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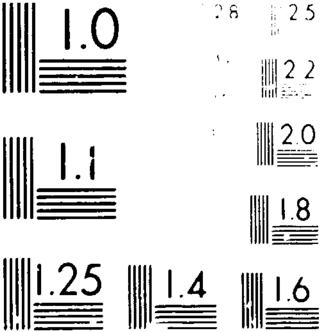

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UNITED NATIONS
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ANNOTATED BIBLIOGRAPHY ON THE UTILIZATION OF AGRICULTURAL RESIDUES AND NON-WOOD FIBROUS MATERIAL FOR THE PRODUCTION OF PANELS*

(1972 - 1979).

by

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* This document has been reproduced without formal editing.

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PREFACE

UNIDO had previously issued, in May 1973, an "Annotated Bibliography on the Utilization of Agricultural Residues and Non-wood Fibrous Material for the Production of Panels" that covered the years 1960 through July 1972 (document no. ID/WG.83/16 by Mr. Hans Augustin). This document was prepared in implementing a recommendation made by the Expert Working Group on the Production of Panels from Agricultural Residues, which UNIDO convened in Vienna from 14 to 18 December 1970.

In 1979, UNIDO commissioned the author of the present paper to update this bibliography. In doing so, several journals have been referred to and authors' abstracts have been made use of. Wherever the original papers were not available, abstracts have been taken from secondary sources.

This bibliography covers the period from 1972 to 1978.. However, a few abstracts for 1971, not mentioned in the earlier bibliography, as well as a few abstracts for 1979 have been included. This bibliography is classified into five main subjects; under each there is a general section followed by sub-sections on various fibrous raw materials. The abstracts in each section are arranged in alphabetical order of the authors' names.

An index is provided for easy location of the abstracts on specific subjects.

A. RESEARCH AND DEVELOPMENT

General

1. Atchison, J.E.
   Agricultural residues and other nonwood plant fibers.
   Science 191, no. 4228: 768-72 (1976).

The author discusses the present and potential uses of sugarcane bagasse, cereal straws and rice straw, bamboo, reeds, papyrus, esparto grass and sabai grass, leaf fibres, and kenaf. Worldwide production of non-wood fibrous materials and present production of pulp from these materials are estimated. Bagasse promises to become the first major non-wood fibrous raw material. Already, several large bleached bagasse pulp mills are either under construction or in advanced planning stages throughout the world. Kenaf and straw fibres will also probably be utilized for pulp and papermaking in the future.

2. Atchison, J.E., and Collins, T.T., Jr.
   Historical development of the composition panelboard industry including use of nonwood plant fibers.
   Tappi C.A. Report no. 67: 29-48 (1976).

The origin and development of various sectors of the composition panelboard industry are reviewed, including insulation board, hardboard, particle board, medium-density fibreboard or fibre-type particle board, thin panelboard, and combinations of standard particles with fiberized material. Growth rates in the production of various composition panelboard products are compared. As a whole this industry is the fastest growing segment of the forest products industry, and within the industry, particle board and fibre-type particle board (medium-density fibreboard) represent the fastest growing sectors of all products being manufactured.

3. Augustin, H.
   Annotated bibliography on the utilization of agricultural residues and non-wood fibrous material for the production of panels. ID/WG.83/16.
   UNIDO Expert Working Group Meeting on the Production of Panels from Agricultural Residues, Vienna, 14-18 Dec. 1970, 108 p.

The same scope and format as this publication.

4. Carruthers, J.F.S.
   A review of current research on panel products.
   Proc. IUFRO - 5th meeting 2: 113-140 (Sept./Oct. 1973).

Research projects being conducted by members of the Panel Products Working Party of IUFRO Division V are listed and outlined by title, location, and subject areas. The latter include raw materials and their effects on board properties; processing factors including bonding and binder selection; and board performance and its assessment.

5. Derveer, P.D. van., and Lowe, L.E., Ed.
Fiber conservation and utilization: Proceedings of the May 1974 Pulp & Paper Seminar, Chicago, Illinois.
San Francisco, Miller Freeman Publications, 1975, 288 p.

Comprises 22 papers on waste paper and wood resources of the US paper industry, including mill experience in pulping whole-tree chips, potential world pulp supply from non-wood plant fibres, mixed tropical hardwoods, tropical plantation woods, generation of energy from wood waste, developments in pulping wood-wastes and wood requirements and resources.

6. Dhamaney, C.P.
Hardboards in India.
Indian Pulp and Paper 28, no.9: 18-22 (1974).

Briefly describes the manufacture of hardboards from ligno-cellulosic wastes, including forest residues, and considers the economic implications in India.

7. Emery, O.
A permanent preoccupation of the paper industry: The supply of raw material.
Cartaio no.2: 25-31 (March/April, 1976) (Ital.).

Agricultural residues (e.g. straw, corn stalks, grape vines, tobacco stalks, etc.) annual plants (reed and genista), and cultivated crops (hemp, sorghum) are discussed as sources of fibre for the paper industry.

8. Fleck, J.N.
Bibliography on fibers and composite materials.
Metals. Ceram. Inform. Cent., MCIC-72-09, 1972, 92 p.

9. Food and Agriculture Organization,
Pulp and Paper capacities, Survey, 1976-1981,
Rome, FAO, 1977, 87 p.

A report on the FAO survey of world capacities with extensive tables of data by country and definitions of the various categories of pulps, papers and boards and their terminology.

10. Guha, S.R.D., and Pant, R.
Fibrous raw materials for the Indian pulp, paper and board industry.
Indian Forester 98, no.7: 409-26 (1972).

This article summarizes work done at the Forest Research Institute (India) on indigenous fibrous raw materials (bamboo, grasses and reeds, wood and agricultural residues) suitable for conversion

into paper and board products in India. The data are tabulated (including references to the experimental work) by species, average fibre dimensions (diameter and length), chemical composition (ash, cellulose, lignin and pentosan contents), pulping method (kraft, soda, mechanical, etc.) pulp yield and products for which the pulp is suitable.

11. Heintze, E.F.
Historical, technical and economic study of fiber-reinforced materials.
Z. Gesamite Textilind. 72, no.2: 163-169 (1970).

The use of engineering and construction materials containing reinforcing fibres during the last 3500 years is discussed.

12. Iyengar, M.S.
Utilization of waste in pulp, paper, sugar, petroleum and agro-based industries.
Chemical Age of India 27, no.12: 1045-51 (1976).

Some of the wastes emanating from the paper, sugar, cement, petroleum and agro-based industries are reviewed and methods suggested for their effective utilization.

13. Jarman, C.G.
Recent research and development in hard fibers.
Shirley Inst . Publ. S28: 99-118 (1977).

Recent developments in the production of hard fibres, particularly sisal, abaca and coir are reviewed.

14. Jetzer, R.
Process for manufacturing a fibrous material from domestic, agricultural, forest, and/or industrial wastes.
Ger. pat. 2,325,056 (Nov. 29, 1973).

A process for manufacturing fibrous material from domestic, agricultural, forest, and/or industrial wastes is based on limited aerobic decay designed to degrade sugars, starch materials, proteins, etc., while avoiding excessive degradation of fibrous material. The fibrous material can be mixed with binder and formed into molded articles.

15. Linlu, L.
Panels, paper and paperboard from agricultural residues.
Unasylva 29, no.118: 12-17 (1978).

Describes the use and the suitability of agricultural residues like bagasse, straw, cotton linters, and flax shives as raw materials for the production of panels, paper and paper boards.

16. McGovern, J.N.
    Expanding sources of natural fibers and resultant pulp quality.
    Tappi 58, no.1: 82-86 (1975).

Reviews changes in the sources of natural fibres for making paper and board in the USA since the turn of the century, when 76% of the furnish was spruce and other species and in recent years, alternative sources of fibres have become increasingly important, e.g. logging residues, whole-tree logging including bark and low-grade hardwoods, sawmill residues, industrial and household waste, non-woody plant fibres and tropical woods. The quality of pulps from these sources is discussed.

17. Madan, R.N.
    Summary of investigations carried out at the (Indian Forest Research Institute's) Cellulose and Paper Branch on suitability of agricultural residues for pulp, paper, and board.
    Indian Pulp and Paper 30, no.4: 15-17, 19-21 (Dec. 1975/Jan. 1976).

The suitability of bagasse, jute sticks, and rice and wheat straw is summarized for the production of pulp (e.g. dissolving pulp), paper (viz. greaseproof, wrapping, writing and printing papers and newsprint), and board (viz. straw, hard, and insulation board).

18. Mohan, D., Rai, M., and Rehsi, S.S.
    Industrial Wastes and building materials.
    UN Seminar on the Use of Industrial and Agricultural Wastes for Low-cost Construction, Puerto Rico,
    Dec. 9 - 13, 1974.

No abstract available. The authors themselves have regretted their inability to supply either the paper or the abstract.

19. Mohan, D., and Singh, S.M.
    Building materials from agricultural wastes.
    UN Seminar on the Use of Industrial and Agricultural Wastes for Low-cost Construction. Puerto Rico,
    Dec. 9 - 13, 1974

India being predominantly an agricultural country produces large quantities of agro-industrial wastes. Rice straw, rice husk, jute sticks, coconut fibre and pith, groundnut hulls, etc., are some of the main agricultural wastes. With the rising cost of petro-chemical based resin binders, it is becoming increasingly uneconomical to use synthetic resin binders in making low cost building boards and sheets from such wastes. Hence the present need is not only to find out effective means of utilization of the agro-industrial wastes but also to develop techniques and materials alternative to the traditional ways of converting these wastes into useful building materials. The Central Building Research Institute, Roorkee (U.P.), India, has worked out several processes of making building boards and corrugated roofing sheets using portland cement and magnesium oxychloride cement as suitable binders. The present paper gives a review of the current R & D work and scope of the development work planned for the future.

20. Murayama, T.
    New Composite plastics.
    Jap. Plast. Age 10, no. 2: 17-23 (1972)

A discussion about plastic-wood laminates and plastic composites with agricultural materials, e.g. straw, chaffs, peanut stalks, and bagasse are described.

21. Niedermaier, F.P.
Technology, engineering, and machinery for manufacturing panelboard from nonwood materials.
Tappi C.A. Report no. 67: 49-66 (1976).

Particle boards made of non-wood materials do not exhibit any essential differences from wood-based boards. They possess satisfactory physical and acoustical properties, as well as good thermal insulation qualities. The technology for gluing, mat forming and pressing is similar to wood based particle boards, although special attention must be given to harvesting, transportation, storage and preservation of the raw materials. Waste materials previously considered of no commercial value can be reconsidered in terms of economical and technologically secure conversion to a valuable product in areas of low forest resources.

22. Regional Research Laboratory, Jammu (India).
Utilization of lignocellulosic wastes.
The Chemical and Polymer Times 6, no.10: 8 . (1978).

A brief write-up on the research carried out at the Regional Research Laboratory, Jammu regarding the utilization of forest wastes and agro-industrial wastes for the production of cellulosic products like fibreboards, straw boards, particle boards, etc.

23. Rudd, G.
Use of waste fiber at the Scandinavian industry foundation.
Tutkinius Tek. no.9: 44-46 (1976) (Fin.).

Waste fibres from the cellulose pulping industry were utilized as additives in cattle fodder, tiles and fibreboard without reduction of quality when fibre content was 5-10%.

24. Singh, S.M.
Agro-industrial wastes and their utilization.
Research and Industry 19, no.4: 159-162 (1974).

In addition to reed, straw, corncob and stalk, many other non-traditional wastes such as coir fibre, coconut pith, groundnut husk, rice husk, jute sticks and bagasse are now obtained in large quantities as wastes from agro-industries. The importance of their conversion into building panels has been stressed. The technological developments in different countries in respect of their processing into various kinds of building boards, blocks and panels are also discussed.

25. Sinha, U.N., Dutta, S.N., Chaliha, B.P., and Iyengar, M.S.
Possibilities of replacing asbestos in asbestos-cement sheets by cellulose pulp.
Indian Concrete J. 49, no.8: 228-232, 237 (1975).

Cement-fibreboards were produced using cellulose pulp instead of asbestos. Compression was necessary in order to meet the Indian strength standards. Variables studied were type of pulp, pulp pretreatment, freeness, and pulp/cement ratio. A 30 tonnes/day plant will soon start producing pulp-cement boards for large scale testing.

26. Soderhjelm, L.
Possible uses for fibrous sludges from the pulp and paper industry.
Paperi Puu 58, no.9: 620-622, 625-626, 629 (Sept.1976).

In Finland the generation of fibrous sludge from treated pulp and paper mill effluents (white water) amounts to ca. 180,000 o.d. tonnes/year which would cost ca. $ 200,000 for land disposal. A major proportion can be or could be recirculated and reused in paper, board, and fibre insulation boards. However, some sludge types are not suitable for recycling. Conversion into animal fodder (silage supplement) and/or soil amendments seems to be an advantageous outlet for low-ash sludges, whereas high-ash sludges may find better use in the building industry, e.g. in bricks, cement tiles, and plastic fillers (to replace wood flour). Additional possibilities include fermentation (of birch- or other hardwood-derived sludge fibres) into xylitol (in ca. 90% yield), other enzymic conversions, oxidation for clay recovery, and incineration a el.

27. Srivastava, J.S.
Wealth from waste.
Yojana 18, no.9: 30-31 (1974).

A review on the utilization of waste materials.

28. United Nations Industrial Development Organization, Vienna.
Information sources on building boards from wood and other fibrous materials.
UNIDO Guides to Information Sources, no.9: 1974, 82 p.

This guide deals with sources of statistics and economic data, basic handbooks, text books and manuals, monograph series, current periodicals (including abstracting and indexing periodicals), proceedings, papers and reports, specialized dictionaries and encyclopaedias, bibliographies, etc., on the subject.

29. United Nations Industrial Development Organization, Vienna. Review of agricultural residues utilization for production of panels, Background Paper no.127, FAO World Consultation on Wood-based Panels, New Delhi, 6-16 Feb. 1975, 8 p.

This paper aims at compiling the information available on agricultural residues useable as raw materials for the production of panels. Twenty five agricultural residues either already used industrially, or on which research work has been carried out are referred to.

30. Vajda, P.
Comparative evaluation of the economics of particle board and fiberboard manufacture.
Tappi C.A. Report no.67: 93-111 (1976).

The manufacturing economics of the well-established UF bonded industrial-grade particle board and the newly-introduced medium-density fibreboard product are compared. The economics of the wet and dry processes for hardboard manufacturing are also compared. Experience with non-wood fibres in the manufacturing of panel products is limited to a few plants scattered throughout the world. In analyzing the suitability of certain non-wood fibres for use in this industry, a number of additional factors must be examined, including the amount of nonfibrous material (such as bagasse pith) which must be separated from the fibres and rejected before the final processing; duration of the harvesting season and feasibility of storing the raw materials for extended periods; as well as the market for such a product in developing countries. The medium-density fibreboard process is thought to have potential for using non-wood fibres as raw material, because non-wood fibres are obtained mostly from relatively small components, such as sugar cane, cotton stalks, or grasses, and would lend themselves more readily to the manufacture of fibres than particles.

31. Vasishth, R.C., and Chandramouli, P.
New panel boards from rice husks and other agricultural by-products. Background Paper no.30, FAO World Consultation on Wood-based Panels, New Delhi, 6-16 Feb. 1975, 12 p.

Agricultural by-products such as rice husks, wheat straw and rye grass are available in abundance and represent a renewable resource. Being fibrous, they are admirably suitable for the production of building materials. Composite boards from rice husk, wheat straw and rye grass can be produced by using 6 to 8% of PF adhesive. Consequently, the economics and commercial production of these boards in rice growing countries like India, Thailand, Malaysia, etc., look very good.

32. Volif, L.A., and Meas, A.I.
Fibers for special purposes.
Moscow, Khiniya, 1971. 223 p.

33. Wnuk, M.
Utilization of forest residues such as leaves, needles and bark in producing particle board.
Holztechnologie 18, no.2: 80-83 (1977) (Ger.).

Report is given on the preliminary investigations on the utility of chips with forest residues such as leaves, needles and bark. Several varieties of boards were produced in the laboratory as well as in the industry. The properties obtained justify the continuation of the research work. An improvement in the property seems possible by debarking the chips.

34. Wood and plant materials.
Science 191, no.4228: 747-776 (1976).

A section of a special issue on materials (with particular reference to USA) contains 6 articles, one article by Atchison, J.E. is on agricultural residues and the other five on non-wood (including bamboo) plant fibres.

Abaca

(see abstract no. 13)

Bagasse

(see also abstract no. 1; 15; 17; 20; 24)

35. Egre, D.
Will sugar cane from Provence become a source of raw material for the French paper industry!
Rev. Forest. Franc. 28, no.2 : 139-147 (1976). (Fr.)

A discussion is presented on the potential of bagasse from sugar cane grown in Provence as a source of fibre for the French paper industry.

36. Ishizawa, S.
Bagasse & Paper: part 1.
Kako Gijutsu 18, no.4: 1-5 (1977). (Jap.)

A review paper.

37. Smith, W.W. Jr.
History and description of current (bagasse fibreboard) operations of Tablopan de Venezuela, (S.A.)
Tappi C.A. Report no.67: 87-91 (1976).

The formation of Tablopan de Venezuela in 1958, and the operation of a pilot plant in 1959-1960 made it clear that high, medium, and low-density bagasse fibreboard could be manufactured economically with a dry process. Tablopan's industrial operation began in 1964. Yearly sales approximated only $ 1,500,000 until 1972, but reached nearly 56 million by 1975, due to increased prosperity in Venezuela and a growing shortage of wood, and the company purchased a second line. Bagasse processing offers good economic incentives to sugar producing countries in which there are small but growing markets for board products, and consequently where flexibility is required in the range of products to be manufactured. If a wood shortage exists in the cane-growing areas, the prospects for a successful bagasse board industry are enhanced.

38. Van Sickle, C.C.
Raw materials for wood-based panels produced in North America. Background Paper no.76, FAO World Consultation on Wood-based Panels, New Delhi, 6-16 Feb.1975, 9 p.

Wood raw material for panel products totalled more than 60 million cubic meters in 1972. Roundwood supplied 82% of the wood used, industrial residues supplied the remainder. Non-wood fibres are obtained mainly from waste paper. Sugar cane bagasse and other vegetable fibres are used in small amounts.

39. Vo Tong, X., and Samaniego, R.
Recent advances in the utilization of sugarcane bagasse.
Sugar News 46, no.7: 276-278, 284-289 (1970).

Work done during last ten years is reviewed.

40. Wright, C.
Bagasse - no longer a health risk.
Board manufacture 13, no.12: 149-154 (1970).

Deals with chemical composition, problems of fermentation and health hazard. Discusses how the problem of bagassosis is overcome by the major technical development carried out by Bahre-Bison Gretenwerke in which full-scale production has been confirmed in the stabilization of bagasse for particle board and fibreboard plants.

Bamboo

(see also abstract no. 1; 10; 34)

41. Meshramkar, P.M.
Solid waste from wood and bamboo as an asset for profitable uses.
Indian Pulp Paper 28, no.10-11: 11-15 (April-May, 1974).

The utilization of sawdust, bamboo dust, bark, and related fibrous wastes for various purposes (pulping, insulation and particle boards, fertilizer, cattle fodder, fuel, chemicals, drilling muds, pesticides, filter media, detergents, absorbents, plastic filters, etc.), is reviewed.

Coconut husk and coir

(see also abstract no. 13; 24)

42. Grimwood, B.E.
Coconut palm products: Their processing in developing countries.
FAO Agricultural Development paper,
Trop. Prod. Inst. London, U.K. no.99: xviii + 261. (1975).

A comprehensive handbook, with contributions from different authors. Includes chapters on utilization of coconut husk, shell, products from coconut palm sap and coconut wood processing and utilization.

43. Samuel, J., and Thomas, M.S.
Small scale processing and engineering research needs of selected agricultural crops in Kerala; Part I - A review on coconut palm.
Seminar on Post-Harvest Technology, College of Horticulture, Vellanikara, Trichur, 20 - 21 Oct. 1978.

Small-scale processing of coconut and its main products including coir boards from coconut husks are briefly reviewed.

44. Singh, S.M.
Corrugated roofing sheet and building panel from coir wastes.
Coir: 4 p. (April 1975).

Shearing waste and other coir wastes such as pith account for a huge amount of industrial waste. Experiments have shown that it is possible to make large size building panels and corrugated roofing sheets from these wastes. The physical and chemical properties of the coir fibre and the composite panels obtained are reported. Also outlines the method of preparation of composite panels like coir-rice straw and coir-pith panels.

45. Tamolang, F.N.
The utilization of coconut trunk and other parts in the Philippines.
NSDB Technology J. 1, no.2: 36-48 (1976).

A summary of research at Forest Products Research & Industrial Development Commission (FORPRIDECOM) on utilization of Cocos nucifera (primarily the stems). The results (tabulated) show that although the hard outer stem layer is sufficiently strong for sidings, flooring and other structural uses, the core is not (but is being tried for picture frames, etc.). Other suggested uses of stem are for pulp and paper, particle board having optimum strength when combined 50:50 with wood particles.

Cornstalks and corncobs

(see abstract no. 7; 24)

Flax

(see also abstract no. 15)

46. Verbestel, J.B.
Raw materials other than wood for the manufacture of panels.
Background Paper no.20, FAO World Consultation on Wood-based Panels, New Delhi, 6-16 Feb. 1975, 15 p. (Fr.)

