on a commercial scale. Successful large-scale commercial production has been limited to bagasse, flax and linseed residues and to the European reeds. The utilization of cereal straws has been hampered by their high moisture content and their central hollow cores, which impede the proper application of a glue binder. The "Stramit" process is the sole means of producing building board from unpulped agricultural waste without the use of an added binder.

13. While the problem of collecting and storing good potential particle board material, such as cassava stems, appears insolvable, economically viable board-making processes have not been developed for such readily available materials as coir dust, rice hulls and groundnut shells.

14. Developing countries should be warned of the danger of installing board plants as a means of saving foreign currency on building-board imports, since they often become committed to spending large sums on synthetic resin adhesives which they themselves are unable to manufacture economically. In this connexion, assistance should be given to those countries where supplies of natural adhesive and adequate supplies of agricultural residue coexist.

15. Despite the international trend towards large-scale plants because of economies of scale, it would be more practical to promote small-scale operations so that the smaller, scattered quantities of potential board materials could be used.

16. The experience of Czechoslovakia in the investigation of such residues as corn cob, flax and hemp shives, bagasse, cotton stalks, palm leaves and stems, bamboo,

papyrus, reeds and esparto grass indicates that in principle it is possible to manufacture agglomerated boards from almost all agricultural residues and non-wood fibrous raw materials. The morphological properties of such boards, however, are often unfavourable, and it has frequently been necessary to increase the glue content of the boards to obtain physical properties equivalent to those of wood-based boards.

17. Another problem restricting the potential use of agricultural residues is that of storage. Not only is the raw material a seasonal product, but it is also bulky, and measures must be taken to inhibit the growth of micro-organisms when the material is baled and stored.

18. The simple technology of manufacturing mats stitched with wire or artificial fibre should be promoted in developing countries. Such mats facilitate the rapid construction of walls and ceilings and, when a layer of bitumen is added, can be used for roofs as well.

19. The Expert Working Group requested that UNIDO compile, update and make available to all interested bodies and individuals in developing countries a bibliography on the research carried out on the utilization of agricultural residues and non-wood fibrous material for the production of panels.

20. In view of the conditions prevailing in developing countries where markets are small in part because of the lack of experience in utilizing the boards and where the possibility of establishing regional plants is limited, the Group stressed the need for adequate documentation to guide prospective investors. It was urged that a means should be devised for the preparation of comprehensive documentation featuring the following items:

(a) Concise instructions relating to market research and feasibility studies;

(b) Adequate samples of various panels with a brief description of their properties and potential end uses. The data thus compiled should serve as the basis for estimates of future consumption of specific assortments such as:

Standard density particle board for general use in accordance with world standards;

Particle board with smooth surfaces and a high degree of tensile strength perpendicular to the surface, suitable for veneering or laminating;

Particle board, bonded with moisture-resistant adhesive, for building and similar purposes;

Thin particle board for packaging and ceilings;

Boards made from particles and bonded with cement for building purposes;

Hardboard;

Semi-hard fibreboard for both the furniture and building industries;

Medium-density fibreboard for thermal and sound insulation purposes;

(c) Concise technological descriptions of the particle board and fibreboard manufacturing processes (wet and dry), including a simple production layout with equipment specifications and a breakdown of approximate

production costs as guidelines. (In this connexion, and in view of the conditions prevailing in the majority of developing countries, the Group agreed that one of the following capacities could be taken as a basis for a preliminary feasibility study: 10,000 m^3 particle board, 15,000 tons hard fibreboard, and 100,000 m^2 cement-bonded boards made from agricultural residues.)

(d) Guidelines relating to the promotion of panels and their utilization, including instructions for quality control and suggestions as to their further processing.

21. The following technical classification of raw materials based on suitability for panel production was agreed upon:

(a) Flax, hemp shives, bagasse and cereal straws: the first two are highly suitable for the production of low- and medium-density particle boards. The diminishing production of such boards in certain European countries is due to the insufficient supply of raw materials rather than to consumer resistance. Bagasse has also proved to be suitable for the production of particle boards, fibreboard, pulp and certain kinds of paper. Cereal straws are being commercially processed into straw slabs and fibreboards. The technical problems arising in connexion with the processing of these materials have already been overcome. Consequently, in cases where such raw materials are available in adequate quantities and markets exist, feasibility studies for establishing such plants could be initiated;

(b) Papyrus, cassava stalks, cotton stalks, jute and kenaf, coconut palm trunks, palm fronds and fruit stems, and esparto grass: these agricultural residues are of certain potential value and common to many developing countries. Commercial experience to date, however, has been insufficient. A small-scale plant in Uganda had manufactured fibreboards using papyrus, but has since closed down. Another plant in Iran has been utilizing cotton stalks for particle boards for the last two years. In 1970 the manufacture of moulded containers using combed esparto was introduced in Morocco. Esparto grass has also been used at the pilot-plant level for the production of both particle boards and fibreboards. The particle boards produced in the conventional manner have not proved satisfactory, but the results obtained with fibreboards are promising. Palm fronds and fruit stems have also undergone pilot-plant testing and the first factory is being established in Iraq. Thus, in view of these experiences, prospective investors are counselled to obtain expert advice and assistance from specialized institutes or international organizations before making a final investment decision;

(c) Cotton-seed hulls, rice husks, coffee husks, cocoa shells, coir, date palm trunks, banana stalks and sunflower seeds: these have so far failed to prove satisfactory for the production of particle boards or fibreboard. Some of them, however, could be used as aggregate in light-weight concrete blocks and slabs.