The residue of certain industrial plants cultivated in large masses in several countries can be advantageously employed in place of wood in the manufacture of particle board. These plants constitute a seasonal and renewable source of raw material. Belgium has been making panels from flax shives since 1948. Some examples are given to illustrate specific panels based on annual plants.

Grasses

(see also abstract no. 1; 10; 31)

47. Jain, N.C., and Mehra, M.L.
Hardboards from spent rosha grass (Cymbopogon martini Var. Motia).
IPIRI Journal 4, no.2: 78-80 (1974).

Rosha grass occurs sporadically in forest areas in several parts of India. After extracting the oil, the spent grass does not find any special use except as fuel. As such it was considered that if this raw material is found suitable for hardwood manufacture, it may be possible to put this to a better use. This paper reports the results of work done on the possible use of spent rosha grass as a raw material for hardboard.

Hemp

(see abstract no. 7)

Jute sticks

(see also abstract no.17; 24)

48. Bandopadhyay, S.B., and Sanyal, A.K.
Waste jute-stick has many industrial uses.
Indian Eng. 23, no.12: 31, 35 (1974).

Reviews the availability of jute sticks and related agricultural raw materials in India and discusses the scope of their utilization for pulp and paper and board industry.

49. Sengupta, S.R.
Scope for development of jute shellac composite products.
Jute Chronicle 8, no.6: 11[illegible]-114 (1973).

Exploratory work at the Indian Jute Industries Research Association indicated that boards from jute-shellac could be prepared. If the water resistance and heat resistance are improved, they can be compared in physical, chemical and mechanical properties with synthetic resin bonded boards.

50. Sengupta, S.R.
Jute-shellac board - a solution to many substitution problems in packaging.
Chem. Age India 27, no.5: 470-474 (1976).

A review paper.

Kenaf

(see also abstract no. 1)

51. Atchison, J.E., and Collins, T.T. Jr.
World wide developments in Kenaf.
Tappi C.A. Report no.67: 15-27 (1976).

A technical literature search on kenaf has uncovered more than 1000 references, of which almost 200 (in the period 1950-1976) dealt with the use of kenaf for paper pulp. In addition to listing the various research organizations and companies involved in studies on kenaf pulping and composition panel board in the USA, this paper presents a general overview of the publications covering these investigations which have been carried on in other parts of the world.

52. Ito, K.
Kenaf, a new pulping material.
Kami pa Gikyoshi 30, no.4: 195-201 (1976). (Jap.)

A review paper giving different applications of the material.

Palm stems and leaves
(see also abstract no. 45)

53. Peh, T.B., Khoo, K.C., and Lee, T.W.
Pulping studies on empty fruit branches of oil palm (Elacis guineensis Jacq).
Malaysian Forester 39, no.1: 22-37 (1976).

Papyrus

(see abstract no. 1)

Peat

54. Bel'kevich, P.I., Gaiduk, K.A., Chistova, L.R.
New trends in the utilization of peat.
Zh. Fiz. Khim. 46, no.12: 3004-15 (1972). (Russ.)

The peat resources of the Soviet Union constitute 62% of the world's resources, and the rational utilization of this natural material is an important problem to be solved. The traditional use of peat as fuel has been largely discontinued in favour of more economical energy sources. In order to develop methods for an efficient utilization of this complex material studies are needed on the composition of peat and its mechanical and physical properties. Such studies, in addition to their practical interest also contribute to the knowledge of the process of carbonization of organic materials. Extensive studies of peat are being conducted at the Peat Institute of the Beloruss. Akad. of Sci., and include the kinetics of p thermolysis, its ion-exchange properties as well as the i trial utilization of the peat components. These studies summarized and some of the most interesting results obtained are discussed.

Reeds

(see abstract no. 1; 7; 10; 24)

Rice husk

(see also abstract no. 24; 31)

55. Columbia Engineering International Ltd., Vancouver, Canada.
Preliminary cost study of rice husk composite board plants.
Cor Tech 2: 39 (1972).

56. Datta, R.K., and Dass, K.
Use of rice husk in building materials.
Seminar on Rice Mill Modernization, East India Rice Mills Assoc., Calcutta, Sept. 22, 1974.

57. Stackman, M., and others.
Rice hull utilization.
Final Report, URS Research Co., California, Sept. 1970.

58. Vimal, O.P.
Utilization of agro-industrial by-products: Part I - paddy husk.
Research and Industry 20, no.3: 113-120 (1975).

This paper presents a broad spectrum of the wide range of uses to which paddy husk can be put. Efforts towards its utilization will not only pay rich dividends to the rice miller, but also be instrumental in providing abundant supplies of raw material for the production of a wide variety of new products.

<u>Sisal</u>

(see abstract no. 13)

<u>Sorghum</u>

(see abstract no. 7)

<u>Straw</u>

(see also abstract no. 1; 7; 15; 17; 20; 24; 31)

59. Hernadi, S., and Lengyet, P.
Utilization of short-fibered materials in the Hungarian paper industry: Experimental investigations and their industrial evaluation.
Papiripar 21, no.1 : 1-7 (1977). (Hung.)

The progress made over the past 25 years in supplying raw materials to the Hungarian paper industry is reviewed. Research on the paper-making utilization of rice and wheat straws and of domestic hardwoods is summarised, and commercial-scale experience with mixed hardwood pulping (by the NSSC and kraft processes) is reported. The sheet properties of hardwood corrugating medium, and the papermaking behaviour (filler retention, beatability, etc.) of hardwood pulps are indicated.

60. Komorowska, H.
Suitability of rice straw for pulp production.
Przegl. papier 27, no.4: 127-131 (1971). (Pol.)

61. Rexen, F.
Straw as an industrial raw material.
Sol. Energy Agric. Jt. Conf., 1976,
UK Sect. Int. Sol. Energy Soc., London, 38-43 (1977).

The utilization of straw in the production of pulp, particle board and proteins is discussed.

62. Roth, L.
Papermaking materials: 1 - Cereal straws.
IPC (Appleton) Bibl. Ser. no. 171, Suppl. III:
63 p. (1975). $ 10.00.

Coverage of the pertinent literature (via abstracts, annotations, and index entries) in this continuing series of bibliographies ranges from ca. 1967 through 1974.

Tobacco waste
(see abstract no. 7)

B. MORPHOLOGICAL CHARACTERISTICS AND CHEMICAL COMPOSITION

General

63. Chakraverty, A.C.
Swelling behaviour and comparative porosity of some vegetable textile fibers at different moisture regains.
Textile Res. J. 41, no.4: 318-21 (1971).

The volumetric swelling of jute, mesta, sunn, sisal, manila, ramie, and flax plant fibres at different moisture conditions was studied. Although the fibres contain different amounts of cellulose, hemicellulose, and lignin, a simple mathematical expression relating volumetric swelling to moisture regain was obtained in all cases. The porosity of the fibres, as established from their apparent density and true density (determined in a density-gradient column), indicated that those having high cellulose content were less porous than those with high noncellulosic contents. Respective porosities of the fibres did not change significantly with increasing swelling.

64. Chow, P., Walters, C.S., and Guiher, J.K.
Specific gravity, bulk density, and screen analysis of midwestern plant-fiber residues.
Forest Prod. J. 23, no.2: 57-60 (Feb. 1973).

Plant residues (hardwood bark, sawdust, and shavings; oak cooperage waste; corncobs and stalks; sunflower seed coats; commercially prepared aspen and southern pine furnishes; and Douglas-fir bark mulch) were refined for use as panel board furnishes.

In general hammermilled furnishes and those processed in a Bauer steam pressurized refiner were 2 to 4 times and 4 to 14 times, respectively lighter than the unrefined solid residues. The specific gravity of an unrefined residue was not always a good indication of bulk density of the refined material. Hammermilling produced uniformly granular particles more suitable for agricultural or horticultural uses (e.g. mulch, growing media, livestock bedding) than for panel boards. The Bauer refiner produced bulky and fibrous materials from the plant residues that were suitable for the manufacture of panelboard products. Even particles of relatively short length (sawdust, shavings, bark, and corncobs), when processed in a Bauer steam pressurized refiner, yielded a fibrous furnish.

65. Escolano, E.U.
Proximate chemical composition of agricultural fibrous materials and its significance.
FORPRIDECOM Tech. Note no.129: May, 1973, 4 p.

The ash, silica, lignin, holocellulose, alpha-cellulose, pentosans, and extractives (alcohol-benzene, hot-water, and 1% NaOH) contents of abaca, Agave and Furcraea fibres, banana fibres, sugar cane bagasse, and coconut palm are tabulated. The suitability of these agricultural crops for paper making is discussed.

66. Gonzales Flores, M.D., and Vazquez Garcia, M.A.
Comparative study of fibers from annual plants with regard to their use in the paper industry.
Sobre Deriv. Cana Azucar (Rev. ICIDCA) 9, no.2: 9-17 (May/Aug. 1975). (Span.)

Bagasse cane residue, tobacco stalk, banana stalk, and kenaf fibres were compared as papermaking raw materials, using as a reference the chemical and morphological properties of woods commonly used by the pulp and paper industry. Bagasse fibre is similar in length to wood fibre, but the length diameter ratio of bagasse is greater, thus making it more flexible. Cane residue fibres are short and thin, and not acceptable for paper. Pulp, cellulose, lignin and pentosan contents of cane residues are lower than in bagasse, but ash content and solubility in hot and cold water and in 1% NaOH are higher. The fibrous part of tobacco stalk is suitable for papermaking, but the bark and pith have inferior properties. Large fibres are found in the petiole of the banana plant, which part is of greatest industrial interest, but such fibres also have a high moisture content. Kenaf pith has acceptable chemical and morphological properties for the production of high-quality pulp, but the woody part has a different structure and is not suitable. Data gathered for the study are tabulated.

67. Jetzer Engineering AG.
Improvements in and relating to the recovery of fibers from waste material.
Brit. pat. 1,448,123 (Sept. 2, 1976).

This process for recovering fibres suitable for forming into structural panels from wastes, etc., is similar to that described in Ger. pat. 2,263,974 (July 4, 1974) and French pat. 2,211,291 (July 19, 1974).

68. Joshi, V.S., and Basu, S.
Kinetic studies on the delignification of cellulosic raw materials during pulping processes.
Chem. Age India 22, no.2: 49-55 (1971).

Rice straw, bagasse and bamboo were subjected to pulping by the sulfate and soda processes and in all cases delignification increased with cooking time and temperature following a pattern of bulk delignification and residual delignification and giving curves from which first order reaction rate constants were calculated. Pulping at more than 120°C and by the kraft process was uneconomical for rice straw and bagasse while for bamboo 140°C for more than 3 hours was necessary to obtain pulp.

69. Khan, A.H., Hashmi, P.K., and Khan, K.A.
Studies on some chemical characteristics of jute, flax, cotton and other vegetable fiber as related to cellulose contents and fineness under different treatments.
Pakistan J. Sci. 20, no.5-6: 198-213 (1968).

The effect of spacing, fertilizer and growing season on the chemical characteristics, e.g. hydrolysis, nitration, carbonation and acid purification, of various plant fibres was investigated. Hydrolysis values ranged from 20.630-35.863% with sunn hemp having the lowest value and ramie the highest. Spacing effects were highly significant at flowering and seed maturity stages, while fertilizer effects were significant at flowering stage. Nitration values ranges from 114.880-140.270% with flax having the lowest value and sunn hemp the highest. The chemical characteristics were directly associated with the cellulose content and fineness in fibres. The higher the values of the chemical characteristics the finer the fibre and the higher the cellulose content.

70. Kim, U.G., and Pak, C.H.
Pulp-forming characteristics of some monocotyledonous plants.
Choson minjujuui Inmin Konghwaguk Kwahagwon Tongbo 24, no.3: 137-141 (1976). (Korean).

Chemical composition, yield reactivity in xanthation, and crystallinity of sulfate pulps from two reeds, straws of sugar cane and corn, and two bamboos were compared with those of fir pulp.

The plant pulps showed higher reactivity in xanthation than for pulp, but the filterability of viscose from the plant pulps was inferior to that of the fir pulp and the plant pulps had a smaller crystallite size.

71. Louden, L.
Pulping of bagasse and other papermaking fibers.
IPC (Appleton, Wis. 54911) Bibl. Ser. no. 270, 1976, 123 p.

This supplement to special bibliography S41 (1970) cites literature published from 1970 to 1975 on the structure, chemical and physical properties, and papermaking characteristics of non-woody fibres, including, abaca, bagasse, bamboo, banana, corn and cotton plant residues, grasses, kapok, legumes, oat hulls, okra, palm, papyrus, reed, sisal, sorghum, tobacco, and similar plant fibres.

72. MacDonald, R.G., and Franklin, J.N., Ed.
Pulp and paper manufacture, Vol.II - Control of secondary fiber structural board coating. 2nd ed.
New York, McGraw Hill Book Co., 1969, xiii + 542 p.

It deals comprehensively with sources of pulp other than wood, and analysis, testing of materials, processes and products other than paper. Chapter 1 includes a section on the world distribution, description and silvicultural characters, availability and procurement, chemical composition and pulping of bamboos, with tables summarising the dimensional characteristics of 31 species and the chemical composition of 53.

73. Moiseev, B.N., Marshak, A.B., Burova, T.S., Sukhova, L.A., and Vinogradova, N.M.
Pulp for the production of roofing board.
USSR pat. 465,458 (March 30, 1975).

The fibrous materials used for the manufacture of roofing boards consist of the following (in wt.%) rag pulp, 30-40; waste paper, 30-40; and pulp from guza-paya (cotton stems and bolls) obtained from a pH 4-9 solution, 20-40.

74. Namazov, M.B., Razikov, K. Kh., and Usmanov, Kh. U.
Structural features of flax, ramie, and kenaf fibers studied by electron microscopy.
Uzbek. Khim. Zh. 16, no.1: 23-7 (1972). (Russ.)

It has been previously reported in the literature that EM studies of flax and ramie fibres which have been treated with base showed that with increasing alkali concentration the fibrillar elements of the fibre structures became more distinct. In this paper the results are given of a study of the surface and the fibrillar and dense zones of flax, ramie, and kenaf fibres before and after various treatments. Fibres were boiled for 3 hours with NaOH. Two-state carbon-polystyrene replicas were made for studying surfaces and fibrillar zones, as well as the dense zones of microfibrils hydrolyzed with 11% sulfuric acid. The methods used were previously described. The photomicrographs of the treated and untreated fibres indicated that the ramie and kenaf fibres are more resistant to treatment with alkali than the flax fibres. The assumption can be made that there are more non-cellulosic materials in ramie and, especially kenaf fibres than in flax fibres, which envelope the structural elements such as microfibrils, fibrils, and their layers, thereby increasing their stability. The study of the fibres before and after treatment with alkali under identical conditions showed differences in their microstructures. The greatest changes were observed in the case of flax fibres. This is probably due to the relatively lower content of non-cellulosic materials in flax and the considerable elimination of these materials as a result of the alkali treatment.

75. Schliefer, K.
Natural cellulose fibres.
Ullmanns Encykl. Tech. Chem.,
4th ed. 247-253 (1975). (Ger.)

The chemical constitution, morphology, microstructure, physical properties and processing of cotton, raffia, flax, hemp and jute fibres are reviewed.

76. Teixeira de Carvalho, W.A., Berson Rousseau, S., and
Britto Persira, C.E. de.
Influence of pectinic acids on the characteristics of cellulosic cells.
Papel 34: 31-46 (Jan. 1973). (Port.)

Infra Red spectrophotometry, beating and sheet-formation studies were conducted on fibres of cotton and eucalyptus as well as on pulps of pine, sisal, hemp, and various other fibrous plants. The IR spectrophotometry showed a characteristic absorption band in the region of 1725 - 1750 cm^{-1} with a clearly defined peak at 5.75-5.80 μm, for the pectocellulosic fibres. This included the fibres of the palm Astrocaryum vulgare as well as of the fibrous plant Neoglaziovia variegata. Due to the pectocellulosic nature of the fibres, pulps of these materials exhibited excellent beating and sheet-formation characteristics compared to those of cotton and wood.

77. Toor, F.D., and Din, M-U.
Pulping stability of various fibrous raw materials of West Pakistan.
Pakistan J. Sci. Ind. Res. 16, no.5: 202-209 (1973).

The properties and suitability of pulps obtained from wheat and rice straw, sugar cane bagasse, cotton linters, kahi, Chloris gayana, Panicum antidotale, Lasiurus hirsutus, Eragrostis megastachya, Sorghum alnium, Cenchrus setigerus, Arundo donax, Diplachina fusca, kenaf, pine, poplar, spruce and paper mulberry are discussed. Kenaf gave the best pulping results of the 14 non-wood fibrous materials investigated as a replacement for unbleached kraft pulp and bleached sulfate pulp.

78. Usmanov, Kh.U., Razikov, K.Kh., Namazov, M.B., Taspulatov, Yu. T., Gitel'makher, M.I., Adylov, A.A., and Soidaliev, T.S.
Structural changes in bark fibres during physico-chemical treatment.
Zh. Prikl. Khim (Leningrad) 47, no.10: 2301-5 (1974). (Russ.)

Flax, kenaf and ramie bark fibres, treated with sodium hydroxide showed changes in supramol. structure, and the X-ray diffractograms and infra-red spectra agreed well with data obtained by electron microscopy. Biological finishing process of the fibres was replaced by chemical treatment with 18% NaOH, and an increase in the thickness of the microfibrillar layer from 200 to 250-300 Å was observed. The X-ray and infra-red spectral data were used for calculation of the degree of crystallinity and the surface area of absorption lines of OH groups of the examined fibres.

79. Weiner, J., and Roth, L.
Papermaking materials. (2) Bast fibers.
IPC (Appleton, Wis.54911) Bibl. Ser. no.176, Suppl. 3, 1973, 61 p.

The morphology, pulping, paper making and other properties of flax, hemp, sunn, ramie, jute, kenaf, sisal, and related bast fibres are covered in this annotated and indexed bibliography which surveys the literature from ca. 1967 through 1972.

Abaca

(see also abstract no. 63; 65; 71)

80. Escolano, J.O., and Villanueva, E.P.
Abaca (Musa textiles) for pulp and paper.
FORPRIDECOM Tech. Note no.140, April 1974, 3 p.

Abaca, better known as Manila hemp, is a perennial plant belonging to the banana family. Its fibre is the world's best cordage material due to its durability and resistance to salt water. A description is given of the abaca plant and the decreasing use of abaca fibre for cordage due to the introduction of synthetic rope-making materials is pointed out. It is suggested that this material be utilized as a raw material for pulp and paper production. Potential uses in other areas are discussed.

Agave

(see abstract no. 65)

Bagasse

(see also abstract no. 65; 66; 68; 70; 71; 77)

81. Bambanaste Mitrani, R., and Lorenzo, C.M.
Influence of cane varieties on the production of high yield pulp.
Sobre Deriv. Cana Azucar (Rev. ICIDCA) 8, no.3: 16-25 (Sept./Dec. 1974). (Span.)

Fibre and pith content, particle size distribution, fibre dimensions, and fibre chemistry of bagasse, and physical, mechanical, and optical properties of pulps prepared from the main varieties of sugar cane were analysed to determine the influence of cane variety on the production of high-yield pulps. (Experimental data are included). Because significant differences were noted only in particle size distribution, high-yield pulps of good quality can be prepared from all of the principal cane varieties proposed for the development of the Cuban industry.

82. Battle, E., Rodriguez, N., and Suarez, J.
Influence of storage methods on the properties of bagasse fiberboards. (1) Effect of storage time on chemical composition and morphology of bagasse bales.
Sobre Deriv. Cana Azucar (Rev. ICIDCA) 8, no.3: 9-15 (Sept./Dec. 1974). (Span.)

The variations in the chemical composition and morphology of bagasse stored for 12 months are analyzed. Under ideal storage conditions, the chemical composition was slightly altered, but the bagasse became a practically stable material within the storage period. Alpha-cellulose, holocellulose, and lignin contents increased in the first seven months, then decreased slightly. Besides storage time, depithing also seemed to affect the length of elemental fibres; fibre length varied with the equipment used and the humidity at which depithing was accomplished.

83. El-Ashmawy, A.E., El-Kalyoubi, S., and Fahmy, Y.
Hemicelluloses of bagasse and rice straw.
Egypt J. Chem. 18, no.1: 149-56 (1975).

Holocellulose was prepared from extractive-free bagasse and rice straw with a AcOH-NaCl mixture. The holocellulose was then extracted with 100% deoxygenated NaOH at room temperature for 20 hours. The extract was adjusted to pH 4.5-4.7 with 5% AcOH and PRt (hemi-cellulose fraction A) was collected by centrifugation. To the supernatant was added 3 vol. of 95% EtOH and PRt was collected (hemicellulose fraction B). The rice straw hemicelluloses contained 70% pentoses. The pentose content was 70 and 80% for rice straw and bagasse hemicelluloses. The hemicellulose fraction A was richer in pentoses than the fraction B. All the hemicellulose fractions contained xylose, arabinose and glucose. Galactose was found only in the fraction B. Xylose was the major sugar in all the hemicelluloses.

84. Espinosa, J A., and Battle, E.
Study of the influence of new Cuban cane varieties on the pulp and paper industry.
Indian Pulp Paper 26, no.10: 149-154 (April, 1972).

The papermaking qualities of 5 varieties of Cuban sugar cane bagasse were studied. They varied only slightly. Among chemical characteristics, cellulose content varied from 47 to 50%, pentosans from 25 to 27%, lignin from 20.13 to 21.58%, and ash content between 0.78 and 3.22%. Fibre length ranged from 0.96 to 1.40 mm, and the length per unit weight from 1.38 to 1.87 mm. Accordingly, no significant differences were observed in the properties of paper pulps from these five varieties.

85. Jacopian, V., and Paul, D.
Morphological studies on bagasse and its decomposition products.
Faser forsch. Textil tech. 23, no.10: 446-447 (1972). (Ger.)

A layering of the secondary walls of the sclerenchyma of bagasse is observed by electron microscopy, in contrast to the homogeneous secondary walls observed in wood cells. Prehydrolysis of bagasse with refluxing 0.5% HCl removes most of the pentosans but little of the lignin. Digestion of unhydrolysed bagasse in 5% NaOH at 160° causes extensive delignification and removes part of the pentosans.

86. Mussi, F.
Bagasse, an important raw material for satisfying national needs.
Papel 31: 33-56 (Aug. 1970) (Span.)

The properties and possible applications of bagasse are reviewed.

87. Ocampo Suarez, G., and Calderin Moser, A.
Fine structure of sugar cane bagasse, Part-I.
Cuba Azucar: 8-14 (Jan./March, 1973). (Span.)

EM studies are presented of the fine structure and morphology of bagasse fibres and parenchymatous cells. Modifications in the fibre fine structure as a result of elimination of hemicelluloses through aqueous prehydrolysis and as a result of elimination of lignin through the action of sodium chloride or sulphate cooking are shown.

88. Paul, D., Jacopian, V., Menninger, H., and Heinrich, G.
Investigation of morphological changes of bagasse during neutral sulfite pulping by means of scanning electron microscopy and porosimetry.
Zellstoff Papier 25, no.3: 74-76 (March 1976). (Ger.)

High pressure mercury porosimetry and scanning electron microscopy were used to evaluate morphological changes in bagasse during neutral sulfite pulping. Bagasse appears relatively compact before depithing, but the void volume is increased by mechanical depithing. The total void volume decreases with time of cooking. It may be that dissolution of the interfibrillar material causes the fibrils to draw together, thus decreasing the volume.

89. Scheiff, J.M.
Bagasse pulp.
Papeterie 94, no.6: 488, 491-4 (June, 1972). (Fr.)

This review of the manufacture of pulp from bagasse covers the chemical composition of bagasse, its use in the manufacture of fibreboards, and its use in the manufacture of paper pulp. Pulping processes are outlined along with yields obtained. Preparation and depithing of bagasse prior to pulping is also mentioned.

Bamboo

(see also abstract no. 68; 70; 71; 72)

90. Austin, R., and Ueda, K.
Bamboo.
New York, John Weatherhill, 1977, 215 p.

This lavishly illustrated book comprises an introductory section on the lore and versatility of bamboo, a 170-page section entitled bamboo; its beauty and uses; and a short account of the growth and cultivation of bamboo, giving information on planting methods, garden and industrial cultivation and special techniques such as bonsai and production of square bamboo. Information is tabulated on 12 sympodial species suitable for tropical and sub-tropical zones and 13 monopodial and intermediate species for temperate zones.

91. Azzini, A.
Influence of dimensions of chips of Bambusa vulgaris schrad on the yield, rejects percentage, kappa number, and brightness of pulp obtained by the sulfate process.
Papel 37: 125-137 (Dec. 1976). (Port.)

A study of the influence of chip dimensions in the sulfate pulping of bamboo showed that the best results in terms of pulp yield, rejects content, kappa number, and brightness were obtained using chips of 6.0 x 0.8 x 0.6 cm (range studied: length, 1.5-6.0 cm; width, 1.2 cm; thickness, 0.2-1.0 cm). Within the range of chip dimensions studied, chip length did not influence pulp rejects content or brightness. Highest rejects and minimum brightness were obtained using chips 1.2 cm wide and 1.0 cm thick. The highest kappa number resulted with chips of 6.0 x 1.2 x 1.0 cm. Data are also presented on density, void volume, fibre dimensions, and chemical composition of the bamboo.

92. Chunwarin, W.
Culm structure, composition and properties of three Thai bamboos.
State Univ. New York College Envir. Sci. Forestry, Ph.D. Thesis, 1975, 208 p.

The anatomy, cell-wall ultrastructure, distribution of chemical constituents in the cell wall, and some physical properties (specific gravity, swelling, sorption isotherms, and electrical resistance) of internodes from the central portion of Bambusa arundinacea, Dendrocalamus membranaceus and Thyrsostachys siamensis were assessed.

The anatomical features of the epidermis were of more value for identifying the three species of bamboo than the fibrovascular bundles. The ground tissue (or parenchyma cells) which fill up to about 70 per cent of the tissue of the internode culm wall store nutrients such as starch granules, etc. However, vascular bundles become progressively smaller in size and denser towards the periphery.

The variation in anatomical structure and physical properties within and among species were inconsistent. Although the sorption isotherms and the electrical resistivity of bamboo in general are similar to those of wood, the culm anatomy, ultrastructure of fibre and parenchyma walls, and the distribution of chemical constituents in the cell wall are entirely different from those of wood.

93. Espiloy, Z.B.
Some properties and uses of bamboos.
Forpride Digest 1, no.4: 6-7 (1972).

Includes a list of 19 erect-growing and 13 climbing species of bamboo grown in the Philippines. The most popular and useful species is the erect, thick-walled Bambusa blumeana.

94. Grosser, D., and Liese, W.
Anatomy of Asian bamboos, with special reference to their vascular bundles.
Wood Sci. Technol. 5, no.4: 290-312 (1971).

The results of an extensive comparative study of the anatomy of 52 bamboo species from India, Pakistan, Thailand, Indonesia, Philippines, Taiwan, and Japan are presented. Characteristic features are described and an identification key is presented.

95. Ku, Y.C., and Chiou, C.H.
Fiber morphology and chemical composition of important bamboos in Taiwan.
Taiwan sheng lin yeh shih yen so Ho Tso Pao Kao Chung-Kuo Nung Ts'un Fu Hsing Lien Ho Wei Yuan Hui Ho Tso. 20, 1972, 8 p.

Morphology and chemical composition of 6 species of bamboo (Phyllostachys makinoi, Sinocalamus latifloras, Bambusa stenostachya, Leleba dolichoclada, Phyllostachys edulis, Leleba oldhami and Bambusa beecheyana) were examined. Samples were prepared in accordance with TAPPI standards for moisture content, ash, hot water solubility, 1% NaOH solubility, alcohol-benzene solubility, ether solubility, pentosans, and lignin. The Wise method was used for holocellulose and alpha-cellulose.

96. Latif, M.A.
Vegetable fibrous raw materials for pulp and paper industries in East Pakistan.
Forest-Dale News 1, no.4: 10-26 (1969).

Fourteen hardwood species, 3 mangrove species and 7 species of bamboo that may be of use for pulping are studied and their chemical composition is given.

97. Lie, S.C.
Site and growth of important bamboo plantations in Taiwan. (4). Long-branch bamboo (Bambusa dolichoclada Hayata), thorny bamboo (B. stenostachya Hackel), and green bamboo (B. oldamii Munro).
Bull. Taiwan Forestry Res. Inst. no.243: 38 p. (Feb., 1974). (Chin.)

98. Liese, W., and Grosser, D.
Studies on variability of fiber length in bamboo.
Holzforschung 26, no.6: 202-11 (Dec., 1972). (Ger.)

Variations in fibre length and width within one internote were studied in the case of Bambusa tulda, B. vulgaris, and Dendrocalamus giganteus. Fibre length was found to first increase across the wall from the periphery and then decreased towards the inner part. However, long fibres were also found in the outer zone. Fibre width did not show these variations. With increasing height in the culm, there was a slight reduction in fibre length. This variation in fibre length should be considered when taking samples and giving average values for a species. A valuable table gives results obtained by other workers on fibre length and width for about 78 species of bamboo.

99. Parameswaran, N., and Liese, W.
Fine structure of bamboo fibers.
Wood Sci. Technol. 10, no.4: 231-246 (1976).

The following species were studied: Cephalostachyum pergracile, Dendrocalamus latiflorus, D. strictus, Melocanna bambusoides, Oxytenanthera abyssinica, Phyllostachys edulis, and Thyrostachys oliveri. Bamboo fibres exhibited a polylamellate structure with alternating broad and narrow lamellae. Fibrils in the broad lamellae were oriented at angles of 2-20 degrees from the fibre axis, whereas those of the narrow lamellae were oriented at 85-90 degrees. Lignin and xylan concentrations were highest in the narrow lamellae. A model for the thick-walled bamboo fibre is presented with a new terminology for the various lamellae.

100. Parameswaran, N., and Liese, W.
Structure of septate fibers in bamboo.
Holzforschung 31, no.2: 55-57 (1977).

Septate fibres were found to occur in Dendrocalamus latiflorus, Phyllostachys edulis, Schizostachyumbra chyclaoum and Oxytenanthera abyssinica. Their characteristics and fine structure are described and illustrated with electron micrographs.

101. Singh, M.M., Purkayastha, S.K., Bhola, P.G., Lala, K., and Singh, S.
Fiber morphology and pulp sheet properties of Indian bamboos.
Indian Forester 102, no.9: 579-595 (1976).

Properties of 12 Indian bamboos (including 5 species of Bambusa and 3 species of Dendrocalamus) are compared. The results are tabulated and a general grading suggested on the basis of pulp yield, alkali consumption and sheet properties. Dendrocalamus hamiltonii was found to be the best. It is concluded that, because of the variation within species, pulp sheet properties of bamboos cannot be predicted from fibre dimension or chemical composition.

102. Wilkie, K.C.B., and Woo, S.L.
Hemicelluloses of the bamboos Arundinaria japonica and A. anceps. (1). Noncellulosic beta-d-glucans from bamboo, and interpretative problems in the study of all hemicelluloses.
Carbohyd. Res. 49: 399-409 (July, 1976).

D.-glucans from 1,3- and 1,4-B-D-linked glucans are present in the leaves and stems of the title-named bamboos. The ratios of the glucosidic linkages in the total hemicelluloses from leaves and stems from *A. japonica* and from the young and old leaves and young and old nodes of *A. anceps*, were 1: 2.5, 8.9, 2.6, 2.4, 19.5, and 15.6, respectively. It is suggested that the quantitative values obtained in studies of all hemicelluloses are subject to vagaries when it is implied that the results of methylation analysis are related directly to the material subjected to methylation. It is also suggested that, where interpretation is possible, quantitative values are more significant when total hemicelluloses, rather than fractionated hemicelluloses are studied.

Banana

(see also abstract no. 65; 66; 71)

103. Das Gupta, P.C., Day, A., and Mazumdar, A.K.
Chemical characterisation of banana (*Musa sapientum* Linn) fibre.
Research and Industry 17, no.3: 107-108 (1972).

The characteristics of the banana fibres have been studied with a view to exploring wider uses for it. The high alpha-cellulose content (61.5), D.P. of alpha-cellulose (1300) and ultimate cell dimensions (length 2.5 mm; width 0-0.25 mm) of the fibre make it a useful cellulosic raw material in paper and other industries.

104. Pablo, A.A.
Production of wrapping paper from banana (saba) leaf sheaths by the sulfate process.
Chem. Quart. 8, no.3-4: 74-85 (1970).

Banana leaf sheaths showed a high cellulose and ash content when put in hot water and 1% NaOH solution, but a comparatively low lignin content. The extremely long fibres with high slenderness ratio gave brown paper with high shear strength. A suitable portion of short-fibre pulps could be blended to give a sufficient supply for producing wrapping paper on a commercial scale.

Coconut

105. Francia, P.C., Escolano, E.U., and Semana, J.A.
Proximate chemical composition of the various parts of the coconut palm.
Philippine Lumberman 19, no.7: 4 . (July, 1973).

Data on the holocellulose, lignin, pentosan, ash, silica, and extractive (alcohol-benzene, hot water, and 1% NaOH) contents of the different parts of the coconut palm (*Cocos nucifera*) are tabulated. Of the various palm materials analysed, the trunk and coir approach closely the chemical composition of Philippine hardwoods, softwoods, and bamboos in terms of holocellulose, lignin, pentosans, and extractives. Their ash and silica contents lie between those of bamboo and wood. The trunk and coir appear suitable as possible paper making raw materials. The rachis, though unsuitable for chemical pulp, may find use for semichemical or mechanical pulp.

Corncobs and cornstalks

(see abstract no. 64; 70; 71)

Cotton

(see also abstract no. 69; 71; 73; 75; 76)

106. Avirom, S.M., Sukhova, L.A., Silvestrov, A.V., and Tarakanova, S.N.
Pulp for preparing a roofing felt.
USSR pat. 255,039 (Oct. 17, 1969).

The title pulp contains in weight %, semichemical pulp from shives 30-5, textile trimmings and rags 30-40, waste paper and paper board 20-3, and cotton processing wastes 10-12.

107. Guha, S.R.D., Singh, M.M., Sharma, Y.K., Kumar, K., and Bhola, P.O.
Utilization of cotton stem and cotton waste for board and paper.
Indian Forester 105, no.1: 57-67 (1979).

Describes the production of cotton stem boards by lime process, wrapping papers by soda or sulphate process, and printing paper by alkaline process. Fibre characteristics as well as proximate chemical analysis of the cotton stems have also been detailed.

108. **Institute of Paper Chemistry.**
The pulping of cotton hulls, stalks, stem, etc.
An annotated bibliography.
Bibliogr. Ser. - Inst. Pap. Chem. S77, 1975, 9 p.

109. **Pavlova, T.A., Kuibina, N.I., and Sharkov, V.I.**
Hemicelluloses from cotton seed hulls.
Teknol. Kompleks. Pererab. Rast. Mater. Metodom Gidroliza: 51-9 (1973). (Russ.)

A study was made of the chemical composition of common grade cotton seed hulls, and the composition and properties of hemicellulose polysaccharides from hulls. The hemicelluloses consist of a mixture of polysaccharides. Their main component, easily hydrolyzed polysaccharide (63%), is an electrophoretically homogenous glucuronoxylan (DP = 222; 12% uronic acids; 0.41% Meo groups; specific rotation = 96.5 deg. for 0.5 g in 1.5% KOH). Its chemical structure was determined by methylation and partial hydrolysis. Most of the glucuronoxylan chain consists of B-Dylopyranose residues joined by 1,4-bonds, part of which are branched at the C-2 and C-3 positions. The main chain is branched with D-xylose, D-glucuronic acid (9.26%) and 4-O-methyl-D-glucoronic acid (2.76%). The unmethylated glucoronic acid is probably attached at C-3. The absence of glucomannan and galactomannan was characteristic of cotton seed hull hemicelluloses.

110. Saleh, T.M., and El-Meadawy, S.A.
Cotton stalks as a fibrous raw material. (1) Anatomical structure and chemical composition.
J. Chem. UAR 15, no.4: 361-7 (1972).

A study of the anatomical and chemical structure of Egyptian cotton stalks showed the stalks to consist of 80% of woody tissue made up of libriform fibres with an average length of 1.1 mm as well as of vessel elements.

Flax

(see also abstract no. 63; 69; 74; 75; 78; 79)

111. Akopov, D.L., Andrev, O.K., Kolchin, E.V., Marshak, A.B., Moiseev, B.N., and Sukhova, L.A.
Roofing board stock.
USSR pat. 508,573 (March 30, 1976).

The stock included 30-40% rag pulp, 30-45% waste paper pulp, and 20-30% pulp from a mixture of pulped wood chips and flax waste in ratios of 1:0.6 to 1:2.

112. Bolev, D., and Tsoneva, A.
Characteristics of flax fiber based on color.
Tekst. Prom (Sofia) 20, no.9: 440-4 (1971). (Bulg.)

The colour of flax fibre is directly correlated with the chemism of its construction, indirectly with its microstructure, and is not influenced by its physical-mechanical characteristics. The organoleptic determination of the characteristics of flax fibres does not give enough information about the fibre quality. The colour determination can be carried out by suitable application by comparison with colour standards.

113. Hara, H.
Study on morphology of papermaking flax.
Japan Tappi 30, no.10: 548-553 (Oct. 1976). (Jap.)

The structure of bast fibres from flax has been investigated by light and scanning electron microscopy. A structural model of the flax stem is presented, showing all morphological portions of the xylem, such as cambium, pith epidermis, phloem (bast), parenchyma, vessels, pith, etc. Dimensions of fibrous elements are also reported.

114. Lesik, B.V., Khilevich, V.S.
Changes in chemical composition of flax fiber during maturation.
Fiziol. Biokh. Kul'turn. Rast. 5, no.3: 318-320 (1973).

Flax fibre quality, depends on the stage of maturity. Current studies have analyzed changes in the chemical composition of fibres. (These are summarized.) This study, over a three-year period, accumulated data on two varieties of flax in four stages of maturity. Flax fibres were defatted with ether and treated with sodium chlorite to achieve delignification, and fractional composition was determined by the sodium hydroxide method. Cellulose content decreased with aging (an effect of hydrolysis); alpha-cellulose decreased sharply while beta- and gamma-cellulose increased. In one variety of flax, cellulose accumulation stopped before the final ripening stage. Lignin content increased steadily, and rapidly in the last two stages. These results will aid in deciding the best harvest dates.

115. Monrocq, R.
Simultaneous or separate effects of sowing density and plant variety on certain characteristics of the elementary fiber of flax.
Bull. Sci. ITF 4, no.15: 209-218 (Aug., 1975). (Fr.)

Studies show that the average diameter for the elementary fibre of flax is 14-15 μm at conventional sowing density, with the possible exception of the Natacha variety. This value has not varied over the last 10 years. In contrast, the average diameter does increase with the use of below-normal sowing densities.

116. Rawa, K.
Changes of the properties of elementary flax fiber. during processing of the raw material and in usage.
Przeglad Wlok. 28, no.11: 584-7 (1974). (Pol.)

Determinations were made of the dimensions (thickness and length), the tensile strength, elongation at break, average DP, and durability of elementary fibres of flax isolated from flax straw, combed flax, yarn, finished fabric, and fabric subjected to simulated laboratory wear. The elementary fibres were separated from these materials by treatment under mild conditions with a solution of 1% NaOH and 0.5% Na bicarbonate for 1.5 hr. The treated fibres were neutralised, washed and allowed to stand for 2-3 days in distilled water to cause complete maceration of pectins. The samples thus obtained were examined under a microscope to check for complete separation and possible damage. The simulated wear consisted in a series of accelerated washings with Cl-containing detergents. The test results are reported for each processing stage. Compared to properties of elementary fibres prior to processing, taken as 100, their tensile strength, elongation at break, and average DP in finished fabric were, respectively, 83.8, 81.2 and 58.2. The corresponding figures for fabric after simulated wear were 54.4, 60.6 and 39.1. There were no significant changes in the dimensions of the fibres. The reduction of the mechanical strength of the fibres took place gradually during the processing stages, while there was an abrupt drop of average DP during bleaching and again during simulated wear.

Grasses

(see also abstract no. 71; 77)

117. Hafeez, M.A.
Suitability of various grasses of the Punjab for the manufacture of pulp and paper.
Pakistan J. For. 22, no.3: 243-8 (1972).

The grasses (Chloris gayana, Eragrostis superba, Cenchrus ciliaris, Panicum antidotale and Lasiurus hirsutus) gave a lower pulp yield and fibre with lower strength than did wheat straw, but these grasses could be used for writing and printing paper manufacture when blended with long fibre wood pulp.

Hemp

(see also abstract no. 75; 76; 79)

118. Bedetti, R., and Ciaralli, N.
Variation in the content of cellulose during the vegetative period of hemp.
Cellulosa Carta 27, no.3: 27-30 (March, 1976). (Ital.)

Chemical analysis of hemp (Cannabis sativa) shows that the cellulose content of both the bark and the woody core increases as the plant matures, while the extractives, ash, and lignin contents decrease. Thus, one can conclude that better pulping yields will be obtained by delaying, weather permitting, the harvesting of the hemp as long as possible.

119. Eres, L.P.
Technological characteristics and chemical composition of hemp bast and fibers isolated by various methods.
Tr.-Vses. Nauchno-Issled. Inst. Lub. Kult. 37: 161-165 (1975). (Russ.)

The method of preparation affects the chemical composition and properties of fibres obtained from hemp. The H_2O-air mercerization of hemp resulted in mechanically strong and flexible fibres with low content of non-fibre materials and the high content of wax-forming substances. The fibres obtained from hemp by deretting was rigid, thick and mechanically weak, and the content of non-fibrous materials and hemicellulose was high. Fibres prepared by chemical treatment of hemp were strong and thick and had a high percentage of pectinous materials and low solubility and low content of wax-forming materials.

Jute sticks

(see also abstract no. 63; 69; 75; 79)

120. Mukherjea, V.N., and Guha, S.R.D.
Constitution of a hemicellulose from jute sticks (*Corchorus capsularis*).
J. Indian Acad. Wood Sci. 2, no.2: 63-8 (1971).