22. Research has been carried out on other agricultural materials. However, the results have not been encouraging and prospective investors are cautioned to undertake exhaustive studies before investing in plants utilizing such materials.

Chapter 2

TECHNICAL AND ECONOMIC ASPECTS OF HARVESTING AND PRE-PROCESSING AGRICULTURAL RESIDUES

23. The Group investigated various problems relating to the harvesting and pre-processing of agricultural residues. Six papers covered these topics: "Technical and economic aspects of bagasse utilization" (ID/WG.83/9), by M. Tantawi; "Economic and technical aspects of harvesting cotton stalks for the production of particle boards" (ID/WG.83/11), by Mr. E. Mahdavi; "Technical and economic aspects of utilization of flax shives and hemp boon for the production of particle boards" (ID/WG.83/12), by Mr. A. Frackowiak; "Technical and economic aspects of processing rape straw into particle board" (ID/WG.83/13), by Mr. W. Kilanowski; "Economic and technical aspects of the utilization of cereal stalks for the production of panels" (ID/WG.83/10), by Mr. S. Bulakul; and "Production of strawboards by the 'Stramit' process" (ID/WG.83/CR.1), by Mr. T. J. Mosesson.

24. The Group examined the suitability for panel and paper manufacture of bagasse, which is generally available in countries with limited wood resources. It was felt that most economic problems could be overcome if the panel mill were set up as a complementary plant to a sugar factory where surplus bagasse is readily available. Bulk storage would also contribute to the reduction of raw material costs, while artificial drying should be avoided wherever possible.

25. The idea was advanced of year-round operation, since this avoided excessive capital costs, social problems inherent in seasonal industries, panel storage problems and the difficulties of establishing an appropriate production programme suited to actual market requirements.

26. Panels may be produced from cotton stalks, which are otherwise left to decay in the fields or used for cooking and heating purposes.

27. The findings of flax- and hemp-processing plants in Poland, with certain restrictions, could apply to developing countries. The prices paid for particle boards made from flax or hemp shives are comparable to those currently being paid in Poland for wood particle board. Again, the need was stressed for careful economic

surveys and feasibility studies prior to introducing processing plants. With careful preliminary planning, panel production from flax and hemp shives could prove most profitable for developing countries.

28. Production on an industrial scale of particle boards from rape straw has proved successful despite the comparatively low cellulose and lignin content. Particle boards manufactured from rape straw in Poland are being used increasingly in the building and furniture industries as substitutes for more expensive types of particle board.

29. Cereal stalks are the basis for the manufacture of "Stramit" boards in Thailand, where these have been used for roof deckings, partitionings, ceilings, interior wall linings etc. The manufacturing process is simple, the main problem being the cost of transporting the straw. Indigenous materials, rice paddy and straw, are used in a ratio of 1:2; the glue and paper are imported.

30. The production of straw slabs by the "Stramit" process has an advantage in its versatility with regard to input. Apart from a requirement that the fibres should be reasonably long with only a limited proportion of strands less than 10 cm, the raw material is accepted as it comes from the harvest fields following threshing. The process is simple in terms of capital cost and manpower once the straw has arrived at the factory. The panels produced are thicker, but otherwise similar to softwood plywood panels. They can be successfully used as roof decking on an open framework, but like other organic materials they require protection from water and stagnant moist air. The slabs are mainly used as insulation panels or as partitions.

31. The following general matters were considered by the Group as relevant to the utilization of agricultural residues:

(a) Transportation: where agricultural residues are not a by-product of other industrial processes, the supply of raw materials becomes critical and must be carefully studied;

(b) Storage capacity: agricultural residues require larger storage areas than is customary in similar capacity plants utilizing wood as raw material;

(c) Storage conditions: raw material deterioriation is possible under certain climatic conditions, unless the moisture content of the stacks is reduced to at least 22 per cent;

(d) Fire protection: the need for ample passageways between stacks is necessary for unrestricted access in the case of fire.

32. The Group then debated the various materials individually and the following points emerged.

Bagasse

33. The cane sugar industry, which is concentrated in countries with limited wood resources, offers large quantities of ligno-cellulosic material. Interest has centred on sugarcane bagasse because it is an industrial by-product of relatively low value, readily available, and in certain cases one sugar mill can meet a panel mill's bagasse requirements. Transport problems could be reduced to a minimum if the panel mill is

located next to the sugar mill, although mill-run bagasse contains a large fraction of non-fibrous material, pith, which has to be removed. Moist depithing of the mill-run bagasse was felt to be the most appropriate system, and the pith can be disposed of by using it as fuel in the sugar factory's steam generating plant. Before processing the dried bagasse into particle board, the remaining pith fraction should be separated pneumatically.

34. A wet bulk-storage system is the most appropriate method if the bagasse is to be processed into hardboard or other panels using wet forming. However, if the bagasse is to be processed into particle board, it should be sufficiently pre-dried. Natural drying of bagasse during storage is preferable, climatic conditions permitting; otherwise it must be dried artificially.

35. If a baling system is adopted for the storage of bagasse, great care should be taken with regard to stack structure and the provision of adequate ventilation between the bales to prevent discoloration and destructive fermentation. Fuel replacement and baling are the most expensive aspects, though where surplus bagasse is available, costs would be considerably lower.