Extraction of the chlorite holocellulose of jute sticks with alkali solutions of successively increasing strength and finally with alkali borate solutions gave three hemicellulose fractions. Analytical data for each fraction are recorded. Partial hydrolysis of the main hemicellulose constituent yielded 2-O-(4-O-methyl-a-D-glucosyluronic acid)-D-xylose. Hydrolysis of the fully methylated polysaccharide gave a mixture of 3-O-methyl-D-xylose, 2,3-di-O.methyl-D-xylose, 2,3,4-tri-O-methyl-D-xylose, and 2-O-(2,3,4-tri-O-methyl-a-D-glucosyl-uronic acid)-3-O-methyl-D-xylose in the approximate molar ratio 6:122:3.6:23. The number average DP of the native polysaccharide was 179-180. These data indicate that the hemicellulose is composed of a linear chain of 1,4-linked B-D-xylose residue and that on the average every seventh residue of the Chain carries a terminal 4-O-methyl-D-glucuronic acid residue attached through C(2).

121. Mukhopadhyay, U., and Mukherjee, A.C.
Density and X-ray diffraction studies of jute at different stages of growth.
Textile Res. J. 47, no.3: 224-227 (March, 1977).

In the early stages of growth, the density and the crystalline order of jute fibres were higher than in mature fibres. It is suggested that lignin is present in a more or less separate phase in the early stages, and that it later infiltrates into the cell wall and pushes the chains further apart, resulting in a more disordered structure and a less compact packing.

Kenaf

(see abstract no. 63; 66; 74; 77, 78; 79)

Palm

(see abstract no. 65; 71; 105)

Papyrus

(see also abstract no. 71)

122. Khristova, P., and Khristov, Ts.
Physicochemical studies on the chemical composition of papyrus stems.
Tseluloza Khartiya 4, no.3: 19-23 (May/June, 1973).

Chemical analysis of the stems of papyrus (Cyperus papyrus L.) was the subject of an earlier study. In this report, experimental data are presented on the raw materials and its components (cellulose, lignin, holocellulose, hemicellulose, and a-cellulose) by DTA and IR Spectrophotometry. Differential thermal and thermogravimetric curves and kinetic degradation data showed the following degradation zones: for the initial raw material 150-370°C; for holocellulose 240-370°C; for a-cellulose 245-400°C; for hemicelluloses 170-330°C; for cellulose 220-330°C; and for lignin a wide range over 200°C. The energies of activation of the main thermodegradation stages were, respectively, 25, 26.5, 42.0, 13.2, 47.0 and 13.0 Kcal/mole. An analysis of the IR spectra of the materials studied indicated a relatively low content of lignin in papyrus stems and a high content of carbohydrates. Structural changes in the individual components which occur during their isolation are discussed.

123. Khristova, P., and Khristov, Ts.
Chemical composition of Cyperus papyrus L.
Tseluloza Khartiya 5, no.1: 15-18 (1974). (Bulg.)

A study was made of the anatomical structure and chemical composition of papyrus stems with the purpose of evaluating its suitability for use as a papermaking raw material. The stems analysed were obtained from the Sudan, where papyrus grows abundantly. Two layers can be distinguished in the cross-section of the stem: a compact outside layer consisting of thick-walled and strongly lignified cells, and a core consisting predominantly of parenchyma cells. The two stem layers differ in their chemical composition; the outer layer "bark", has a higher content of ash, lignin, and cellulose, while the core is rich in pentosans and other easily hydrolyzed polysaccharides. The whole stem has a high content of cellulose (48%) and a low content of lignin (18%) so that good yields can be expected when this material is processed into pulp. Data on the chemical composition of papyrus of other provenances indicates even higher content of cellulose (over 56% in papyrus from the Congo). The chemical composition of papyrus is similar to that of bagasse, especially the cellulose lignin ratio (2.5 for papyrus, 2.6 for bagasse). Sudan has a large supply of both, and their joint pulping should be considered. The high content of pentosans in papyrus stems indicates that it could constitute a good raw material for the hydrolysis industry.

124. Lunn, N.A., Ragab, H., Reynolds, T.S., Hepper, F.N., Sadler, H., Kitsch, J., O'Casey, J., Johnson, M., Maney, A.S., and Bradley, E.
The nature and making of papyrus.
Barkston Ash, Elmete Press, 1973, 86 p.

This booklet describes the anatomy of the papyrus plant (Cyperus papyrus), ancient uses (for scrolls, codices, mats, caulking tow, etc.), historical and modern sheet-forming techniques, and future potential as a paper fibre.

Peat

125. Universite de Sherbrooke.
Peat moss in Canada: Symposium Proceedings
April 24-25, 1972, Sherbrooke, Quebec.
Univ. de Sherbrooke, 1972, 352 p.

Of the 23 separate contributions at this symposium, 5 are in French and the rest in English. They deal with Canadian peat resources, soil types, chemistry, mining (production), and utilization as constructional material, soil conditioner, adsorbent, and in miscellaneous such as activated carbon manufacture.

Pineapple fibres

126. Cueto, C.U., Palmario, M.S., Imperial, Z.S., Tayco, S.A., Soriaga, R.P., Buenaventura, R.V., and Decruzman, M.C.
Pineapple fibers; Part I - The retting process.
Philipp. Text. Inf. Dig. 7, no.1: 1-9 (1977).

A series of experiments on microbial retting of pineapple fibres were conducted to determine the most efficient method of fibre extension using the criteria of physical appearance, strength and chemical composition. The best process was retting in a closed system consisting of tap water, a pure culture of micro-organisms and 5 mg MgO/g dry fibre at pH 6.8-7.2 at room temperature for 26 hours.

Ramie

(see also abstracts no. 63; 69; 74; 78; 79)

127. Wu, H.
Effect of gibberellin on the growth and development of ramie (Boehmeria nivea) as well as the quality of its fibers.
Chihwu Hsueh Pao 15, no.2: 195-203 (1973). (Ch.)

Treatment of 20-day-old ramie (B.nivea) seedlings with gibberellin promoted stem growth and prevented early flowering. Fibre length and elasticity were also increased by gibberellin treatment.

Reeds

(see also abstract no. 70; 71; 77)

128. Joseleau, J.P., and Barnoud, F.
Hemicelluloses of Arundo donax at different stages of maturity.
Phytochem. 14, no.1: 71-5 (Jan., 1975).

The hemicellulosic composition of the reed A. donax depends on the maturity of the tissue. The percentage of xylose in the total hemicellulose increases with increasing plant maturity. The main hemicellulose is an arabino-4-O-methyl glucuronoxylan which is already present in the youngest tissues and has the same structural features regardless of the age of the tissues. The average DP of this polysaccharide increases from ca. 60 to 130 with maturation of the plant tissue.

129. Joseleau, J.P.
Studies on determination of structural characteristics of three types of hemicelluloses.
Univ. British Columbia, Ph.D. Thesis, 1975.

The structural characteristics of the principal hemicellulose of adult reed (Arundo donax), the hemicellulose of redwood (Sequoia sempervirens) and the cell wall carbohydrate composition of one-month-old reed stems were determined.

130. Kim, U.G., Kim, D.L., Pak, C.H., and Son, S.J.
Pulpifying characteristics of some monocotyledonous plants.
Choson Minjujuui Inmin Konghwaguk Kwahagwon Tongbo. 25, no.6: 320-323 (1977). (Korean)

Cooking of reed with a liquor containing 17% active alkali as Na_2O and 12% sulfidity for 2-2.5 h at 170° gave dissolving pulp containing 1.4-1.8% lignin in 28-35% yield. The reed constituents such as bark, pith, etc., caused a decrease in the filtration characteristics of the pulp.

131. Ovchinikov, Yu.B., Karzhavina, L.A., and Khe, A.
Arundo donax - a raw material for the pulp paper industry.
Tsellyul. Bum. Karton. no.R4: 12-13 (1976). (Russ.)

The giant grass Arundo donax which grows in central Asia and southern Transcaucasia can be used as a raw material for the production of kraft pulp in 62.5% yield. The stalks of Arundo contain: cellulose, 44.6; lignin, 22.7; pentosans, 25.1; resins and fats, 3.0; and ash, 4.2%. The mechanical properties of pulp from Arundo are similar to those of pulp from common cane.

132. Ovchinnikov, Yu.B., and Petrova, L.V.
Cellulose content in the stems of Arundo donax L. growing in the Volga delta.
Rastit. Resur. 13, no.1: 112-13 (1977).

A. donax introduced into the Volga delta in experimental plots yielded about 30 t/ha of dry stems reaching up to 5.6 m height, containing on a dry matter basis 38.3-41.7% cellulose. Because of easy adaptation and cultivation, high yields and high cellulose content, A.donax is recommended as a cellulose source for the paper and pulp industry.

133. Popescu, G.
Comparative morphologic and anatomic characteristics of reed grown under normal vs. high flood conditions in the Danubian delta. (1) Morphological aspects. (2) Anatomical aspects.
Celuloza Hirtie 22, no.5: 177-82; no.6: 225-32 (May-June, 1973). (Rom.)

134. Tepla, N.I.
Chemistry of reed as a raw material for the pulp and paper industry.
Rast. Resursy 6, no.3: 428-30 (1970). (Russ.)

The height of reeds varies widely, from 0.5 m high. The purpose of this study was to investigate the chemical composition of reed as a function of its height. Plants of three height groups were studied: height (over 3 m), medium height (2-4 m), and low (less than 2 m). The following components were determined in extracted stems; cellulose, lignin, substances soluble in hot water, substances soluble in 1% alkali, and ash. The tall reed plants contained 3-5% more cellulose, and 1-6% less of the other components than the low-growing varieties. The medium-height reeds had a chemical composition intermediate between the two. These differences involved only the stem. There were no differences in chemical composition of the sheaths or the panicles. Analysis of the stems at different heights showed the highest cellulose contents in the lower parts of the stem. Consequently, when reed is harvested, the stems should be cut as close to the ground as possible.

135. Uglea, C.V.
Hemicellulose fractionation.
Makromol. Chem. 175, no.5: 1535-42 (May, 1974).

The properties of solutions of hemicelluloses obtained from the reeds Phragmites communis and Arundo donax were investigated. Results led to the conclusion that the molecular weight distribution (MWD) of hemicelluloses depends on the products studied. The parallel existence of chemical inhomogeneity and MWD determines the bimodal aspect of differential distribution curves obtained by fractionation.

Rice husk

(see also abstract no. 68; 77; 83)

136, Coté, W.A.,
Rice husk characterization using SEM and EDXA.
J. Indian Acad. Wood Sci. 5, no.1: 9-17 (1974).

An explanation of the probable reasons for the efficacy of rice husk as raw material for composite boards is provided by the study of the characterization of rice husk by scanning electron microscope (SEM) and Energy Dispersive X-ray Analysis (EDXA). These two devices help to completely characterize rice husk both before and after incorporation into composite board.

Sisal

(see also abstract no. 63; 71; 76; 79)

137. Barkakaty, B.C.
Some structural aspects of sisal fibers.
J. Appl. Polymer Sci. 20, no.11: 2921-2940 (Nov., 1976).

The structural, mechanical and fractural properties of sisal fibres were studied both before and after various chemical treatments. The molecular structure of the cellulose, which is the major constituent of the fibre, was studied by x-ray diffraction. The multicellular structure, surface topology and fracture morphology of the fibres were studied by SEM and the mechanical properties with a microextensometer and Instron tensile tester. The results offer an insight into the multicellular structure and the relation between the molecular structure and the mechanical properties of the fibre.

Sorghum

(see also abstract no. 71; 77)

138. Clark, T.F., Nelson, G.H., Cunningham, R.L., Kwolek, W.F., and Wolff, I.A.
A search for new fiber crops: potential of sorghums for pulp and paper.
Tappi 56, no.3: 107-10 (March, 1973).

In the research laboratory of the U.S. Agricultural Research Service, over 125 accessions of 5 sorghum spp. (Sorghum almum, S.bicolor, S.durra, S.halepence, and S.sudanense) were evaluated as raw materials for pulp and paper manufacture on the basis of their physical and chemical compositions. Considerable variations were noted between spp., "lines", and crops of different years. Among promising samples, crude cellulose contents range from 42.6 to 55.9%, alpha-cellulose from 26.0 to 35.3% and arithmetic average fibre lengths from 0.80 to 1.77 mm. All accessions of S.almum contained less than 14% pith. Many samples of S.bicolor had less than 20% pith.

Straw

(see also abstract no. 68; 70; 77; 83)

139. Chawla, J.S.
Poppy straw - a new source for fibreboards.
Indian Pulp and Paper, (Dec., 1977-Jan., 1978), 2 p.

Poppy straw was studied for the production of fibreboard and straw board. The physical and chemical properties of the fibres are recorded and the properties of the boards manufactured have also been reported.

140. Mian, A.J., and Haque, S.
Rice plant.
Dacca Univ. Stud. 21, no.2: Pt.B: 51-56 (1978).

The proximate composition of rice straw from Bangladesh was investigated and the hemicellulose present in it was isolated and characterized. The results obtained indicate that the hemicellulose contained a slightly branched framework of (1 - 4) linked D-xylose residues to which are attached (1 - 2) - linked 4-O-methyl-glucuronic acid per average 10 anhydroxylose units. The straw contained 40.25% cellulose, 26.16% pentosans, 21.23% lignin and 15.96% ash.

Sunflower

(see also abstract no. 64)

141. " pescu, G.
phological and anatomic characterization of sunflower .ems (Helianthus annuus L.).
Celluloza Hirtie 21, no.7: 377-87 (July, 1972). (Rom.)

Sunflower stalks (residues remaining after harvesting of seeds or seed oil) represent an annual source of valuable fibrous material. A study was therefore, made to examine the papermaking and related characteristics (density, fibre dimensions, cellulose content, etc.) of this plant crop.

Sunn hemp

(see also abstract no. 63; 68; 79)

142. Mazumdar, A.K., and Dey, A.
The nature of sunn hemp (Crotalaria juncea Linn.) fibre.
Research and Industry 18, no.4: 148-150 (1973).

The characteristics of the sunn hemp (Crotalaria juncea linn.) fibre of different varieties have been studied with a view to exploring wider uses for them. The samples analysed had 70-85% alpha-cellulose content with degree of polymerization 1200-1600 and ultimate fibre length 3.7-6.5 mm. Although all the varieties studied showed potentialities for use as cellulosic raw materials in paper and other industries, the Banaras variety is recommended as the best among the varieties investigated.

Tobacco

143. Kim, B.T., Cho, W.K., and Yoon, C.B.
Pulping of tobacco stalk.
Kongnipkongop yongusopogo, no.20: 25-30 (1970). (Korean)

The chemical components of tobacco stalks were determined and chemical pulps were made from the stalks. The lignin content of the stalk was 24.63% and nicotine content was 0.14%. The pulp yield from the stalk was approximately 40% and was lower than that of cereal straws or hardwood. The mechanical properties of the kraft pulp from the stalk were inferior to those of other pulps.

C. TECHNICAL AND ECONOMIC ASPECTS RELATED TO HARVESTING, TRANSPORTATION, STORAGE AND PRE-PROCESSING

General

144. Granofibers : An original process.
Bois Hebdo 81, no.43: 6-7 (1975). (Fr.)

'Granofibres', 2-8-mm diameter granules, are manufactured from waste wood, straw, or bagasse fibres, separated by a thermo-mechanical pulping process, and mechanically recombined without use of a binder. Uses include components of insulating and acoustic panels in buildings.

Agave

145. Hurter, A.M.
Process and apparatus for use in making raw fiber, and for making pulp from agave plants.
Brit. pat. 1,374,198 (Nov. 20, 1974).

A system is provided for making raw fibres and pulp from agave plants such as sisal. The leaves and stems of the plants are chopped or shredded, and the skin, pith, and waste material is then separated from the raw fibre in the short sections. The chopping or shredding is carried out in a direction perpendicular to the axis of the plant part, and may be effected in a disk refiner. Separation of the raw fibre may be done by screening. The raw fibre may be converted to pulp by an alkaline digestion process.

Bagasse

(see also abstract no. 144)

146. Abou-state, M.A., and Helmy, S.A.
Dissolving pulps from Egyptian bagasse: I - Effect of depithing on the chemical, physical and submicroscopic characteristics of viscose pulps.
J. Appl. Chem. Biotechnol. 22, no.12: 1227-32 (1972).

Optimum yield, whiteness and better chemical characteristics of Egyptian bagasse are discussed. Prehydrolysis-sulfate pulp, suitable for the preparation of viscose, were achieved by 2% depithing before prehydrolysis. Depithing (10%) after prehydrolysis gave a product with slightly better reactivity towards xanthation, but all other properties were better in the former case.

147. Batlle Colome, E., Rodriguez Tellez, N., and Suarez Lopez, J.
Influence of storage method on the properties of bagasse fiberboards. (2) Influence of bale storage time on the properties of hard fiberboards made by the wet-dry process.
Sobre Deriv. Cana Azucar (Rev. ICIDCA) 9, no.1: 56-66 (Jan./April 1975). (Span.)

The influence of storage time of baled bagasse on the properties of hard fibreboard is analyzed. It was found that the rupture modulus value tended to rise in the first seven months of storage, and then decreased sharply until it was less than the initial value for fresh bagasse. Such behaviour appeared to be correlated to the chemical composition rather than to the degree of depithing or the granulometric composition of the pulp. Granulometric composition of the bagasse samples used is tabulated. It is suggested that depithing is intimately related to ultimate board properties. In commercial practice, similar behaviour can be expected as a result of storage time, as well as cooking parameters.

148. Benzinger, H.
Today's bagasse technology.
Pulp Paper Intern. 17, no.6: 42-44, 57 (June 1975).

Current bagasse processing technology is discussed, based on the recent expansion of Pars Pulp & Paper Co. of Iran. The three principal methods for storing and depithing bagasse (dry depithing, wet depithing, or a combination of the two) are emphasized, as storage and depithing are critical aspects of bagasse pulping. Pre-depithing in the sugar mill and then wet depithing in the pulp mill appears to be the most economical means of fibre/pith separation. Bulk storage after depithing is more practical than storing the bagasse in bales. A description is provided of the system utilized by Pars Paper to produce 200 tons/day of bleached bagasse pulp which is used to manufacture printing and writing grades on three paper machines.

149. Bush, A.B.
History and description of current (bagasse panel) operations at Celotex (Corp.) - Marrero (LA).
Tappi C.A. Report no.67: 85-86 (1976).

The Celotex Corp. plant at Marrero, LA, produces 400 million sq.ft. of structural insulation board/year from bagasse. Rising fuel prices can affect bagasse raw material costs as well as board manufacturing costs, since bagasse required for boiler firing in sugar mills, is sold on a fuel replacement cost basis. Methods used for storing, cleaning, refining, forming, and drying the bagasse to produce exterior and decorative panel products are described.

150. Cusi, D.S.
Process for preserving lignocellulosic material by controlling airflow through a pile of lignocellulosic material.
U.S. pat. 3,802,957 (April 9, 1974).

A process for preserving a pile of lignocellulosic material such as wood chips or bagasse involves controlling the air flow through the pile to provide a controlled temperature environment within the pile which favours the growth of microorganisms which consume soluble nutrients present in the lignocellulosic material while retarding the growth of other microorganisms which degrade the lignocellulosic material.

151. Hesch, R.
Process for storing bagasse.
Ger. pat. 2,209,465 (Sept. 6, 1973).

A process for storing bagasse to be used in paper making or in the manufacture of particle board, involves loosely piling the bagasse outdoors on a base, e.g. a concrete slab, giving protection from ground water. A roof may also be included in areas of heavy rainfall. The piles are formed in horizontal layers in a manner so as to give good ventilation and avoid excessive fermentation.

152. Hesch, R.
Method for storing bagasse.
U.S. pat. 3,964,961 (June 22, 1976).

This method for storing bagasse prior to use in papermaking or in particle board manufacture is similar to that described in Ger. pat. 2,209,465 of 6 Sept. 1973.

153. Hsieh, W-C., Liu, Y-T., and Chen, M-S.
Wet storage of bagasse in bulk: I - storaging process.
Tai-Wan Tang Yeh Yen Chiu So Yen Chiu Hui Pao 61:
83-90 (1973). (Ch.)

Bagasse was wet stored for more than 300 days at pH 4.5-5 and 75-80% water content. During storage, the pentosan and lignin content decreased, while the cellulose content increased by 2.5-3%. Pulps obtained from wet-stored bagasse had high yields, low permanganate number and improved physical properties.

154. Hsieh, W-C., and Chen, M-S.
Wet storage of bagasse in bulk: II - pulping conditions.
Tai-Wan Tang Yeh Yen Chiu So Yen Chiu Hui Pao 61:
91-9 (1973). (Ch.)

The optimum pulping conditions for wet stored bagasse were: 10-11% Na_2O, 15-20% sulfidity at 160°, 40 min. and liquor ratio 1 : 4. Pulps obtained from the wet stored bagasse had higher yields, and improved physical properties.

155. Lacey, J.
Molding of sugarcane bagasse and its prevention.
Ann. Appl. Biol. 76, no.1: 63-76 (1974).

Microorganisms present in stored bales of bagasse were identified and the total number determined. The cellulolytic activity of some of the fungi was assessed. Self-heating and moulding were decreased either by drying the bagasse to 25% moisture before storage or treating it with 2% propionic acid.