Flax and hemp shives

36. Neither raw material presents outstanding transport or storage problems after twenty years of industrial experience, since the plants have usually been an integral sector of flax- and hemp-processing complexes. Under central European conditions, annual capacities of 15,000 m^3 to 18,000 m^3 are economically viable, and additional raw materials may be transported over distances of up to 120 km. As the raw material must always be dried in the textile plant to extract fibres, normal pretreatment is unnecessary. The amortization periods for the plant quoted on page 4 of the paper by A. Frackowiak (ID/WG.83/12) were felt to be exceptional even for Poland and should not be applied as a general rule to other countries.

Rape straw

37. Despite limited cultivation of rape in developing countries, the recently developed process and the problems of collecting and pre-processing are similar to those of other potentially usable agricultural residues and hence could serve as guidelines for like cases.

38. Studies relating to the economics of production show that plants producing 15,000 m^3 or 9,000 tons per annum are economically viable in Poland if no less than 6 per cent of all the land within a radius of 60 km is planted with rape.

Jute and kenaf sticks

39. Jute sticks are good raw material for the production of particle boards, as evidenced by their commercial use in a plant in Pakistan. Kenaf sticks of Asian origin present no outstanding pre-processing problems as raw material for particle boards.

Cotton stalks

40. A plant in Iran has been utilizing this raw material successfully, the stalks being harvested locally by manual labour 20–30 km from the plant. The raw material, with some husks, is transported in bulk without baling or chipping. However, it was felt that more research could be done into the reduction of transport and storage costs, and of fire risk by chipping in the field. The factory gate price of cotton stalks is half that of the alternative material (poplar), and the yield obtained is very low (33 per cent).

41. In certain cotton-growing areas, cotton stalks have to be burnt to prevent the spread of cotton worm and other insects. In Iran, where such measures are not mandatory, the stalks have to be treated with insecticide which costs about $U.S. 1.00 per ton of stalks.

Cereal stalks

42. Rice, wheat and barley are often intensively cultivated and, though unsuitable for the production of particle board, they may be used for fibreboard and straw slabs.

43. To overcome underutilization in certain areas, harvesting and collection methods (manual or mechanical) could be organized to ensure regular supplies. Baling in the field to prevent decay is recommended as long as the moisture content (on a wet basis) does not exceed 22 per cent. For processing purposes, however, the straw moisture content should be between 13 and 16 per cent.

Chapter 3

TECHNICAL PROCESSES FOR THE PRODUCTION OF VARIOUS TYPES OF PANELS FROM AGRICULTURAL RESIDUES

44. The Group discussed several papers dealing with the various methods of producing panels. These papers included: "Technical and economic aspects of the processing of rape straw into particle boards" (ID/WG.83/13), by Mr. W. Kilanowski; "Economic and technical aspects of the utilization of cereal stalks for the production of panels" (ID/WG.83/10), by Mr. S. Bulakul; "Production of strawboards by the 'Stramit' process" (ID/WG.83/CR.1) by Mr. T. J. Mosesson; "Particle board from annual plant wastes" (ID/WG.83/5), containing a comprehensive bibliography, by Mr. M. Mestdagh; "The dry process for the production of fibreboards" (ID/WG.83/6), by Mr. M. Lepeut; and "Technical processes for the production of wood-wool/cement boards and their adaptation for the utilization of agricultural wastes" (ID/WG.83/4), by Mr. W. Sandermann.

45. In an analysis of the manufacture of phenolic resin-bonded flax and bagasse boards, the difficulties encountered in endeavouring to produce low-density board from flax were pointed out. While bagasse has value for particle-board production, storage problems arise from the short sugarcane cutting season. The results of an industrial test run on phenolic resin-bonded bagasse board indicated that these duplicated those achieved with flax shives.

46. Other materials, such as rice hulls, peanut shells, cereal straws, maize, sisal, abaca, coconut fibres, bamboo and reeds were briefly considered, and the results were examined of using tannin extracts as adhesives in bagasse particle boards.

47. It was felt that distinctions made between wood and non-wood panels should be based on board properties rather than on the raw materials. The potential value of particle boards in the construction of prefabricated living units was pointed out, and their suitability for finishing and surfacing purposes was especially stressed.

48. The dry process for the production of fibreboards enables the manufacturer to use previously unsuitable species, obviates the problem of effluent control, and minimizes the loss of wood (12 per cent less than with the wet process).

49. The process, however, requires great amounts of resin and is still rather difficult to operate. It was felt that, in view of the excellent results in the use of all species of wood, there should be no difficulties with other types of ligno-cellulosic matter.

50. The advantages and limitations of wood-wool boards with respect to other wood-based raw materials and building materials were compared. Bagasse was considered one of the most promising fibrous raw materials for the manufacture of such products. Extensive tests have demonstrated that cement-bonded boards and building blocks made from agricultural residues have almost the same properties as those made from wood-wool shavings.

51. The equipment needed to manufacture cement-bonded boards from agricultural residues and wood-wool is similar. Some modifications, however, are necessary, as additional equipment for baling, storing, shredding and depithing is required. Certain fibrous materials contain cement-setting inhibitors, e.g. sugars, tannins, hemicelluloses, requiring mineralization before use. Some agricultural residues are none the less unsuitable for the manufacture of high-quality boards.

52. Strict quality and process controls are very important. And, despite the simplicity of the manufacturing process, key technicians are indispensible.