156. Lin, S.J.
Multistorage pulping of bagasse.
Tai-Wan Shing Lin Yeh Shih Yen So Pao Kao 268, 9 (1975). (Ch.)

Yield and quality of pulp from bagasse was improved by modifying conventional bagasse pulping to retain the hydrolyte tissue parenchyma. The bagasse, after light depithing and discarding of 10% powdery pith was digested with 1% NaOH so that subsequent coarse screens showed a very high reject rate. These rejects, comprising the best papermaking fibre, were passed to a disk refiner followed by a second stage digestion with caustic soda, neutral sulfite, soda, or sulfate to complete the pulping action.

157. Lowgren, U.
History and application of the Asplund defibrator for fiberboard production from nonwood materials.
Tappi C.A. Report no.67: 67-70 (1976).

Since the early 1950's, a great number of defibrator continuous digesters have been put into operation in most sugar-cane producing countries around the world for the production of paper pulps from bagasse. These digesters are equipped with large vessels to provide for the required cooking time for the various types of pulps. These continuous non-wood pulping digesters were developed from the original Asplund defibrator which was operated as early as the late 1930's for the production of nonchemical pulps from straw and bagasse for the production of insulating materials and hardboard. The development of the Asplund defibrator for the use of non-wood raw materials for panel board manufacture is described.

158. Muliah.
Storage experiments on bagasse.
Berita Selulosa 11, no.1: 1-10 (1975). (Indonesian)

The amount of water soluble acids and solubles in bagasse having high content of pith depended on the method and time of storage. When storing fresh bagasse in the centre of the lot, an increase in temperature (40-42°) occurred. Weight loss and fibre content decreased slightly when bagasse was stored in open air. When stored in still water the fibre content decreased markedly.

159. Plasti-Fiber Formulation Inc.
Bagasse fiber products and process.
Brit. pat. 1,357,462 (June 19, 1974).

A method for treating bagasse to separate fibrous components from sugar, pith, and the like comprises contacting the bagasse, preferably after an initial dry mechanical attrition treatment but without any preliminary chemical treatment with an aqueous solution of alum for a time sufficient to leach out all the residual sugar in the fibrous portion of the bagasse. Concurrently with this sugar solution, the bagasse is subjected to mechanical attrition to defibrate it and to free the fibres from the pith. The fibres are then separated from the pith and from foreign matter, such as dirt and sand, and the fibres are dried. The fibres are of use as a reinforcing medium for synthetic resins; the pith can be used to make board of insulating material.

160. Rodrigues Jimenez, J.
Storing, depithing, transporting, and pricing of bagasse.
Invest. Tec. Papel 8, no.30: 1133-56 (Oct. 1971). (Span.)

This discussion covers the wet storage of bagasse, depithing methods (dry, moist, wet and biological), bagasse handling methods (conveying, trucking, etc.), and the estimation of the value of bagasse as a pulp raw material.

161. Salaber, J., and Maza, F.
Bagasse bleaching.
Tappi C.A. Report no.53: 41-49 (1974).

Results are given for various bagasse bleaching trials at Ledsema, S.A.A.I. Buenos Aires, Argentina. Variables studied included depithing procedures and bleaching and pulping conditions. The influences of wet depithing and bulk storage (Ritter process) on pulp bleachability is discussed. A CEH sequence for bleaching bagasse pulp is described. The use of sulfamic acid in the hypochlorite stage to increase pulp brightness is discussed. With improved depithing, storage, and pulp cleaning, a brightness of 86 General Electric could be obtained with acceptable viscosity and tear values. The use of peroxide after the hypochlorite stage decreased brightness reversion.

162. Wickings, J.A.
Bagasse preservation.
Brit. pat. 1,394,477 (May 14, 1975).

A process for preserving and predigesting bagasse in preparation for storage comprises slurring the bagasse with an aqueous solution of a lower saturated carboxylic acid, e.g. formic or acetic acid, at a pH of 3-5, and draining off the excess solution prior to storage of the bagasse.

163. Wright, C.L.
Treatment of bagasse with a nontoxic fungicidal acid to prevent mycelial deterioration.
U.S. pat. 3,666,620 (May 30, 1972).

Bagasse intended for the production of particle board is stabilized against mycelial deterioration in storage by treating fresh bagasse from a sugar mill, after reducing the moisture content to below 50% by weight, with a nontoxic fungicidal acid in the liquid phase in an amount which reduces the pH of the treated material to 4.5 or below. The preferred acids are formic, acetic, and propionic acids. It is the same as Brit. pat. 1,242,257 (Aug., 11, 1971).

164. Zegarra Russo, J.R.
Methods for evaluating yields and efficiency of (bagasse) depithing systems.
ATCP 16, no.4: 191-201 (July/Aug. 1976). (Span.)

The efficiency of bagasse depithing and pulping systems is considered in terms of the various systems and equipment available for depithing: methods available for analysing bagasse, e.g. fibres, and soluble content, and methods for evaluating the yield and efficiency of depithing systems. A practical example of the calculation of yield and efficiency of wet depithing is included, which is designed to closely resemble operational reality.

Bamboo

165. The bamboo and its use in the manufacture of pulp in Democratic Republic of Vietnam.
Zellstoff 20, no.9: 259-261 (1971).

Outlines the distribution of bamboos in Asia and the range of climate and altitude within which they grow. Reports the occurrence of more than 50 species in (North) Vietnam and briefly discusses the mode of growth and morphological properties of bamboos. Also describes both the older and more modern methods of making bamboo paper pulp.

166. Chandra, R.
Production and cost of logging and transport of bamboo.
FAO (Rome) Report no.FAO/SWE/TF 157, (1975) 72 p.

Various aspects and phases of bamboo harvesting and processing, of interest to developing countries in which bamboos and reeds abound are described. The need for extensive research on cutting cycles, manual processing tools, time-and-motion studies, and training is pointed out. Costs of felling, long- and short-distance hauling (by water, trucking, rail), storage, chipping, and overheads are also indicated.

167. Gajdos, J., Farkas, J., and Janci, J.
Bleaching of sulphate pulps from bamboo.
Papir a celuloza 26, no.6: 69-79 (1971).

Gives results of laboratory trials with pulps made from air-dry bamboo with yields of 39-58%. A comparison with typical pulps made from central European conifers and hardwoods shows that bamboo pulps are more difficult to bleach and are generally inferior in mechanical properties.

168. Ramakrishnan, A.
Economics of bamboo and eucalyptus plantations.
Ippta 9, no.3: 220-1 (July/Sept. 1972).

Some data are briefly presented on the costs of developing eucalyptus and bamboo stands in India. Such stands offer the best means of overcoming the projected shortage of raw materials for paper making.

169. Sahi, S.P.
Bamboo and mixed hardwood in Bihar forests (in India).
Ippta 9, no.3: 254 (1972).

Bihar forests produce about 200,000 tonnes of bamboos annually out of which 112,000 tonnes have been leased to various paper mills. The balance of 88,000 tonnes meets the other local needs. Since new bamboo plantations in Bihar State are limited, it is suggested that the paper mills in Bihar and Bengal have to depend on the use of mixed hardwoods which are available in sufficient quantities.

170. Singh, S.
Cheapest, quickest and surest way to solve raw material shortage problem for pulp and paper industries in India.
Indian Pulp Paper 27, no.12: 9-11, 13-20 (June, 1973).

Annual bamboo yields in India have suffered a sharp decline in successive felling cycles from several bamboo forests. Although this may go unnoticed in many areas of the country, at other places the situation has become alarming. Various causes for this depletion of bamboo forests are indicated, along with ways of remedying the trend. Experimentation with simplified silviculture and soil cum water conservation measures gave excellent results for rapidly boosting bamboo harvests. Of all the techniques known and alternatives available, this is the cheapest, quickest, and surest answer for meeting the country's requirements for more and better pulpable raw materials, even beyond the projected demands for the future.

171. Vela Galvez, L., Boyas Delgado, J., and Garcia Sanchez, F.
Bamboos.
Inst. Nacl. Invest. Forest (Mexico) Bol. Tec. no.50: Aug., 1976, 38 p. (Span.)

The geographic distribution, cultivation and vegetative propogation practices, and commercial uses (including paper pulp) of various bamboo species are outlined. Tables in which bamboo types are classified by distribution and genus are appended.

172. Waheed Khan, M.A.
Management of bamboo forests in the State of Madhya Pradesh (in India), as producers of raw materials for pulp and paper industry.
Ippta 9, no.3: 215-17 (1972).

A brief review is presented of measures considered necessary to halt the destruction of bamboo forests in the area. Most of the measures relate to control of grazing, burning and cutting.

Banana stalks

173. Gomez, F.M.
Shredder, especially for banana-tree fibrous material.
Fr. pat. 2,113,572 (June 23, 1972).

The apparatus for processing banana stalks is designed to effect chipping, dewatering, partial defibration, and separation of fibrous and nonfibrous material. The apparatus is similar to that provided in Ger. pat. 2,109,087.

Coconut

174. Kaushish, J.P.
Problems in chipping coconut husk for making particle board.
IPIRI Journal 1, no.2: 63-66 (1971).

It has been shown that if coconut husk is chipped without its pith being separated from the fibres, only 0.5% resin adhesive is required to make a particle board as against 6-9% required for the manufacture of particle boards from other materials. As the usual wood chippers have been found unsuitable for chipping the coconut husk to the required specifications, design and development of a suitable chipping machine was taken up at the Central Building Research Institute. This paper discusses the problems faced in the design and development of such a machine.

Corn stalk

175. Abou-state, M.A., and El-Masry-A.M.
Pulp and paper from corn stalks: II.
J. Appl. Chem. and Biotech. 23, no.12: 925-927 (1973).

The chemical composition and optical and strength properties were determined for paper manufactured from corn stalks by pulping at atmospheric and more than atmospheric pressure, and from corn stalks which was deleaved, and both deleaved and depithed. The pulping pressure did not affect the chemical composition. Strength was greatest when pulping was at atmospheric pressure and decreased by removing the leaves. Paper of intermediate strength was obtained from deleaved and depithed plants.

Cotton stalk

176. Inomata, M., and Hanabusa, K.
Nonwoody pulp.
Jap. pat. 74,108,301 (Oct. 15, 1974).

Non-woody fibres were pulped in the presence of oxygen and alkalies. Thus 200 g cotton linters were cooked at 120°C for 4 hr in the presence of 10% (based on the linters) alkali and 0.3% MgO to give 74% yield.

177. Saleh, T.M., and El-Meadwy, S.A.
Cotton stalks as a fibrous raw material: II - sulfite pulping methods.
Egypt J. Chem. 15, no.5: 459-70 (1972).

In the preparation of chemical sulfite pulps from debarked cotton stalks, the use of 6% total SO_2 with combined total SO_2 ratio of 40% at 140° for 0.5 hr gave a pulp yield of 55% having lignin content 4.5%, pentosans 9%, brightness 75%. High alpha-cellulose pulps were prepared in 42% yield with combined total SO_2 37.5% at 150° for 2 hr.

Hemp

178. Basso, F., and Ruggiero, C.
Influence of nitrogen fertilization and harvesting time on the production of fiber and cellulose by cultivars and hybrids of hemp: Note I.
Cellulosa Carta 27, no.3: 17-26 (March 1976). (Ital.)

Results are reported on a two-year test conducted in the Volturno river plain (Italy) on cultivars and hybrids of hemp, with the aim of investigating the effects of two levels of N fertilization (80 and 160 kg/ha), two application methods (solid and liquid), and two harvesting times (full bloom and mature seed) on cellulose fibres yield. Higher production levels were obtained with the "Eletta campana" and "Superfibra" cultivars and with the "IB_1" and "IB_4" hybrids than with "Cs", "Fibranova", and "Paesana comune" cultivars. N fertilization gave better results when employed at 160 kg/ha. Application method appeared to make no difference. Better results as regards cellulose fibre yield were obtained when harvesting was conducted on plants with mature seeds. An appreciable amount of seeds was also obtained. The "Superfibra" was the best cultivar with respect to technological properties of the fibre.

179. Rivoira, G., and Marras, G.F.
Hemp for the papermaking industry: Aspects and problems of cultivation techniques.
Cellulosa Carta 26, no.12: 9-24 (Dec., 1975). (Ital.)

Results of three-year Sardinian field trials with hemp for pulp manufacture are reported. The following aspects were studied: cultivar selection, sowing period, harvesting period, irrigation volume and cycles, and nitrogen fertilization. The late-flushing hybrids and cultivars were found to give the highest yields. The optimum sowing period appeared to be that between the end of March and the first ten days of April; the best harvesting period, the middle of July. Such a growing season keeps irrigation requirements to a minimum. The response of hemp to nitrogen fertilization seemed to be associated with amount of rainfall in the spring. Growth was best with high irrigation volume and short irrigation cycles, but from a practical standpoint, a cycle of 12-15 days with a seasonal water consumption of 2500-3000 cu m/ha appears to be preferable.

Kenaf

180. Atchison, J.E.
Kenaf for paper pulp in the Lower Mekong Basin: A prefeasibility study.
U.S. Agency for Internatl. Devt., Report PN-AAC-600; May, 1976; 766 p.

This study was published for the Regional Committee for Coordination of Investigations of the Lower Mekong Basin (LMB) and sponsored by the Regional Economic Development Office of A.I.D. in Bangkok, Thailand. The complete report is organized into a synopsis-summary (76 p.) plus 11 detailed chapters devoted to the following: Early history of kenaf as papermaking raw material, including review of worldwide experiences; History of the kean and allied fibre industries in Cambodia, Laos, Vietnam and Thailand; Kenaf agronomy and fibre production; Potential kenaf growing areas in the LMB; Kenaf production for paper pulp (stalk composition, site preparation, seed varieties, planting, fertilizer use, cultivation, harvesting, baling, mill operating needs, etc.); Handling, storage, fiberizing, etc. Utilization for paper pulp manufacture (effect of storage on pulp yield and quality, pulp washing and screening, drying, sheet forming, pollution control measures, etc.); Financial and economic aspects (purchasing and handling costs, delivery costs, capital and operating costs, cash flow, revenue estimates, etc.); Developmental activity needs; and Project organization and management. The agro-economic portions present a plan for supplying whole stalk or bast ribbon to a projected mill of ca. 70,000 ad. metric tons/yr which would require an area of ca. 25,000 ha (using whole stalk) or 80,000 ha (for bast ribbon) to grow South Asian kenaf (Hibiscus sabdariffa). Only half of these areas, but of better soil, would be needed for western hemisphere kenaf (H. cannabinus). Of 6 primary sites in the 4 LMB countries, 2 in NE Thailand show commercial possibilities. The market study supports the conclusion that a kenaf bleached soda or sulphate pulp mill would be economically viable and beneficial to the nation. Market acceptance should, however, be assured before building such a mill, preferably by full-scale experimental production of kenaf pulps in existing bagasse mills. Further possibilities for utilizing kenaf in newsprint/furnishes and composition panel boards are also discussed.

181. Bagby, M.O., Clark, T.F., Adamson, W.C., and White, G.A.
Kenaf stem yield and composition: Influence of maturity and field storage.
Tappi C.A. Report no.58: 69-72 (1975).

As an annual fibre crop, kenaf can be harvested either green or after a killing frost. Extended harvesting schedules, planting density, and location all influence the fibre yield and chemical composition. From planting densities of 100,000 and 200,000 plants/ha at Glenn Dale, Md. maximum yields of dry matter at frost were 11.6 and 12.2 t./ha, respectively. In an identical sequence at Fleming, Ga., the maximum yields (15.7 and 15.8 t./ha) occurred one month after frost. In both locations, extractives content decreased after frost, while cellulose and pentosan percentages increased. Even three months after frost, cellulose content remained at least equal to that six weeks before frost.

182. Crouse, B.W.
Effects of growing temperature on chemical-physical properties of kenaf fiber.
Crop Sci. 13: 52-5 (1973).

Several cultivars of kenaf (Hibiscus cannabius) were grown under five different thermal regimes simulating a wide latitudinal distribution in the US. Xylose hydrolyzate content of unfractionated kenaf stems and single bast fibre tensile strength increased with increasing growing temperature. It is suggested that pulps from kenaf grown in a warmer or southerly location may exhibit strength characteristics superior to those of pulps produced from kenaf grown in a northerly location.

183. Pathak, R.C., Kumar, R., Jivendra, and Jain, S.C.
Mesta plant: A potential papermaking raw material.
Ippta 9, no.3: 275-8 (July/Sept., 1972).

Mesta (kenaf) is discussed with respect to availability and agronomical aspects (cultivation, harvesting, and collection, yield). Data are included comparing the fibre dimensions and chemical composition of mesta, bamboo, and eucalypt wood. Since mesta is an annual crop with high bulk, storage area requirements are high and the cost of the pulp is about 10-15% above that of bamboo pulp. This cost could be reduced by the introduction of scientific methods of cultivation. It would be helpful to introduce baling arrangements to reduce transportation and handling costs.

184. Watson, A.J., Davies, G.W., and Gartside, G.
Pulping and papermaking properties of kenaf.
Appita 30, no.2: 129-134 (Sept. 1976).

Kenaf (Hibiscus cannabinus) has attracted considerable attention in recent years as a source of papermaking fibres. Pulping trials have been made on wood and bark from kenaf grown under irrigation conditions in northern Australia and harvested at periods ranging 90 days after planting up to the time of plant maturity (approx. 220 days). Time of harvesting influenced the biomass per hectare but had little influence on pulp yield or papermaking properties. Chemical, semichemical, and mechanical pulps were prepared from the bark and core fractions; pulping and papermaking properties reflect the differences in chemical composition and fibre characteristics. The bark pulps have high tear strength and resemble softwood pulps in general properties. The core is more difficult to pulp, and the pulps are of lower quality, particularly with respect to tear. They have slower drainage characteristics than wood pulps made by the same processes. Although beating produces some improvement in bonding properties, it soon leads to unacceptably low drainage rates.

Sisal

185. Lai, M.L.
The influence on quality of sisal fibers softened by different chemical processes.
Tai-Wan Nung Yeh Chi Kan 11, no.3: 62-76 (1975). (Ch.)

The softening of sisal fibres consisted of boiling with mild to strong caustic solutions, chlorination, and treatment with pyridine. Fibre quality was related to variations in softening procedures.

Sorghum

186. White, G.A., Clark, T.F., Craigmiles, J.P., Mitchell, R.L., Robinson, R.G., Whiteley, E.L., and Lessman, K.J.
Agronomic and chemical evaluation of selected sorghums as sources of pulp.
Econ. Bot. 28, no.2: 136-44 (April/June 1974).

Nine accessions representing 3 sorghum species (Sorghum bicolor, S. almum, S. dudanense) were grown at 6 localities to evaluate their potential as fibrous raw materials for pulp and paper making. Evaluations were based on field yields, agronomic characteristics, and chemical composition. Growing conditions caused considerable variation, but maturity, time of harvest, and harvesting methods also influenced composition. Preferred locations based on production of whole stalks (exclusive of roots) and of culms were Iowa, Indiana, and Georgia. The best productivity for several accessions exceeded 10 t./acre for whole stalks and 6 t./acre for culms. The mean content (for 3 locations) of crude cellulose in culms ranged from 41 to 54% and of alpha-cellulose from 28 to 35%; the level of pith ranged from 6 to 15%. Ash content in culms was 3% or less compared with 7% or more in leaves. Broom grass, sorghum grass, and two kafir types merit further consideration as sources of papermaking pulp.

Straw

(see also abstract no. 144)

187. Lee, H.C., Kini, C-Y., and Kini, K.H.
Preparation of straw pulp in our electrolytically heated digester.
Hwahak Konghak 13, no.5: 275-280 (1975). (Korean)

Rice straw was cooked in aqueous solution containing graphite electrode. The heating by a.c. for 50 min and then d.c. for 10 min. resulted in higher delignification than that by a.c. alone. In the cooking with a.c. and d.c. heating the highest brightness of paper from the pulp prepared was obtained at cooking pressure 4 atm. but tensile strength and breaking length decreased with increasing cooking pressure.

188. Mukherjee, M.N.
Pulp from agrowaste.
Indian Pat. 129,599 (Dec. 8, 1973).

Rice straw was converted to pulp by a process described using NaOH as cooking agent.

D. PROCESSES FOR VARIOUS TYPES OF PANELS.

General

189. Back, E.L.
Medium density fibre building board.
Meddelande, svenska Traforskningrinst; tulet. no.403: 97-110 (1976).

A brief review of manufacturing processes, range of products and strength properties for fibre board in the density range 350-850 kg/m^3 is given.

190. Brooks, S., and Hunter, W.
Recycling of waste cellulose materials.
U.S. pat. 3,741,863 (June 26, 1973).

Fibreboard was manufactured from recycled waste cellulosic products by shredding, drying, separating non-cellulosic materials, heating in a nonflammable medium, e.g. steam, abrading under pressure to rupture H bonds and soften lignin, separating the fibre bundles from the nonflammable medium, adding a resin, forming into a mat, and applying heat and pressure to give the product. The apparatus used in the fibreboard manufacturing process is described.

191. Buechner, R., Buechner, M., Friedemann, O., Braeuer, W., Preissler, W., Braeuer, G., Forcheim, E., Hoecker, R., Schulze, A., and Eickstroh, S.
Boards from lignocellulose chips or fibers with improved covering layers.
Ger. pat. 103,414 (Jan. 20, 1974).