53. The current decline in the production of cement-bonded light-weight boards in the Federal Republic of Germany is due to substitution by other boards made from different materials, e.g. particle board, asbestos cement sheets, mineral fibreboard, synthetic polyurethane board, grassfibre boards and mats etc. Despite the difficulties of breaking into the highly conservative building industry, it was felt that cement-bonded boards and slabs would be of inestimable value to countries with limited wood resources but ample agricultural residues, such as Cuba and certain regions of Brazil.

54. Research into a large number of vegetable plants has shown that individual raw materials can be used only to produce certain types of panels. However, work on other raw materials remains to be done since there is a tendency to extrapolate results and deduce that these present no specific problems.

55. Current agglomeration methods and processes demonstrate that panels can be obtained by various methods regardless of the agricultural residue. These methods, however, do not automatically yield products whose technological qualities are always comparable. Experience shows that the success or failure of a project depends to a large extent upon the correct choice of process, and consequently upon the properties of the products manufactured. Products obtained from any one agricultural residue can have totally different technological properties depending on whether the panel or slab produced is:

(a) Particle board (flat pressed or extruded). For flat-pressed board, properties vary depending on whether the panel is mono-layer, three-layer or multilayer;

(b) Fibreboard produced either by the wet or dry process;

(c) Mineral-bound panels (wood-wool/cement or wood shavings type);

(d) Extruded panel manufactured from stalks of cereal plants.

56. Consequently, it was recommended that feasibility studies be prepared by impartial specialists on the basis of detailed questionnaires supplied by the promoter of the project, containing:

(a) Detailed technical data on the proposed raw material;

(b) Marketing prospects, including those for competitive products;

(c) Socio-economic aspects;

(d) Required infrastructure costs;

(e) Detailed analysis of the performance of the material with respect to the end uses envisaged in the market survey carried out under *(b)*.

57. Furthermore, investors should employ the services of an impartial specialist to advise on the preparation of calls to tender, the selection of bids and the setting up of trial runs. Assistance from bilaterial or multilateral organizations offering aid should be sought whenever appropriate.

58. Interested parties in the developing countries should realize that the preparation of detailed studies facilitates the examination of projects by prospective investors. Key technical personnel should be trained to ensure the efficient operation of the plant upon opening, as the satisfactory operation of a panel plant depends from the very outset upon the competence of the technologist (who could also be the production manager), and a highly skilled electrician and mechanic.

59. The Group strongly recommended that prospective investors in the developing countries devote particular attention to regular process and quality control to ensure the maintenance of standards. Hence, projects should include properly equipped control laboratories. It was further recommended that UNIDO consider extending its programme of technical assistance fellowships to key production personnel from panel plants in developing countries so that they might be trained in modern production and process control operations and plant maintenance.

60. The feasibility of producing building materials from agricultural residues on a village-industry or intermediate technology scale is problematic, and there is need for further study to this end.

Particle boards

61. The information relating to the production of particle boards from agricultural residues is mostly applicable to flat-pressed boards.

62. Products should be diversified and a 10,000 m^3 yearly production on a two-shift basis should be aimed at to attain economic viability in the small local markets common to most developing countries. A certain degree of production-line mechanization is necessary to minimize quality fluctuations and to lower production costs.

63. As the furniture industry in certain developing countries is often still at the craftsman stage, surface-finishing equipment should be provided at the panel plant to facilitate the introduction of the products on the local market.

64. In order to facilitate their adoption by the local building industries, panels resistant to local climatic conditions should be promoted.

65. A certain degree of flexibility in production techniques is a fundamental prerequisite of the production unit and has to be kept in mind when considering the cost of the plant.

Fibreboards

66. Economies of scale play a much more important role in the production of fibreboards than of particle boards. Fibreboard production must be in the order of 15,000 tons yearly on a three-shift basis. Consequently, the results of a market study are the major determinant in the decision for investment. The Group also felt that the need for producing oil-impregnated boards locally should be ascertained in any market survey.

67. The respective merits of the dry and wet processes are linked with the raw materials and local conditions, both of which are the main parameters in the final choice.

Cement-bonded slabs

68. Several agricultural residues, such as wheat, rice, straw, cotton stalks, corn stalks, bagasse, flax, hemp, rice hulls, and coconut fibres, have been tested. Despite various claims that the problems of cement-setting inhibition have already been solved, commercial applications have not been started and further research is necessary.

69. The Group recommended that specialized institutes, both in the developing and industrialized countries, attach priority to research in view of the boards' importance in low-cost housing programmes in developing countries where cement-bonded slabs greatly reduce erection times. Furthermore, this process is particularly suitable for developing countries because of the simple technology, local availability of practically all raw materials, absence of economies of scale, and the labour-intensive process involved.

Straw slabs

70. Less sophisticated plants are of interest to developing countries because they can operate profitably on annual productions as low as 2,000 tons. They can work on a single-shift basis, mainly processing local raw material to produce building slabs for low-cost housing schemes.

71. The resin and paper that have to be imported usually represent about one third of the total production costs. The unskilled labour requirements arising from labour-intensive handling methods and the increased regular cash crop for farmers make the process attractive to developing countries.

72. The process could be used for rice, wheat and barley straws, which in certain areas are underutilized, but the market has to be tested before deciding on the establishment of a plant and its capacity.

73. The slabs' fire resistance and good heat insulation qualities make them useful for housing. In tropical climates the paper liner has to be treated against fungal and termite attacks. Owing to their comparatively high mineral content, the straws have an abrasive effect which calls for care when choosing cutting tools.

Chapter 4

PROBLEMS OF MARKETING AND PROMOTION OF PANELS MADE FROM AGRICULTURAL RESIDUES

74. The Group took note of the paper prepared by Mr. M. de Longeaux, entitled "Problems of marketing and promotion related to the introduction of panels from agricultural wastes into the markets of the developed countries" (ID/WG.83/3), which emphasized the problems facing panel producers in developing countries. The paper also enumerated the main measures to be taken in developing countries to ensure local consumer acceptance.

75. Consumers in developed countries regard wood-particle board as improved wood. Consequently, any panel products from agricultural residues would have to offer substantial technical and/or economic benefits in order to compete successfully with wood-particle board in developed countries. Particle board for domestic markets in developing countries, however, could be subject to less stringent specifications.

76. Competition among producers is stiff and customers are always setting increasingly high standards. Hence, those wishing to enter the market should supply high-quality products at closely calculated prices and provide efficient before- and after-sales services. In developed countries, sales staff receive technical training to enable them to advise buyers and users. Advertising, distribution networks and attendance at trade fairs depend on the scale of production.

77. Detailed information should be obtained with regard to potential markets for new panel products in the developing and developed countries through the services of specialized organizations and institutes.

78. The importance of a comprehensive market study for the anticipated product, covering the producer country and possibly its neighbours, should not be underestimated. The study should be concerned with both the product and related materials and their interrelationship. The new product's properties should be adequate for normal local end-uses and climatic conditions. It should also investigate the possibility of finding new applications for the panels to be produced specific to local customs and requirements.

79. Courses on the correct utilization of panels should be offered at vocational training schools, which should be supplied with samples produced under pilot-plant conditions even prior to the start of industrial production.

80. The Group recommended that special attention be devoted to the training of technical salesmen to promote the product for specific end uses, to advise on correct applications, and to prevent the buildup of consumer resistance, which in many cases could be ascribed as much to misapplication of the product as to poor quality.

81. The Group also emphasized the importance of preparing promotional material and technical documentation for local consumers in their respective languages. The developing countries should approach the various manufacturers in industrial countries or their associations, both national and international, to obtain information on the different uses of the panels.

82. Panel producers in developing countries should endeavour to broaden local building codes and government specifications to include the utilization of locally manufactured panels whenever possible.

83. Whereas the word "agricultural wastes" is acceptable technically, its use when promoting the product should be avoided because it could cast doubt on the quality of the product.

84. Since local products produced from agricultural residues must compete with wood-based panels, they should be marketed and promoted under their trade names without specific reference to their raw materials.

85. It is unlikely that fibreboards, cement-bonded boards and straw slabs will be exported from developing countries to developed countries in the near future. In the case of particle board, prospective investors should not be over-optimistic because of consumer preference in industrialized countries for wood-based particle boards. This situation may well change because the future supply of industrial wood to the particle-board plants in developed countries is uncertain.

86. Manufacturers should ensure that the technical properties of the panels are maintained throughout and that consumers are kept informed of their characteristics. Panel manufacturers should initially recommend their panels for specific applications; at a later stage production control by an external body could lead to the establishment of a quality label.

Chapter 5

SELECTION AND PRODUCTION OF ADHESIVES FOR USE WITH AGRICULTURAL RESIDUES

87. The Group investigated the problem of selecting and producing adhesives suitable for use with agricultural residues, following the presentation of a paper by Mr. A. G. Seljestad entitled "Synthetic resin adhesives; a survey of production, production techniques and world trade" (ID/WG.83/8).

88. In certain cases the economic benefit of establishing a local panel industry is curtailed by the burden placed on the national economy from having to import resins. In the production of particle boards, resins represent the largest single cost element, the more so in developing countries.

89. The Group noted with interest UNIDO's proposed expert group meeting on the selection of resins tentatively scheduled for 1972. This meeting was recommended, as it would help to overcome the problems facing adhesive production and utilization, which have limited the introduction and expansion of the panel industries in developing countries.

90. It was suggested that UNIDO include the following topics in the agenda for the above meeting: local natural adhesives; world trade in adhesives; mineral adhesives; production of chemicals for resins used in the wood-processing industry; auto-agglomeration processes; and the application of surfacing materials.

91. It was suggested that the following studies should be undertaken by UNIDO or other bodies:

(a) Adhesive costs in relation to raw materials and production costs in various countries;

(b) Shelf-life prolongation problems of different adhesives in hot climates;

(c) The use of tannin, furfural and cashew nut-shell liquid as potential substitutes for one of the resin components (these raw materials are readily available in some developing countries and hence would help reduce the drain on foreign exchange);

(d) The transportation of sulphite waste liquors in concentrated or dried form, should their use as adhesives for particle board prove commercially successful (reasonable pressing time, mould resistance etc.)

92. Formaldehyde is an essential component in the manufacture of resins, which, if produced locally, require formaldehyde to be imported in a water solution, representing a great increase in transport costs. The importation of paraformaldehyde in powder form was thought to be uneconomic. The production of furfural in the developing countries to replace the imported formaldehyde is a possibility, which Cuba has been exploring.