Boards with improved covering layers were manufactured from lignocellulosic chips or fibres in a 1-step moulding process by using as a covering layer, a resin-impregnated, needled felt, preferably from waste textile fibres.

192. Champeau, C.A.
Building material from waste stock from a papermaking process.
U.S. pat. 3,769,116 (Oct. 30, 1973).

The waste stock from various phases of the papermaking process was fed to a settling tank, the effluent pumped to a flocculation tank, the solids from both tanks mixed, converted to sheets by a standard papermaking machine and a multiplicity of the sheets laminated to give building material panels. The sheets before lamination could be treated with hardening agents, e.g. sodium silicate, shellac or varnish.

193. Chawla, J.S.
Composite boards from agrowaste.
IPIRI Journal 5, no.2: 81-84 (1975).

The investigation was carried out for converting agricultural wastes like groundnut shell, paddy husk, corncobs, maize and mentha marc into composite products. Varying proportions of other fibres have been blended and the properties of composite boards thus made are studied.

194. Cherkinskii, Yu.S., and Knyaz'kova, I.S.
Fibrous pulp for manufacture of roof-insulating board.
USSR pat. 445,716 (Oct. 5, 1974).

The addition of 0.001-1.0% poly (vinyl-pyridine) containing aminated chloromethylated polystyrene to cellulose pulp or synthetic fibres gave roof-insulating board with increased absorbency.

195. Clad, W.
Use of waste paper in particle board production.
Holz als Roh- und Werkstoff 28, no.3: 101-4 (1970).

Boards were made experimentally from shredded waste paper bonded with a UF glue. Data are given for strength properties and swelling of boards made (1) entirely of waste paper; (2) with a middle layer of waste paper and outer layers of wood chips or veneers; and (3) with outer layers of waste paper and a middle layer of wood chips. Mixtures of waste paper and chips present difficulties because of differences in density. Writing and printing papers gave better results than newsprint. The mat thickness is considerably greater with waste paper than with wood chips.

196. Demakina, G.D.
Preparation of constructional boards from organic raw material.
Sb. Tr., Vses. Nauch-Issled. Inst. Nov. Stroit. Mater. no.26: 185-92 (1970). (Russ.)

A method is described of obtaining acoustic-constructional boards from wood residues, chopped straw, cotton plants, and similar waste products. The boards are made by compressing with bonding paste. The paste consists of finely ground wood residues and water; preservative, such as sodium fluorosilicate, and fire retardant, such as sodium silicate, can be added to the paste. During the compression water is partly removed by suction. The remaining water is removed by heating to 180-200° at 15-20 kg/cm^2 pressure for 2.5-3 min. The boards are finished by annealing at 160° for 3-4 hours. The boards can be either enamelled or covered with veneer. Their density varies from 400 to 800 kg/m^3 and their bending strength from 32.1 to 131.0 kg/cm^2. The boards do not contain toxic volatile components and can be used in building construction.

197. Deppe, H.J., and Ernst, K.
A handbook of particle board technology.
Taschenbuch der spanplattentechnik (1977), 300 p. (Ger.)

The main part of the book describes the technology of particle board manufacture, dealing with each stage in the process. Sections cover the development of the particle board industry, materials used in particle board manufacture, and the planning of installations. Author and subject indexes are provided. The appendix containing analytical methods, tabulated summaries, specifications and useful addresses (including those of suppliers of plant and equipment, and of bodies involved in particle board research).

198. Eskins, K., Krull, L.H., and Sloneker, J.H.
Fiber boards from feedlot waste.
Tappi ann. meeting (Miami Beach): 285-9 (Jan., 1974).

The conclusion of cattle feeding into fewer facilities has resulted in large feedlots with corresponding increase in feed lot waste (FLW) materials. FLW generally contains a high percentage of cellulose and hemicellulose, a generous portion of which exists as partially pulped fibre. Fibre from 1-3 and 1-6 month old FLW and from fresh FLW was examined as a substitute for wood pulp in the production of hardboard. The fibres from the aged FLW were similar but neither contained a network of fine fibres present in the fibres of fresh FLW, as shown by Scanning Electron Microscope (SEM). Hardboards were produced from these fibres by both the wet- and dry-pressing procedure using PF resin as binder. The hardboards prepared with the fibres isolated from the fresh FLW had the best characteristics with low water absorption and strength equal to one-half that of composite board.

199. Etelkozi, E.
Synthetic wood panels based on agricultural wastes.
Fr. pat. 2,036,882 (Dec. 31, 1970).

Panels are made of agricultural wastes, such as rice straw, flax, corn stalks, and sunflower stems, together with resin. A three-months supply of the raw materials is accumulated and stored under cover. The straw and stalks are hammermilled and digested for 3 to 4 hr using a 1.5% NaOH solution at a pressure of 2 to 6 atmosphere. The pulp is washed until neutral. Natural or synthetic resin is dissolved in water at 100°C and fed to the treatment vessel. HCl is diluted with water and mixed with the fibre and resin. The mixture is dewatered in a mould, the surfaces are treated with wax, and the panel is hot-pressed.

200. Fahmy, Y.A., and Fadl, N.A.
Study of the production of hardboard from some indigenous (Egyptian) agricultural residues.
Egypt. J. Chem. 17, no.3: 293-301 (1974).

Hardboards were prepared from cotton stalks, bagasse, and kenaf pulped by different processes. Bending strength and water resistance values generally were better than for hardboard prepared from a commercial rice straw pulp.

201. Fineman, I., Helge, K., and Soderhjelm, L.
Fibersludge, an interesting raw material.
Svenskpapperstidning 81, no.4: 110-113 (1978). (Sw.)

Considerable amounts of fibrous sludge are generated yearly by the pulp and paper industry, amounting to about 180,000 tonnes oven-dry matter in Sweden, of which about 30% is reused. The disposal costs of the remainder average about $ 5 to $ 40 per oven-dry tonne. Recycling of fibrous sludge in the mill is the most attractive, especially for sludge low in fillers and pitch. Fodder supplements and soil amendments are advantageous outlets for low-ash sludges. The construction industry offers possibilities for use of high-ash sludges in fibre building boards and cement tiles, and of pitch and filler-rich sludges in cement tiles. Successful trials with fibrous sludge have produced panel boards, low density bricks and moulded fibre articles. Economics of sludge reuse must be evaluated separately in each case, as they depend on dewatering and transport costs, as well as on proper cooperation between sludge producer and consumer.

202. Fredriksen, H.
Recycling - practical possibilities.
Emballering 7, no.5: 30-31, 41 (May 1976). (Norw.)

Various types of solid and liquid wastes discharged by different industries in Scandinavia (notably Norway) and their amounts (volumes) are discussed with regard to recovery problems. The sorting, pyrolysis, and production of building panels from municipal refuse are outlined.

203. Fujimoto, K.
Plastic wood boards.
Jap. pat. 4,198,275 (April 16, 1975).

Monomers are used to impregnate wood chips, twigs, or straw ropes, the monomers are polymerized, and the impregnated materials are heated under pressure, treated with mixtures of vinyl monomers, polymers, and powdered wood or plant fibres to fill the holes on the surface, and moulded under pressure and heat to prepare boards. Thus, asbestos was coated with a 15% solution of polystyrene in benzene, methyl methacrylate/styrene copolymer (MAS) and with 20 g hemp rope composite containing 44.8% MAS. The assembly was pressed at 130°C and 5 kg/sq.cm, coated with a mixture of 100 parts 15% solution of MAS (containing 1% AIBN) and 10 parts powdered bark, and pressed at 130°C and 5 kg/sq.cm. for 5 min and at 130°C and 23 kg/sq.cm for 30 min to prepare a board.

204. Garriga Cucurull, S., and Rubio Gonzalez, E.
Process for converting vegetable materials into a moulding composition.
Ger. pat. 2,216,426 (Dec. 7, 1972).

Agricultural and forest wastes (straw, grape vine tendrils, bark, sawdust, branches, etc.) are converted into moulding compositions through treatment with ammonium, alkali, or alkaline-earth hydroxides, with sulphur compounds or with hydrotropic salts. Chemical concentration, reaction period, and reaction temperature depend on the material being treated. The chemical treatment is followed by mechanical defibration.

205. Guha, S.R.D.
Corrugated box manufacture.
Indian Pulp Paper 29, no.8-9: 9-11, 13-15 (Feb-March 1975).

Apart from reviewing the principles of corrugated board production and corrugated box design, the author reports experiments conducted at the Forest Research Institute of Dehra Dun on (1) the NSSC pulping of mixed Indian hardwoods for corrugating medium (2) the soda pulping of rice straw and its use (80%) in combination with gunny waste pulp (20%) for corrugating medium and linerboard; and (3) the hot-soda semimechanical pulping of jute sticks, bagasse, and related fibres for corrugated medium.

206. Inglin-Knuese, I, Josef.
Hard fiber tiles, especially floor tiles.
Swiss pat. 510,719 (Sept. 15, 1971).

Moisture and static-resistant, non-flammable floor tiles are prepared from a straw, grass, cotton linter or jute filler in urea-formaldehyde copolymer (I) or phenol-formaldehyde copolymer (II). Thus, a mixture of ground filler 120, molten paraffin wax 4.5, and I (containing NaOH cure inhibitor) 9 kg is prepared at 90-5° and combined with 21-26 kg I-acid catalyst mixture and 0-2% dye solution and moulded into tiles at 100-30° and about 50 atm. Tiles containing II in place of I are moulded at 140°.

207. Jayaraman, T.M., and Thacker, R.C.
Preparation of fiber-polymer composites from styrene systems by radiation polymerization.
Large Radiation Sources for Industrial Processes; Proceedings of a Symposium on the Utilization of Large Radiation Sources and Accelerators in Industrial Processing,
International Atomic Energy Agency, Munich, Aug. 18-22, 1969, 453-465.

The preparation and properties of fibre polymer composite from Indian woods, bagasse, plywood, particle boards, jute and coir are described.

208. Jetzer, R.
Fibrous materials from domestic, agricultural, forestry and industrial wastes.
Swiss pat. 542,292 (Nov. 15, 1973).

Household garbage, agricultural and forestry wastes, and(or) organic industrial wastes are aerobically partly degraded to form fibrous materials suitable for manufacturing pressboard. The wastes are aerobically treated at 51.5° for 48 hours in a rotating drum with water content of about 45%. The product is dried at about 150° to a water content of about 5% and sterilized. The easily degraded materials, i.e., sugars, starches and proteins, have been degraded. The cellulose and lignins have not been degraded, thus the fibres produced in this process are longer and the press boards have a higher strength.

209. Jetzer, R.
Improving the flexibility of fibres produced from domestic, agricultural, forest product, organic industry and/or tannery wastes.
Swiss pat. 584,732 (Feb. 15, 1977).

Fibrous cellulosic waste material is impregnated with a styrene copolymer (I) before being combined with formaldehyde-melamine-urea copolymer (Kauramin 540) (II) binder to form boards with bending and tensile strength. Thus, fibrous material was impregnated with 4% I and dried at 120-60° to water content 2%. The impregnated material is treated with II (6%), hardener 2.3, ammonia 0.6, and water 30 g and moulded for 6 min at 18 kg/cm^2 (1.5 cm) and then at 160-205° to give a board (density/ 800 kg/m^3), with bending strength 75 kg/cm^2 and tensile strength 2.8 kg/cm^2 compared to 64.0 and 2.5 kg/cm^2, respectively for a board prepared with 11% II and no I.

210. Kaminaga, K., Ito, H., and Oishi, K.
Flame-retardant treatment of pulp sludge board.
Shizuoka-Ken Kogyo Shikenjo Hokoku 20, no.15-19: (1976). (Jap.)

Adding fireproofing agents such as $Al(OH)_3$, NH_4 polyphosphates (I), chlorovinyl polymers, etc., to cellulose pulp sludge slurries, cold-pressing to 50-60% moisture content, drying at room temperature, and hot-pressing at 110-130° gave fire-resistant boards. Minimum quantities of $Al(OH)_3$ and I to prevent the combustion of the boards were 50-70% and 30-50% respectively.

211. Kichlu, K.
Resin- fiber sheets.
Brit. pat. 1,437,031 (May 23, 1976).

Wall paper, flooring, and related building materials are manufactured by applying to a suitable backing a covering sheet consisting of 3-20% natural animal or plant fibres embedded in a cured resin. Jute, manila hemp, and sisal fibres are suitable and can be applied as tows of 8-12 ft long fibres. Laid straight the fibres simulate the appearance of wood grain and are useful in making veneers. The fibres can be laid in a tangled mass from carding.

212. Klingel, W.
Weatherproof building material from vermiculite and wastes.
Ger. pat. 2,125,453 (Dec. 21, 1972).

Materials of increased strength and rigidity were prepared at low costs from vermiculite, polyester resin binders, and wastes from natural fibres (sisal, coconut, jute), synthetic fibres (polyamide, spandex, polyester), acrylic resins or polystyrene resins, paper or paperboard, or wood fibres.

213. Mahanta, D., Rehman, A., Chaliha, B.P., Lodh, S.B., and Iyengar, M.S.
Binderless process for making boards and moulded articles from agro-industrial wastes.
IPIRI Journal 1, no.4: 178-181 (1971).

Describes a single stage dry process for making panels from agro-industrial wastes like sawdust, paddy husk, wheat husk, wheat straw, coconut husk, bagasse and groundnut shell. This process eliminates the use of conventional binders.

214. Maloney, T.M.
Modern particle board and dry-process fiberboard manufacturing.
San Francisco, Miller Freeman Publns. 1977, 672 p.

The 19 chapters of this monograph deal with all aspects of structural insulating and hardboard and fibreboard manufacture.

215. Mehta, S.K., Johar, P.S., and Sayanam, R.A.
Utilization of agro-wastes for mineral based building panels.
Symposium on Production and Utilization of Forest Products, Jammu-Tawi, India, March 5-7, 1979.

Experiments were conducted at the Regional Research Laboratory, Jammu-Tawi (India) on the utilization of mineral and agro-wastes in the production of building panels. The method of manufacturing these boards on rural oriented cottage industry basis without much capital investment is outlined.

216. Miller, H.A.
Particle board manufacture.
New Jersey, Noyes Data Corporation; 1977, 315 p.

Based on the U.S. patent literature issued since approximately 1960, this review presents technical information on the production of wood (and related) particle boards and moulded wood articles. Details are given on raw materials (chips, flakes, shavings, splinters, excelsior ribbons, sander dust, rice hulls, bagasse) adhesive binders (PF, UF, PU, etc.), fillers and other additives;

and on processing and finishing techniques and equipment (pressing, conveying, particle orientation, laminating, overlaying, surface decorating). Investor, assignee, and patent number indexes are appended.

217. Mosesson, T.J.
Production of straw boards by the 'Stramit' process.
Doc.No.ID/WG.83/CR.1, UNIDO Expert Working Group Meeting on the Production of Panels from Agricultural Wastes, Vienna, 14-18 Dec.1970, 11 p.

Of the non-wood fibrous materials available for the production of panel products, it is probably straw and reeds that have been most successfully used in manufactured forms. 'Stramit' is a slab of compressed straw, consisting of unpulped straw with smooth facings.

218. Nishikawa, K., Matsumoto, A., and Niiro, O.
The influence of the mixing ratio of waste paper for the manufacturing fiber board.
J. Hokkaido For. Prod. Res. Inst. 5: 5-9 (1975). (Jap.)

The influence of mixing ratio of waste paper, newspaper and corrugated cardboard for manufacturing fibreboard were studied. Freeness was not affected by mixing ratio less than 40%, therefore, it is possible to use the raw materials for wet process fibreboard. The board was superior in impact strength.

219. Pablo, A.A., Ella, A.B., Perez, E.B., and Casal, E.U.
The manufacture of particle board using mixtures of banana stalk (Saba: Musacompreso blanco) and Kaatoan bangkal (Anthocephalus chinensis (Rich) ex.walp) wood particles.
Forpride Digest 4: 36-44 (1975).

Particle boards of density 592-640 and 672-720 kg/m^3 were prepared from banana stalk and wood chips in various proportions, with 10% UF resin as binder. The physical and mechanical properties of the high-density boards were superior to those of the low-density boards. The strength of boards increased with increase in the proportion of wood chips in the mixture.

220. Riewer, M., and Wulffes, H.
Pressed board made from fibrous material and a binding substance.
Brit. pat. 1,312,383 (April 4, 1973).

A structural board is formed by compacting comminuted reed or sedge grass material with a synthetic resin binder such as a urea resin.

221. Rutkowski, J.
Economic significance of the production of particle board from rape.
Przeglad Wlok. 27, no.5: 284-5 (May, 1973). (Pol.)

The main wood substitute used in Poland for the manufacture of particle boards is flax and hemp straw. This material is presently utilized 100%. A material that remains to be utilized fully is rape straw. It has been calculated that 4 cu.m. board can be produced from 1 ha flax; 8 cu.m. from 1 ha hemp and 5 cu.m. from 1 ha rape. One cu.m. board requires 3.28 cu.m. wood, an amount that corresponds to an annual increment from 1.5 ha. In 1970, the production of rape straw was about 1500 thousand tons. Utilization of only 60% of this amount would yield 900 thousand cu.m. board. Studies conducted several years ago indicated that rape straw is a raw material suitable for the production of constructional and insulation boards. More recently, a plant for the production of 9000 ton board annually was designed.

222. Semana, J.A.
Manufacture of fiberboard.
Forpridecom Tech. Note No.152, April, 1975, 3 p.

This note reviews briefly the raw materials, pulping and refining, sheet forming, pressing/drying, and finishing (trimming, oil-tempering, etc.) techniques, and binders and additives used in making hardboard and insulation board.

223. Singh, S.M., and Aggarwal, L.K.
Portland cement bonded panel products from agricultural wastes.
Research and Industry 22, no.4: 242-245 (1977).

The use of portland cement as a binder has been under investigation at the Central Building Research Institute, Roorkee. Particle boards from rice husk, groundnut husk, coconut pith and wood chips have been made under pressure. It is found that they do not exert inhibitory action on strength development in portland cement. Building panels of adequate strength are obtained when rice husk/coconut pith and cement are mixed in the ratio 1:2 by weight and consolidated to a density of 1100-1200 kg/m^3. Groundnut husk and wood chips, however, require more cement.

224. Stillinger, J.R., and Wentworth, I.
Bison endless systems for producing nonwood fiber panel board.
Tappi C.A. Report no.67: 71-84 (1976).

Even though the majority of panel factories use wood in some form as the basic raw material, there are several plants currently in operation throughout the world using such nonwood fibrous residues as flax, bagasse, alpha grass, rice husks, cotton stalks, corn straw, and hemp as raw material for board products. Each of these raw materials has unique properties and problems in processing into usable products. After these raw materials have been collected properly milled and/or refined and dried to a low moisture content, the major equipment components required to manufacture a useable product involve the steps of air classification, blending, forming and pressing. The latest technology recommends using the endless calendar (Mende) press for making panels in thickness from 2 mm to 7.5 mm and the endless flat segmented-platen press for products from 7.5 mm to 22 mm.

225. Takahashi, H., Moriyama, M., Osawa, K., and Endo, H.
Manufacture of three-layer medium-density fiberboards from (sedimented) pulp waste.
J. Hokkaido For. Prod. Res. Inst. no.5: 7-11, 18 (May, 1974). (Jap.)

An experimental study was performed on the optimum utilization of settled pulp waste (white water sludge) for the manufacture of medium-density insulation boards by a dry forming process. Three-layer boards 9 mm thick exhibiting both high bending strength and desired surface smoothness were produced from two facing layers composed of sedimented pulp fibre waste and a central (core) layer made of basswood chips (chipper dust). The dry process involved 2-stage hot-pressing, viz., 30 sec at 15 kg/sq.cm. followed by a reduced pressure of 10 kg/sq.cm applied until the board temperature reached 170°C. The best board bending strength was obtained by adding synthetic resin binder in ratios of 10% to the face layers and 4% to the core layer.

226. TAPPI, Nonwood Plant Fiber Committee.
Nonwood plant fiber pulping. Progress Report no.7 (featuring utilization of nonwood plant fibres for manufacture of composition panel boards).
Tappi C.A. Report no.67: 111 p. (1976).

Ten technical papers presented at a conference held in Dallas (Sept. 1976) are included in the volume. Most of them deal with the manufacture of particle boards and related building panels from bagasse, kenaf and other nonwood fibrous raw materials.

227. Vladar, J., Vladar, I., Juhasz, M., Vladar, P., and Vladar, G.
Process for the preparation of building units.
Brit. pat. 1,422,738 (Jan. 24, 1976).

A process for making building boards comprises mixing 15-85 parts by weight of a base material with 10-65 parts of residual oil, e.g. bitumen, and/or coal distillation residue, e.g. tar, and optionally a resin such as rosin at 120-250°C, 1-20 parts of an oxide and/or hydroxide of an alkali metal and/or alkaline earth metal, e.g. NaOH, having been previously added to the base or to the distillation residue, and shaping the resultant mixture at a temperature above 80°C. The board so formed can be faced with metal, plastic, fibre or the like. Suitable base materials include inorganic and rubber materials as well as cellulosic materials such as rice hulls, nut shells, corn stalks, corn cobs, sawdust, straw, pine needles, etc.

228. Watson, A.J., and Gartside, G.
Utilising woody fibre from agricultural crops.
Australian Forestry 39, no.1: 16-22 (1976).