93. The price of melamine might soon drop considerably as a result of a recent technological development.

94. The establishment of industries from agricultural residues has often been hampered by the high cost of resins.

Chapter 6

THE ROLE AND IMPORTANCE OF STANDARDS AND QUALITY CONTROL IN THE DEVELOPMENT OF NEW PRODUCTS

95. The Group took note of the paper entitled "Standards and quality control for panels made from agricultural wastes" (ID/WG.83/7), by Mr. H. Neusser. The author pointed out that particle size was the most important factor to be observed when processing agricultural residues.

96. To offset the extra costs involved in storage and transport, production standards used in industrialized countries could tolerate some reduction. The limits of certain minor properties could perhaps be lowered by as much as 30 per cent, or all property limits by 10 per cent.

97. Particular attention should be paid to the properties of the raw material during storage and production. Other important aspects are energy input, wages, working hours, service-life of the tools and output level.

98. Production control is expensive, but when properly applied it can contribute to the profitability of the plant. The prerequisites are: qualified staff, adequate equipment and economically acceptable standards. Since laboratory findings are not always directly applicable to production on a commercial scale, plant tests on a full commercial scale are important, despite the possible necessity of transporting great volumes of raw materials over long distances for this purpose.

99. Fundamental differences exist between testing methods and quality standards. The former are simply guidelines relating to procedure for obtaining comparable results, whereas the latter stipulate levels and certain characteristics that the product must attain for specific end uses.

100. Quality labels guarantee that specifications have been met and that the product is suitable for certain uses; in developing countries they should be established according to local conditions.

101. In many cases internationally accepted standards are not directly applicable to the needs of the developing countries and their local markets, but they can be taken

as guidelines. The potential end uses of panels manufactured from different agricultural residues depend upon the physical and mechanical properties of these residues.

102. The equipment supplied for panel production from agricultural residues should be comparable in quality to that used by leading panel producers in the industrialized countries.

103. The Group recommended that a model set of conditions be formulated relating to the supply of board-making machinery to developing countries and incorporating the necessary safeguards.

Chapter 7

RECOMMENDATIONS

A. *It was recommended that UNIDO:*

(1) Compile, update and make available to all interested bodies and individuals in developing countries a bibliography of the research relating to agricultural residues and non-wood fibrous material used in panel production;

(2) Convene an expert group meeting on the selection of resins to help overcome the problems facing glue production and utilization, which have limited the introduction and expansion of the panel industries in developing countries;

(3) Consider extending its programme of technical assistance fellowships to key production personnel from panel plants in developing countries so that they might be trained in modern production and process control operations and plant maintenance.

B. *It was recommended that specialized institutes both in the developing and industrialized countries:*

(4) Attach priority to research on cement-bonded slabs in view of their importance in low-cost housing programmes in developing countries where these slabs greatly reduce erection time. The product is felt to be particularly suitable for developing countries because of the simple technology, local availability of practically all raw materials, absence of economies of scale, and the labour-intensive processes involved.

C. *It was recommended that prospective investors and producers:*

(5) Arrange for feasibility studies to be prepared by impartial specialists as the basis of detailed questionnaires supplied by the promotor of the project, containing:

(a) Detailed technical data on the proposed raw material;

(b) Marketing prospects, including those for competitive products;

(c) Socio-economic aspects;

(d) Required infrastructure costs;

(e) Detailed analysis of the performance of the material with respect to the end uses envisaged in the market survey carried out under *(b)*.

(6) Employ the services of an impartial specialist to advise on the preparation of calls to tender, the selection of bids and the setting up of trial runs;

(7) Seek expert advice and assistance from specialized institutes or international organizations whenever appropriate;

(8) Train key technical personnel to ensure the efficient operation of the plant upon opening, since the satisfactory operation of a panel plant from the very outset depends upon the competence of the technologist (who could also be the production manager), and a highly skilled electrician and mechanic;

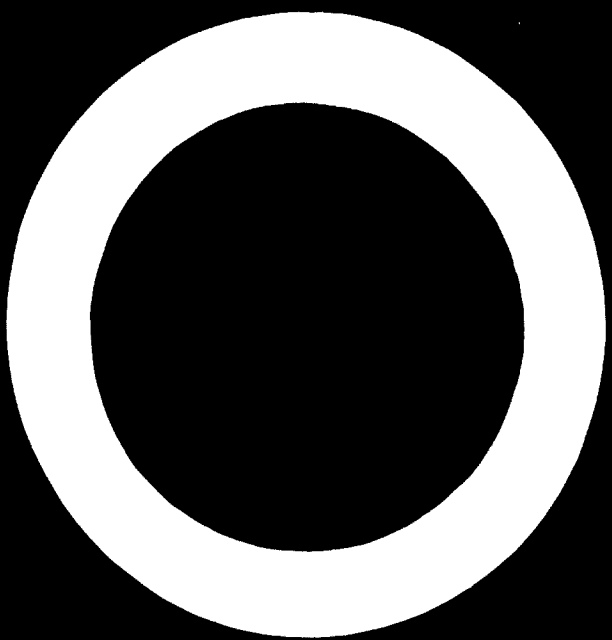
(9) Devote particular attention to process and quality control to ensure the maintenance of standards;

(10) Pay special attention to the training of technical salesmen to promote panels for specific end uses, to advise on correct applications and to prevent the buildup of consumer resistance, which in many cases could be ascribed as much to misapplication of the product as to poor quality;

(11) Endeavour to broaden local building codes and government specifications to include the utilization of locally manufactured panels whenever possible;

(12) Formulate a model set of conditions relating to the supply of board-making machinery to developing countries and incorporating the necessary safeguards.