The pulping and paper making properties of kenaf (Deccan hemp) (Hibiscus cannabinus) and elephant grass (Penniselum purpurum) were measured and compared with those of conventional pulpwoods. Pulp made from the bark of kenaf resembled softwood pulps and pulps from wood of kenaf or from elephant grass resembled hardwood pulps. The possibilities of using the stem and leaf material of grain sorghum, cassava stems and abaca fibre are also briefly considered. Of these, only abaca seems to have much potential value.

229. Yano, T., Take, T., Nakahara, K., and Sasano, T.
Process for producing a board of cement-like material reinforced by fibrous material and apparatus for the process.
U.S. pat. 3,972,972 (Aug. 3, 1976).

A process for continuously producing a dense board of cement-like material reinforced by fibrous material comprises preparing granules of cement-like material having a diameter of 1-10 mm by adding water to a powdery cement-like material, e.g. alumina cement, gypsum, etc., in the minimum amount required for granulation, preparing a granule mixture of the cement-like material and a fibrous material, e.g. wood wool, asbestos, vegetable fibre, glass fibre, etc., by means of a pan-shaped pelletizer or a drum-type rotary system mixer by sprinkling fibrous material having a fibre length of 20-100 mm dispersed in air onto the above prepared granules, and forming the granular mixture into a board under compression with the addition of water in such an amount that the total amount of water is the minimum amount theoretically required for hydration.

230. Zukowski, R.J.
Building board.
B t. pat. 1,404,001 (Aug. 28, 1975).

An asbestos-free building board having good fire resistance is formed by paper making methods from a furnish including a water-settable inorganic binder such as calcium silicate or portland cement, fibrous reinforcing material comprising organic fibres which do not melt below 140°C, e.g. pulp fibres or synthetic fibres, and vermiculite.

Abaca

(see abstract no. 211; 228; 272)

Bagasse

(see also abstract no. 200; 205; 207; 215; 216; 224; 226)

231. Ball, G.L., and Salyer, I.O.
Development of low-cost roofing from indigenous materials in developing nations: Final report.
Aid Research and Development Abstracts 6, no.1: 38 (1978).

Four composite panel roofing material systems were developed which utilize major percentages of indigenous bagasse filler, and minor amounts of phenolic or other resin binder. Three of the four processes use an intensive (Banbury) mixer. All four have compression moulding as a final process step in panel fabrication. The products range in raw material cost from 6-14¢ per sq.ft. of roofing panel, depending on composition, resin content, etc. Local labour, material and facilities were utilized to demonstrate manufacture of roofing, by one or more processes, in the Philippines, Jamaica and Ghana.

232. Botz, R.
Roofing composition.
S. African Pat. 7,202,322 (Nov. 17, 1972).

A roofing composition comprises a vinyl acetate homopolymer, a vinyl acetate-lower alkyl acrylate copolymer (or their mixture), a fibrous filler derived from bagasse and containing an alum, and a finely divided pigment. Thus, to a mixture of 90 lbs plyamal 40-155 (55% solids) and 90 lbs walpol 40-133 (55% dispersion of vinyl acetate-2-ethylhexyl butylacrylate copolymer) is added to 1 lb concentrated grade alum in 5 gallons water. After thorough mixing, approximately 20 lbs bagasse fibre (containing 0.3 wt % alum and prepared by contacting the bagasse without prior digestion or chemical treatment with an aqueous alum solution; the bagasse is defibrated mechanically and fibres separated from pulp and dried) is added. After mixing again, about 11.8 lbs of water base paint is added.

233. Botz, R.
Bagasse-reinforced resin bodies and method of making same.
U.S. pat. 3,714,084 (Jan. 30, 1973).

Bagasse is treated with an aqueous solution of alum and defibrated to give a fibrous product of use as reinforcement in moulding resin composition. The fibre can be pulverized to yield a flour suitable as a filler in moulding resins. The treatment also produces a clean sugar-free moisture-resistant low-density cellular pith material suitable for manufacturing insulation and acoustical material.

234. Bryant, B.S.
Corrugated roofing panels from agricultural residues.
Appropriate Technology 4, no.4: 26-28 (1978).

A process is described that permits the conversion of fibrous agricultural residues such as bagasse from sugar-cane into a corrugated oriented fibre roofing panel. The process is designed to be labour intensive and requires relatively low capital investment. When suitably protected with impregnants or coatings such as asphalt and aluminium paint, the roofing material may be comparatively durable and significantly less expensive than corrugated galvanized iron. The potential benefits to third world communities resulting from the manufacture of the product include the creation of employment, savings of foreign exchange and strengthening of agricultural based economies while providing low-cost construction material for local housing.

235. Carbajal, M.
Process for making moldable bagasse compositions.
U.S. pat. 3,748,160 (July 4, 1973).

Ground bagasse is treated with salts to convert residual sugar juices into inert compounds, and the treated bagasse is mixed with portland cement to form a mass which can be moulded into wallboards.

236. Dhamaney, C.P., and Singh, K.R.
Note on cork substitute sheets.
Paintindia 27, no.3: 19-21 (1977).

Treating ground Erythrina suberosa bark, bagasse and Cryptemeria japonica , with rubber latex-based adhesives yielded cork substitute boards with satisfactory properties. Adhesives based on cashew-nut shell liquid and rosin-NH_3 also gave boards satisfying the requirements of cork substitutes.

237. Grefco Inc.
Thermal acoustical insulating boards.
Brit. pat. 1,390,736 (April 18, 1975).

A process for producing a thermal and acoustical insulating board comprises forming a slurry of a thermally expanded mineral aggregate (Perlite), defibred cellulosic fibrous material, e.g. newsprint pulp, kraft paper pulp, bagasse, etc., and a binder such as asphalt and clay; sheeting out the slurry; partially dewatering the sheet, coating the still-wet surface of the sheet with a coating containing glass fibres; dewatering, pressing, and drying.

238. Hay, C.S.
Pulping bagasse on a commercial scale.
Berita selulosa 7, no.3: 131-5 (1971). (Indonesian)

A review paper.

239. Hsieh, W-C., and Chen, M-S.
Preparation of phenolic resin bagasse particle board.
Tai-Wan Tang Yeh Shih Yen So Yen Chiu Hui Pao, no.57: 95-107 (1972). (Ch.)

Phenol-formaldehyde resin, phenol-m-cresol-formaldehyde resin and phenol-resorcinol-formaldehyde resin were prepared, mixed with bagasse particles, pressed for about 15 minutes at about 145-150°/ 12 kg/cm^2 to give particle boards which met WCPA specifications, and their resistance to weathering tested. All the boards had good weathering resistance, and in accelerated aging tests had flexural strength 70-85% of the original.

240. Kossoi, A.S., Zvirblite, A., Livshits, E.M., Badusov, A.A., Guryanov, V.E., and Malyutin, N.A.
Pulp for fibrous slabs.
USSR pat. 334,309 (March 30, 1972).

Pulp for fibreboard was produced by the chemical treatment of lignocellulose, e.g. chopped sugar-cane, followed by beating. To improve the board quality and lower the energy consumption during beating, the lignocellulose was treated with spent sulfate liquor of density 1.03-1.04 g/cm^3 and total alkalinity 11.5-15 g/litre Na_2O containing 70-100 g/litre solids at pH 10.5-11.5."

241. Potter, E., Potter, I.W., and Smyth, R.M.
Process for manufacturing particle boards.
Ger. pat. 2,414,090 (Oct. 7, 1975).

This process for producing particle board from a wide range of lignocellulosic materials, e.g. sawdust, shavings, chips, bark, bagasse, etc., is similar to that claimed in U.S. pat. 3,804,935 (April, 1974).

242. Potter, E.
Process for manufacturing particle board.
Fr. pat. 2,267,198 (Nov. 7, 1975).

The process for producing particle board from a wide range of lignocellulosic materials, e.g. sawdust, shavings, chips, barks, bagasse, etc., is similar to that claimed in U.S. pat. 3,804,935 (April, 1974) and Ger. pat. as given in the preceding abstract.

243. Rakszawski, J.F., and Schroeder, H.F.
Single stage addition of resin in the preparation of multilayer bagasse boards.
U.S. pat. 3,493,528 (Feb. 4, 1970).

The ratio of resin in the pith-and-fibre fraction (A) to resin in the fibre fraction (B) of milled bagasse composition for making pith-coated fibreboard was controlled at 1.97-3.43 : 1 by a single stage application of 8.3-13.3% resin or 38% aqueous solution of viscosity 100-955 cP to a mixture of A & B having the amount of pith adjusted to 16-26%, e.g. A from milled green bagasse was separated from B and then readded to give 16% pith concentration; and phenol-HCHO resin (I) solution of viscosity 710 cP, containing 5% NaOH, was added to the given composition of 8.3% total resin content and an A-B resin ratio 2.54 : 1. Laminating 2 air-felted layers of A with an intermediate B-layer, and pressing at 300°F until I was cured gave boards with high density surfaces and strongly bonded interiors. Surfaces of boards prepared with an A-B resin ratio less than 1.8 were not printable since ink tended to be absorbed and diffused through the soft powdery surfaces. When the ratio was too high, the fibre resin content was so low that the board had low bending strength and modulus of elasticity.

244. Rengel, F., and Bartolucci, L.A.
Boards from sugar-cane bagasse and quebracho tannin-formaldehyde resins: Boards prepared from cellulosic waste sugar-cane.
Ind. Quim. 26, no.3: 178-182 (1968). (Span.)

The board is prepared with disintegrated, fully extracted sugar-cane wastes and a resin binder made with 50% sulfited quebracho tannin solution, formol, and hexamethylene-tetramine.

245. Rionda, J.A.
Process for making a bagasse pith composite structure.
U.S. pat. 3,663,673 (May 16, 1972).

A process for the manufacture of a structural board comprises forming a felted mat of bagasse pith, fine, and coarse fibres with the fines being distributed on the surfaces of the mat, applying a resin to the surfaces of the mat, and subjecting the mat to heat and pressure.

246. Saneda, Y., Yamada, H., and Takizawa, T.
Bagasse-based building boards.
Jap. pat. 7,793,432 (Aug. 6, 1977).

Bagasse is mixed with regulated set cement or $CaSO_4$ 0.5 H_2O in a 35-50 : 50-65 ratio (dry basis) and optionally 1-50% polyvinyl alcohol as aqueous 10-20% solutions, compacted at 0.5-1.5 kg/cm^2 and hardened. Thus, 82 g bagasse containing 15% water was dipped in water for 3 hr, mixed with 105 g regulated set cement after removing excess water, moulded, compressed at 0.7 kg/cm^2 for 24 hr, and dried at 20°C to obtain a bagasse board having specific gravity 0.56 and bending strength 20 kg/cm^2.

247. Simunic, B.
Process for production of high-quality cement-bound wood-chip or similar boards, especially wall panels made of wood, bagasse or woodlike raw materials.
Brit. pat. 1,414,310 (Nov. 19, 1975).

A process is provided for making board from cement-bound particles of wood or bagasse or the like. The particles are mixed with water and cement and the mixture is moulded, pressed, and dried to form a finished board. A copolymer is incorporated in the board either by adding an aqueous dispersion of the copolymer to the chip/cement mixture before moulding, or by treating the moulded board before pressing. The preferred copolymer is a copolymer of 5-40% vinyl chloride, 40-80% vinyl carboxylic acid ester, and 5-25% ethylene.

248. Wang, Ung-Ping.
Scale up production of bagasse plastic combinations using gamma radiation.
Ho Tzu K'o Hsueh. 12, no.1: 12-22 (1975).

The impregnation of bagasse boards with vinyl acetate-vinyl chloride mixture, methyl methacrylate, unsaturated polyester-methyl methacrylate mixtures or styrene dissolved in EtOH, followed by irradiation with a ^{60}Co source, gave plastic-bonded structural boards with higher resistance to insect damage than the untreated bagasse boards.

Bamboo

249. Arora, K.L., Gokhale, Y.C., and Iyengar, M.S.
Bamboo pulp-portland cement building materials.
Indian pat. 105,930 (Sept. 13, 1969).

Bamboo chips (I) were digested for 5 hours with 20% NaOH solution 4 parts under a steam pressure of 8-10 kg/cm^2, the pulp washed, and beaten for 8 hours to give 30 Schoopper-Riegler freeness. The 5 parts of pulp obtained was mixed with portland cement 95 parts, and the mixture spread in a mould for roofing sheet of 6 mm thickness, pressed to a minimum density of 1.8 g/cm^3, cured in H_2O for 28 days to give a roofing sheet having rupture load of 160 kg/cm^2, water absorption 19.2%, and resistance to acidified water 0.103 g/cm^2. The mixture could also be moulded to give building boards, pipes and sanitary fittings.

250. Ma, T-P., Jai, S-Y., and Tsou, C-T.
Experiment on the manufacture of bamboo glu-lam.
Bull. Taiwan For. Res. Inst. no.285: 14 (1976). (Ch.)

Uniform laminae of *Phyllostachys edulis* and *Sinocalamus latiflorus* were treated with preservatives, steamed, and kiln dried to 10-12% moisture content, and laminated with a UF/melamine resin adhesive. The properties of the resulting glu-lam were similar to those of wood, except for a much greater modulus of elasticity.

Banana stems

(see abstract no. 219)

Cassava stalks

(see abstract no. 228)

Coconut husk and coir

(see also abstract no. 206; 212; 213; 223)

251. Central Building Research Institute, Roorkee, India.
Corrugated roofing sheets from coir waste or wood wool.
Technical Note no.68: 1978, 5 p.

Describes a process developed at the Central Building Research Institute, Roorkee, for the production of corrugated roofing sheets from coir waste and wood wool. The sheets obtained were light and tough, and possessed good thermal insulation properties.

252. Couquet, F., and Fonquernie, A.
Wall or floor covering and process for its manufacture.
Fr. pat. 2,277,673 (Feb. 6, 1976).

A wall or floor covering material is manufactured by contacting a continuous fibrous fleece (preferably a layer of parallel coir yarns) with a paper or nonwoven web which has just been coated with a thermosetting synthetic resin, e.g. a polyester resin. The resulting laminate is passed around a heated cylinder cooperating with a press roll to harden the resin.

253. George, J.
Development of building materials from coconut husk and its by-products.
National Seminar on Development and Utilization of New Materials in Building Technology, Trivandrum, India, Sept. 1976, 6.01-6.09 p.

The paper summarises the work of the author on the preparation of panel materials from coconut husk and its by-products. The results show the immense possibilities for the commercial exploitation of these abundant raw materials.

254. Goto, F., and Ikeda, T.
Coir sheets.
Jap. pat. 7,828,086 (Aug. 26, 1976).

Light-weight sheets, useful as sound and thermal insulators, were prepared by blending a binder with coir dust 100, phenolic resin 3-100 and polyethylene fibres 5-100 parts, heating at about 180° and pressing to give a sheet about 3 mm thick.

255. Ogawa, H.
Utilization of coir dust for particle board.
Osaka Kogyo Gijutsu Shikensho Kiho 28, no.3: 231-233 (1977). (Jap.)

Particle boards having bending strength over 100 kg/cm^2 were prepared from coir dust, over 10% fibre and urea resin.

256. Ohtsuka, M., and Uchihara, S.
Boards from resin impregna . coconut husk.
Jap. pat. 7,322,179 (March 20, 1973).

Fibres and cork from coconut husk were impregnated with vinyl monomers and pressed after polymerizing the monomers to give a board. Thus, 1 kg coconut fibres and 1 kg coconut cork were evacuated and impregnated with 1.6 kg of a mixture of styrene 45, methyl methacrylate 50 and divinyl benzene 5 parts containing 0.9% azobisisobutyronitrile. The mixture was heated for 4 hr at 65°C to polymerize the monomer, and the product was arranged in such a way that the cork was sandwiched between fibre layers and pressed at 15 minutes at 100°C and 20 kg/cm^2 to give a board with density 0.80, flexural strength 750 kg/cm^2 and compressive strength 860 kg/cm^2.

257. Ohtsuka, M., and Uchihara, S.
High-strength inorganic hydraulic material-coconut and fiber-polymer composite.
Jap. pat. 7,603,354 (Feb. 2, 1976).

A paste containing long or short coconut fibres, hydraulic material, and water is moulded, hardened, and impregnated with monomer or oligomer. Thus, high-early-strength cement 100, coconut fibre (length 4-6 cm) 20, and water 90 parts were mixed, moulded, hardened for 12 hr; cured in water for 10 days, and dried at 60°C for 24 hr. The moulded product was impregnated with a solution containing methyl methaceylate 80, styrene 20, and benzoyl peroxide 1 part, heated with hot N at 60°C and treated in a furnace at 105°C for 20 min. The composite contained 22.0% polymer and had specific gravity 1.18 and bending strength 235 kg/cm^2, compared to 1.15 and 145 kg/cm^2 for that made with crushed rice hulls.

258. Roth, J.
Process for manufacturing products of fibers and synthetic foam and products thus obtained.
Fr. pat. 2,276,922 (Jan. 30, 1976).

A process for manufacturing insulation board involves forming a fleece of fibres, e.g. coir, preferably via a carding process, needling the fleece, cutting the fleece into sheets, treating the sheets with a foamable polyurethane composition with a long activation period, and hot-pressing the treated sheets at very high pressure such that the polyurethane, in expanding, becomes distributed throughout the thickness of the fibre fleece and polymerizes to fix the fibres in place.

Coffee hulls

259. Runton, L.A.
Method of producing molded articles from coffee bear hulls.
U.S. pat. 3,686,384 (Aug. 22, 1972).

The method of producing moulded articles from coffee bean hulls or from rice hulls or from mixtures thereof in which the hulls are ground, dehydrated and moulded at a temperature from 450° to 500°F, and at pressures of ½ to 10 tonnes per square inch, whereby the resin component flows to form a resin based moulded rigid article.. Synthetic resin binders can also be used.

Corncobs and corn stalks

(see also abstract no. 193; 199; 224; 227)

260. Chow, P.
Reconstituted board products from plant-fiber residues.
U.S. pat. 3,927,235 (Dec. 16, 1975).

Particle board made from waste fibre materials has a core layer made of nonstalk portions of plants, e.g. tree bark, corn cobs, coffee grounds, etc., and face layers made of the stalk portions of plants, e.g. corn stalk fibres, wood shavings or sawdust, veneer sheets, etc.

261. Deml, M.
Apparatus for manufacturing construction and insulation boards of granular material, especially from comminuted corncobs.
Ger. pat. 2,224,470 (Dec. 6, 1973).

A manufacturing line for the production of particle boards or the like is particularly suited to the processing of comminuted corncobs as raw material. Specifically, hammer mills, flow-through drum-drying units, and containers for rejects are positioned between the raw material supply hopper and the binder-applying station.

262. Deml, M., and Limberg, J.
Apparatus for preparing a binder mixture for application of organic particles in producing boards or moulded articles for building purposes.
Ger. pat. 2,228,672 (Jan. 10, 1974).

An automatic mixing and pumping system is provided for preparing a reinforcing agent/binder composition particularly for use in manufacturing particle board from comminuted corn cobs.

Cotton

(see also abstract no. 196; 200; 224)

263. Akkerman, A.S., Volkova, V.D., Petri, V.N., Lazareva, A.D., Abrosimov, S.P., and Ivanov, V.I.
Lignocarbohydrate plastic from guza-paya without the use of binders.
Izv. Akad. Nauk Kirgiz. SSR no.6: 70-74 (1975). (Russ.)

A comparison of the components of pinewood, birchwood, aspen wood, and guza-paya (cotton-stems and bolls) indicated that guza-paya was similar to wood and contained high amounts of reactive lignin and water-soluble or easily hydrolysed polysaccharides, which made it suitable for making moulded products without a binder. Experimentally determined optimum conditions, obtained by studying process variables, were: pressure, 25 kg/sq.cm, pressing temperature 170-175°C, pressing time 1.0-1.2 min/mm of board thickness, initial moisture content, 19-21%. The products had a bending strength of 170-220 kg/sq.cm, swelled in water by 15-17% in 24 hr. and absorbed 11-14% moisture. They had a moisture content of 9-10% after pressing and a density of 1.11 - 1.16 g/cu.cm.

264. Burkhart, G.W.
Fibreboard.
Ger. pat. 1,912,657 (Oct. 16, 1969).

Anionic fibres of kraft pulp, nylon, rayon, cotton or asbestos are slurried in water, treated with $Al_2(SO_4)_3$, adjusted to pH 8-9 with NH_4OH, treated with a latex based on a butadiene-styrene copolymer (I), polybutadiene, nitrile rubber, or polychloroprene, treated with a 3:2:5 acrylonitrile-butadiene-styrene copolymer (II) polyvinyl chloride, or a phenolic resin stabilized with a linear Na alkyl benzene sulfonate (III) and used to prepare fibreboard.

265. Cotton Technological Research Laboratory.
New products from waste materials.
Chemical Weekly 24, no.17: 67 (1979).

The Cotton Technological Research Laboratory, Bombay has developed a new process for making particle boards from cotton stalk and jute waste. This paper presents a brief outline of the process.

266. Luthardt, H.
Processing of cotton wastes into insulating sheets.
Holztechnol. 12, no.3: 131-6 (Sept., 1971). (Ger.)

Particle boards were manufactured from cotton wastes (broken seed hulls) and a granular phenolic resin binder, and the physical technical properties (resin content, thickness, density, thickness swelling bending strength, compression modulus, dimensional stability dampening factor, dynamic modulus of elasticity, and heat conductivity) of the boards were measured. Results indicate such board to be well suited for use as a core layer in multilayer heat and/or sound-insulating boards.