ANNEXES



Annex I

STATEMENT BY MR. E. G. ROTHBLUM, ASSISTANT DIRECTOR OF THE INDUSTRIAL TECHNOLOGY DIVISION, ON BEHALF OF MR. I. H. ABDEL-RAHMAN, EXECUTIVE DIRECTOR OF UNIDO

UNIDO's essential task is to assist the developing countries in their efforts towards rapid and successful industrialization. Although most of our work consists of technical assistance to various countries in the form of field operations, expert group meetings are one of the means by which UNIDO seeks to carry out its objectives.

Many developing countries are not self-sufficient in wood and wood products; nevertheless they have large quantities of other suitable raw materials, such as agricultural residues and non-wood fibrous materials, which may not be fully utilized.

The purpose of this meeting is to ask you, who are experts in the production of panels from agricultural residues, to evaluate and assess past experiences in this field and to help UNIDO in identifying those materials that could find application in the production of panels in the developing countries. In a broader context, we hope that this will also touch upon the various problems that the developing countries must resolve in order to utilize more fully these potential raw materials, which exist in most countries that are not endowed with forest resources. If suitable substitutes for wood-based products can be identified and as a result new industries can be established, former dependence on imports can be reduced, opportunities for employment created, and the savings in foreign exchange used for further development.

Although many of you present are concerned with applied research in one field or another, we hope that your recommendations will be action-oriented. We also trust that your report will highlight the criteria to be chosen, and recommend the economic prerequisites and the appropriate technology which you believe must be applied by the governmental bodies, the industrialists and entrepreneurs in the developing countries to ensure a successful introduction of new technologies and novel features in this industry.

UNIDO attaches particular significance to the technical and engineering aspects of the subject under discussion. Through meetings such as this, UNIDO hopes to continue its role as a catalytic agent in the transferal of technology from the advanced countries to the developing countries. In this connexion, it must be kept in mind, however, that the large-scale, capital-intensive and sophisticated processes that are increasingly common in industry in the developed countries need to be largely adapted prior to their application in developing countries, where the markets are

usually much smaller and governments are anxious to train many unemployed or underemployed workers. Moreover, there are potentially useful agricultural wastes that exist only in the developing countries, for which technological processes may not as yet have been developed. You may conclude that in assessing market requirements, the quality of the products need not necessarily be the same in the developing countries as is required in the developed countries for some of their more sophisticated end uses; these may not have immediate applicability in developing countries. Developing countries should be aware of the potential pitfalls that they must avoid if they are to successfully introduce the technology of the developed countries; mistakes are especially costly in the early stages of development. Finally, it need not be pointed out that conditions and priorities vary considerably from one developing country to another.

We welcome any recommendations you care to make that would be applicable to our technical assistance programmes and that would accelerate the development of this industrial sector in the developing countries.

It would be premature to anticipate at this juncture the type of recommendations that will emerge from your discussions, or the need for UNIDO's follow-up action. It might be appropriate, however, to emphasize that UNIDO devotes just as much attention to the action resulting from meetings such as this as to the meeting itself. We do not consider these meetings as isolated events, but as starting points for a series of measures within the scope of UNIDO's technical assistance programmes, and I hope that we can continue to count on your support in pursuing follow-up activities.

Annex 2

LIST OF PARTICIPANTS AND OBSERVERS

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Annex 3

AGENDA

1. Opening of the meeting and adoption of the agenda
2. Election of the Chairman and Rapporteur
3. Historical outline of past research on the production of panels from agricultural residues and future trends
4. Economic and technical aspects of harvesting various agricultural residues
5. Technical processes for the production of various types of panels and their adaptation to agricultural residues
6. Problems of marketing and promotion of panels made from agricultural residues
7. Selection and production of adhesives for use with agricultural residues
8. The role and importance of standards and quality control in the development of new products
9. Adoption of the report

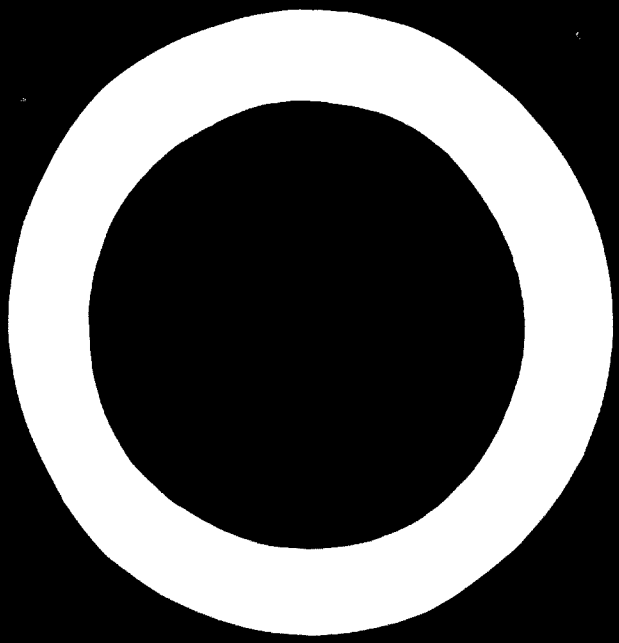
Annex 4

LIST OF DOCUMENTS PRESENTED TO THE MEETING[1]

ID/WG.83/1	Provisional agenda and provisional work programme
ID/WG.83/2 and Corr. 1 and Summary	Historical outline of past research on the production of boards from agricultural wastes and future trends (document prepared by Mr. A. E. Chittenden, Tropical Products Institute, Culham, Abingdon, Berkshire, United Kingdom)
ID/WG.83/3 and Summary	Study of marketing and promotion problems relating to the introduction of panels produced from agricultural wastes into the markets of developed countries (document prepared by Mr. M. de Longeaux, Honorary President, European Federation of Particle Board Producers Association, FESYP)
ID/WG.83/4 and Corr. 1 and Summary	Technical processes for the production of wood-wool/cement boards and their adaptation for the utilization of agricultural wastes (document prepared by Mr. W. Sandermann, Federal Research Organization for Forestry and Forest Products, Reinbek, Hamburg, Federal Republic of Germany)
ID/WG.83/5 and Summary	Particle board from annual plant wastes (document prepared by Mr. M. Mestdagh, S. A. Verkor N. V., Lauwe, Belgium)
ID/WG.83/6 and Summary	The dry process for the production of fibreboard (document prepared by Mr. M. Lepeut, CIFAL, S.A., Paris, France)
ID/WG.83/7 and Corr. 1 and Summary	Standards and quality control for panels made from agricultural wastes (document prepared by Mr. H. Neusser, Austrian Wood Research Institute, Vienna, Austria)
ID/WG.83/8 and Summary	Synthetic resin adhesives: A survey of production, production techniques and world trade (document prepared by Mr. A. G. Seljestad, Norsk Spraengstofindustri A/S, Oslo, Norway)

[1] A limited number of copies of these documents are available upon request in the language in which they were presented. Summaries in English, French or Spanish are also available.

ID/WG.83/9 and Corr. 1, Corr. 2 and Summary	Technical and Economic aspects of bagasse utilization (document prepared by Mr. M. H. Tantawi, Société des Sucreries et Distilleries d'Egypte, Cairo, Egypt)
ID/WG.83/10 and Corr. 1 and Summary	Economic and technical aspects of the utilization of cereal stalks for the production of panels (document prepared by Mr. S. Bulakul, Stramit Board Company Ltd, Bangkok, Thailand)
ID/WG.83/11 and Corr. 1 and Summary	Economic and technical aspects of harvesting cotton stalks for the production of particle board (document prepared by Mr. E. Mahdavi, Gorgon S. A. Gorgon, Iran)
ID/WG.83/12 and Corr. 1 and Summary	Economic and technical aspects of the utilization of flax shives and hemp boon as a raw material for the production of particle boards (document prepared by Mr. A. Frackowiak, Institute for Bast Fibres, Poznań, Poland)
ID/WG.83/13 and Corr. 1 and Summary	Economic and technical aspects of the processing of rape straw into particle boards (document prepared by Mr. W. Kilanowski, Institute for Bast Fibres, Poznań, Poland)
ID/WG.83/14	List of participants
ID/WG.83/15	Report of the expert working group meeting on production of panels from agricultural residues
ID/WG.83/CR.1 and Summary	Production of strawboards by the "Stramit" process (document prepared by Mr. T. J. Mosesson, Tomo Trading Co. Ltd, Uxbridge, United Kingdom
ID/WG.83/CR. 2 and Summary	Some experiences in research and manufacture of panels from agricultural wastes and non-wood fibrous raw materials in Czechoslovakia (document prepared jointly by Mr. K. Eisner, University College of Forestry and Wood Technology, Zvolen; and Mr. A. Travnik, Lignoprojekt, Bratislava, Czechoslovakia)



The following studies on various uses of wood have been published by the United Nations Industrial Development Organization:

ID/10	Production Techniques for the Use of Wood in Housing under Conditions Prevailing in Developing Countries, Report of Study Group, Vienna, 17–21 November 1969
ID/61	Production of Prefabricated Wooden Houses, by Keijo N. E. Tiusanen
ID/72	The Role of Wood as a Packaging Material in the Developing Countries, by B. Hochart

Printed in Austria

Price: $U.S. 1.00
(or equivalent in other currencies)

United Nations publication

71-7106 - March 1972 - 3,650

Sales No.: E.72.II.B.4

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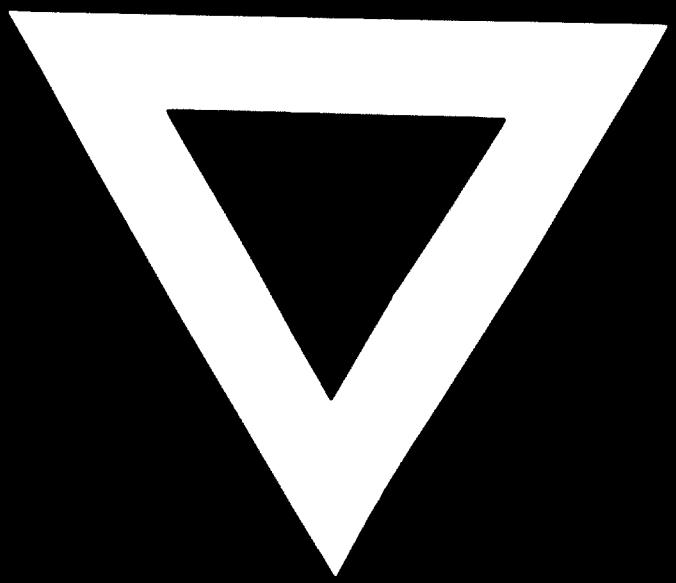

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