267. Mobarak, F., and Nada, A.
Fiberboard from exotic raw materials (2) Hardboard from un-debarked stalks.
J. Appl. Chem. Biotechnol. 25, no.9: 659-662 (Sept., 1975).

Hardboards of acceptable properties were prepared by mechanically pulping cotton stalks previously soaked in water. Pretreatment of the stalks with sodium or calcium hydroxide at 100°C before mechanical defibration improved the properties of the hardboard, and reduced the resin requirements. The semichemical pulps had a much higher freeness than those from rice straw, and the hardboards were better than those obtained from rice straw or average samples of wood wastes.

268. Volkova, V.D., Abrosimov, S.P., Petri, V.N., Akkerman, A.S., and Ivanov, V.I.
Lignocarbohydrate binderless plastic from guza-paya and wood wastes.
Izv. Akad. Nauk Kirgiz. SSR no.1: 46-48 (1976). (Russ.)

A mixture of comminuted guza-paya (cotton stems and bolls) and waste pinewood from wood-processing factories was made into a binderless moulded product by hot pressing at 165-170°C. The moisture content of the mixture was 17-19%. There was no limitation on the amount of guza-paya used. After conditioning at 60-70% RH for 30 hr at 20 $\pm$ 2°C the finished product (board) had a bending strength of 180 kg/sq.cm, 15% swelling in water after 24 hr and not less than 1.18 g/cu.cm density. Experimental data indicated that a mixture of comminuted guza-paya and pinewood gave moulded products with sufficiently high physico-mechanical properties.

Flax

(see also abstract no. 199; 221; 224)

269. Surmeli D.D., Pelep, T.M., Avirom, S.M., Sukhova, L.A., Ustinova, E.T., and Morozyuk, L.V.
Waterproof roofing material.
USSR pat. 352,986 (Sept. 29, 1972).

A durable waterproof material is obtained by coating a fibrous base consisting of low grade wastes from the production of flax.

Grape vine

(see also abstract no. 204)

270. Bouvier, A.
New molding material and diverse products obtained.
Fr. pat. 2,232,434 (Jan. 3, 1975).

Comminuted grapevine stems are used as raw material in the manufacture of particle board. The board is characterized by good sound insulation properties and moisture resistance.

Grasses

(see abstract no. 206; 220; 224; 228)

Ground-nut shells

(see also abstract no. 193; 213; 223)

271. Mars, P.A.
An inquiry into the feasibility of producing particle board from ground-nut husks in India.
Tropical Products Institute Report no.G.55, 1970, 73 p.

Production costs for particle board made from ground-nut husks were estimated at Rs.1.24/sq.ft. compared with Rs.1.52 for wood particle board (Rs.1.40 is the present wholesale price for wood particle board). It was considered unlikely that sufficient husk particle board would be sold in India to cover costs, unless wood prices rose sufficiently to make it competitive.

Hemp

(see also abstract no. 211; 221; 224)

272. de Coursac, H.
Process and apparatus for producing fibrous material from Manila hemp and similar plants with a high moisture content.
Fr. pat. 2,056,023 (May 14, 1971).

Manila hemp and similar plant material with a high moisture content is prepared for use in the manufacture of paper or particle board by drying of the chopped material to about 45-55% moisture content in a continuously operating press.

Jute sticks

(see abstract no. 205; 206; 207; 211; 212; 265; 292)

Kenaf

(see also abstract no. 200; 226; 228)

273. Bagby, M.O., and Clark, T.F.
Kenaf for hardboards.
Tappi C.A. Report no.67: 9-13 (1976).

Frost-killed kenaf was evaluated as a hardboard raw material, and trial results demonstrate its use to be technically feasible. Boards with densities of 0.78 to 1.15 g/cc had tensile strength ranging from 2,980 to 11,150 psi. The boards compare favourably with wood derived hardboards having densities of 1.02 g/cc and tensile strengths of 5,080 psi.

Pine needles

(see also abstract no. 227)

274. Gupta, R.C., Singh, S.P., and Nautiyal, S.N.
Hardboards from pine needles.
IPIRI Journal 7, no.1: 30-32 (1977).

Laboratory trials showed that hardboard with fairly good strength properties (suitable for packing cases) could be produced from fresh needles of chir pine (Pinus roxburghii). Water absorption by the boards was markedly reduced by coating them with wax on one or both sides. The pine needles are available in large quantities (P. roxburghii covers about 890,000 ha in N.India), and are a fire hazard in the forests. Their utilization will both save timber and increase employment opportunities.

275. Howard, E.T.
Needleboards: an exploratory study.
Forest Prod. J. 24, no.5: 50-1 (1974).

Attempts to prepare hot-pressed boards from slash pine needles (using PF and UF resins) were unsuccessful. Needles flattened in a sheet metal roller and dewaxed with benzene as well as untreated needles were poorly bonded. Pretreatment with 10% NaOH improved bending strength and internal bonding, but stiffness and dimensional stability of the boards were poor.

276. Regional Research Laboratory, Jammu.
Fibre-board packing cases.
Regional Research Laboratory, Newsletter 2, no.5: 17 (1975).

The present demand for fruit packing cases in northern India is approximately 14 million/yr, requiring a large volume of timber. Trials on the use of fibreboard made from pine needles for packing case manufacture have shown that packing cases made from this material have adequate strength properties, tolerating a static load of 1 t when supported with wooden battens and plastic strappings. It is estimated that a small-scale unit, processing 2 tonnes needles/day, could produce approximately 850 packing cases/day, at a cost of approximately Rs.5.00 per case, against Rs.5.50 for wooden cases.

277. Regional Research Laboratory.
Production unit for packing cases from pine needles.
Regional Research Laboratory, Jammu, Newsletter 3, no.5: 17-18 (1976).

A description (with two photographs) of a Government sponsored pilot plant set up in Bilaspur, Himachal Pradesh (India) in June 1976, for the manufacture of packing cases with fibreboard made from fallen needles of chir pine (Pinus roxburghii). The needles had no previous commercial use, and are a forest fire hazard. The plant has an annual production capacity of 750 tonnes fibreboard (250,000 packing cases); daily production on a 3-shift basis would be 2-2.5 tonnes. The simple manufacturing process, requiring little capital investment, and using local materials, should benefit the regional economy. Each plant of this size would provide approximately 50 full-time jobs, with approximately 100 part-time employees required for collection and transportation of needles.

278. Singh, S.M.
Corrugated roofing sheets from forest products.
Symposium on Production and Utilization of Forest Products, Jammu-Tawi, March 5-7, 1979.

Building boards and roofing sheets produced experimentally at the Central Building Research Institute, Roorkee (India) from some forest products like pine needles, bhabar and munja showed adequate fire resistance and durability.

Reeds

(see abstract no. 217; 220)

Rice hulls and rice husks

(see also abstract no. 193; 200; 205; 213; 216; 223; 224; 227; 295; 300)

279. Cor Tech Research Ltd.
Resin-coated rice hulls and production of composite articles therefrom.
Brit. pat. 1,403,154 (Aug. 13, 1975).

Rice hulls are coated with a caustic-free thermosetting PF resin, the resultant mass is shaped into a desired article such as a board, and the resin is cured. The resin is of a type which in its uncured state has a viscosity of more than 100 Krebb units at 120°F. The coating of the rice hulls may be accomplished by directing an atomized spray of heated resin on to the hulls while agitating the hulls in a rotating blender.

280. George, J., Zoolagud, S.S., and Jagadeesh, H.N.
New building materials from rice husk - production, properties and application.
National Seminar on Development and Utilization of New Materials in Building Technology, Trivandrum, India, Sept. 1976, 5.01-5.08 p.

Modified phenolic resin adhesives having special properties to bind rice husk into boards of high quality have been developed. It has been found that raw rice husk as it comes from the rice mill can be converted into boards of a wide range of densities from as low as 250 kg/m^3 to over 1300 kg/m^3 with high internal bond strength and other desirable physical-mechanical properties. No pre-treatment of the husk is necessary except wind sifting to remove dust, and paddy and rice grains if any.

Modified phenolic adhesives have been successfully used in the production of rice husk composite boards of widely ranging properties from rice husk and materials such as bamboo, jute fibre, coconut fibre, paper, jute mats, bamboo mats and wood veneer.

Rice husk particle board possesses many characteristics one would except to find in an ideal building material for a tropical environment such as moisture, termite, insect, decay, and fire resistance and good thermal insulation property. Rice husk board is therefore a very promising building material for low cost mass housing and general construction.

281. George, J., Zoolagud, S.S., Surender, G.D., Narayana Prasad, T.R., Rangaraju, T.S., and Mohandas, K.K.
Improvements in or relating to composite boards from rice husk and composite board obtained by said process.
Indian pat. 146015 (Aug. 30, 1976).

Process for making improved composite boards from rice husk characterised in coating and admixing the raw rice husk with a water dispersible resin wherein the said resin is prepared by the method comprising condensation of phenol, cardanol and/or cashew-nut shell liquid with an aldehyde in the presence of an alkaline catalyst wherein the improvement comprises in the one-step condensation of the following ingredients in the proportion as set forth herein: (i) cardanol and/or cashew-nut shell liquid 25 to 66% by weight; (ii) phenol 34-75% by weight; (iii) formaldehyde 1-5 to 2 mol (formalin) on cardanol and phenol used as above and (iv) alkaline catalyst 5% by weight of cardanol and phenol used above, spreading thus coated and admixed rice husk into a mat of desired thickness and subjecting the same to hot pressing at 160°C-220°C.

282. Indian Plywood Industries Research Institute, Bangalore.
Feasibility report for the manufacture of rice husk boards, 1978, 26 p.

The feasibility report is for a complex to produce rice husk boards. The complex consists of (1) a labour-oriented rice husk board manufacturing plant of capacity 15 tonnes per day, (2) a full-fledged adhesive plant to produce adhesives for the manufacture of rice husk boards. The report includes information on process description, production (including varieties of products that can be produced), product application and market considerations. Details of economics of production, investment on equipment and machinery, land & building, wages & salaries, material & energy and profits & return on investment are included in tabular (10 tables) forms. Diagram of the process of manufacture of particle board from rice husk is also appended.

283. Sarkaria, T.C., and Iyengar, M.S.
Hardboard and tiles from agriculture waste.
Indian pat. 101,714 (June 15, 1968).

Sawdust or rice husk was sieved, air-dried, mixed for 5-10 minutes with 20% by its weight water, and moulded at 160°/80.5 kg/cm^2 for 1 hr to give boards with breaking tensile strength 110-125 kg/cm^2, compression strength 130-145 kg/cm^2, water absorption 17-18% after 7 days soaking. Urea and H_2SO_4 were added for waterproofing the product.

284. Shibata, N.
Light weight concrete.
Jap. pat. 77,152,924 (Dec. 19, 1977).

Rice hulls, fine hollow glass spheres such as Shirasu, and cement are kneaded with water, moulded and hardened to obtain light weight concrete products.

285. Vasishth, R.C.
Manufacture of composite boards from rice husks using a batchwise, labour-oriented plant: Feasibility study - India.
Cor Tech. 1, 1972, 24 p.

A detailed economic analysis of the process for present day Indian conditions has been made. It shows that even small, batchwise labour oriented units are economically viable. It is estimated that a small plant with a rated capacity of 5 tonnes per day costing about Rs.500,000 or Rs.600,000 would produce a total profit of about 300,000. The estimates made also show that for comparable size large plants, the plants using rice husks for the manufacture of composite boards would cost around 30% less than the corresponding size plants producing wood particle boards. The manufacturing cost of rice husk composite boards is also estimated to be substantially lower, due to lower processing cost. It is therefore envisaged that the process developed would form a sound basis for the development of a useful industry in rice growing areas.

286. Vasishth, R.C.
Composite boards from rice hulls.
Cor Tech. 3, 1973, 9 p.

Describes a process developed at the Cor Tech Research Ltd., Canada, for making boards from rice hulls. The economic aspects of the process, the properties and uses of the boards obtained are briefly dealt with.

287. Vasishth, R.C.
Composite rice hull resin articles, products thereof, processes for making resin-coated rice hulls and products thereof.
Malagasy Republic Pat. 55079 (July 12, 1974).

288. Vasishth, R.C.
Process for making composite rice hull-resin articles, products thereof, processes for making resin-coated rice hulls and products thereof.
U.S. pat. 3,930,089 (Dec. 30, 1975).

A process for making a composite article comprises forming a mass consisting of rice hulls to which has been applied a water-immiscible caustic-free thermosetting PF resin which in its uncured state has a viscosity above 100 Krebb units at 120°F, and curing the resin. The article can be a structural board, in which case the mass is shaped into board form prior to curing the resin.

289. Vasishth, R.C.
Processes for making composite rice hull-resin articles, products thereof, processes for making resin-coated rice hulls and products thereof.
Can. pat. 1,010,173 (May 10, 1977).

This process for making an article such as a structural board from rice hulls and a resin is similar to that described in Brit. pat. 1,403,154. (See abstract No. 279 above).

290. (The) Western India Plywoods Ltd., Baliapatam, Kerala, India.
Improvements in or relating to particle board.
Indian pat. 142208 (May 17, 1976).

The invention relates to the manufacture of particle board from paddy husk, coffee husk and like agro-industrial husks. The conventional method of manufacturing particle board requires resins such as phenol-formaldehyde and urea-formaldehyde. These resins cannot be used for bonding paddy husk and other agro-industrial husks since they have polished surfaces and are not susceptible for proper wetting and bonding. The resin used for bonding the husk is made by condensing cardanol with formaldehyde in presence of caustic soda. The resultant condensation product is further condensed with phenol and formalin in presence of NaOH.

Sisal

(see also abstract no. 211; 212)

291. Pittsbourgh Corning Corpn.
Lightweight aerated concrete panel.
Brit. pat. 1,298,874 (Dec. 6, 1972).

An aggregate of asbestos, nylon, or sisal reinforcing fibres and multicellular glass nodules is bound in a cellular matrix of cement. Spherical nodules, 1/8-½ in diameter with an actual density of 10-25 lb/cu.ft and bulk density 7-10 lb/cu.ft are used in a dry volume ratio to cement of 4 : 1. Reinforcing fibres are added in an amount of 0.5-2.0 wt. % of dry cement. Lignosulfonic acid or licorice root residue air-entraining agents are added to the cement. The mortar is poured into a mould, the mould removed when partially cured, and divided into panels. Completely cured panels 1-1/8 - 1-5/8 in thick have a density of 25-38.5 lb/cu.ft and flex strength of 60-416.7 psi.

292. Plastic Research Laboratories Ltd.
Wood substitute.
Belg. pat. 837,086 (April 16, 1976).

PhOH-HCHO resin (I) reinforced with at least partially prealigned sisal and/or jute fibres is suitable as a wood substitute. Typically, carded jute was immersed in alcohol I and waste sisal fibres and cord were immersed separately in the same bath. The compositions were calendered, pressed into B-stage sheets, and assembled as a sisal-reinforced I core, jute-reinforced I -faced composite.

293. Yang, J.C.S.
Thermal shock-resistant asbestos-cement composition and their preparations.
U.S. pat. 3,933,515 (Jan. 20, 1976).

Asbestos-cement articles, such as boards, which are resistant to thermal shock are prepared from a furnish of asbestos fibres, portland cement, and silica flour, in which part of the silica flour has been replaced by a finely divided porosity-increasing additive such as nylon fibres or sisal fibres.

Sorghum

(see abstract no. 228)

Straw

(see also abstract no. 196; 200; 203; 204; 205; 206; 213; 217; 224; 227)

294. Basler, H.
Molded objects made from fibrous cellulosic material and procedure for manufacturing same.
Ger. pat. 2,525,376 (Dec. 16, 1976).

Pentosan-free furfural-containing fibrous wastes from the production of furfural from wheat straw are used in the manufacture of hardboard and the like.

295. Buchmann, R.C.
Light construction materials from rice straw fillers.
Ger. pat. 2,016,745 (Oct. 21, 1971).

The hydrophobic properties of rice straw are eliminated by applying and hardening a layer with good binding power on the straw surface before mixing or moulding the straw with the inorganic or organic binder. Thus, sufficient adhesion to the base material is obtained. The layer separating the straw and coating consists of a film forming plastic dispersion or of curable aqueous adhesive solutions based on urea, e.g. 1 m^3 rice straw is sprayed and mixed with 10-15 litres of a 50% dispersion of polyvinyl propionate, the mixture is conveyed with agitation in a 2-3 cm layer and heated to 20-35° so that a relatively waterproof film is formed on the straw surface. Optionally, fine sand particles for improving the binding strength, and flame retarding substances are added. The rice straw thus treated is used, e.g. for manufacture of building plates and moulded articles by mixing with cement slurry and pressing.

296. Cucurull, G., and Gonzalez, R.
Converting basic vegetable material into moldable raw material.
S. African pat. 7,202,218 (Dec. 12, 1972).

A mouldable raw material was prepared from agricultural and forestry wastes, e.g. straw from wheat, rye or rice, and bark, brushwood, or scrub of beech, eucalyptus or poplar, by delignification with alkali, sulphur compounds, or hydrotropic salts at 16-170° followed by mechanical defibrillation in a disc or stone mill. Test sheets formed from the above pulp gave basic wt. 1500 g/m^2, freeness 10-120° CSF, refining 6-30° SR, thickness 1.5-3.5 mm, sp.gr. 0.6-1.5 and tensile strength 150-160 kg/cm^2.

297. Hamachi, T.
Epoxy resin impregnated fiberboards.
Jap. pat. 7,406,547 (Jan. 25, 1974).

A fibreboard when treated with poly-epichlorohydrin, had good mechanical strength and water resistance. Thus, a slurry of 70:30 beaten kraft pulp and straw pulp was made into a fibre mat containing 60% water. The mat was treated with 3% diethylene glycol-epichlorohydrin copolymer of epoxy-equivalent 145, 8.1% Cl, and viscosity 25 cP and 1% of a 10% aqueous $Ca(OH)_2$ and pressed 30 min at 150° and 10 kg/cm² to give a 12 mm fibreboard. The fibreboard had density 0.52, flexural strength 83 kg/cm², surface peel strength 54 kg, water absorption 21, and swelling with water 14%, compared with 0.52, 75, 36, 23 and 19 respectively, for a similar board bound with 3% phenolic resin, and 0.51, 48, 29, 42 and 26 respectively for a similar board without resin treatment.

298. Hesch, R.
Straw is a viable raw material for particle board industry.
Plywood and panel magazine 19, no.7: 26-27 (1978).

A brief study on the availability, economics of utilization and operating costs of straw as a raw material for particle board industry.

299. Klee, O.G.
Pressing straw into constructional materials.
Ger. pat. 2,553,968 (June 16, 1977).

Straw is mixed with Bakelite or polyester resin binders and pressed to form constructional materials.

300. Kluge, Z.E., Saveleva, T.G., and Vedernikova, N.A.
Possibility of producing solid slabs from rice straw without a binder.
Khimiya i Khini. Tekhnol. Drevesiny. 5: 114-118 (1977). (Russ.)

301. Mobarak, F., Nada, A.A., and Fahmy, Y.
Fiberboard from exotic raw materials (1) Hardboard from rice straw pulps.
J. Appl. Chem. Biotechnol. 25, no.9. 653-658 (Sept., 1975).

The suitability of rice straw as a raw material for the production of hardboards was studied. Boards with properties comparable to those made from wood were produced by first steaming the straw, mechanically defiberizing it, and then treating it with 6% NaOH for 2 hr at 80°C.

302. Munz, M., and Simunic, B.
Treatment of plant fiber material containing inhibitors for setting cement.
Ger. pat. 1,696,395 (Aug. 20, 1970).

A suitable aggregate for the production of a lightweight building material containing 400 kg/m³ cement and having a weight less than 650 kg/m³ is obtained by the treatment of vegetable matter with 10-30% cement and a CO_2-enriched air current heated up to 90° in such a way that at least 60% of the total water of the mixture is removed in 48 hr. Preferably, a solution of 3.2 kg

$Al_2(SO_4)_3 \cdot 18H_2O/m^3$ light building material is added and the air is moistened at the beginning of the drying process. Thus, a mixture of 90 kg chopped straw, 26% $Al_2(SO_4)_3$ solution, 7.3% H_2O, 60 kg portland cement, and 40% mixing H_2O was treated for 48 hr in a cascade conveyor with a mixture of air and flue gases from a combustion chamber sprayed with H_2O. The resulting mixture weighing 175 kg was mixed with H_2O 210, portland cement 260, 1.5% $CaCl_2$ 4.8, and 0.5% $AlCl_3$ 1.6 kg to give 1 m^3 tamped building material having a weight of 600-20 and 500-20 kg/m^3, and a bending strength of 4-5 and 7-10 kg/cm^2 after 3 and 28 days respectively. A similar mixture contained sugarcane bagasse instead of straw.

303. Ohtsuka, M., and Uchihara, S.
Straw and chaff molding.
Jap. pat. 7,322,346 (May 28, 1970).

Vinyl monomer impregnated chaff and rice straw layers were moulded to give laminates useful as construction materials. Thus, 1000 parts air-dried chaff (15% water content) was impregnated 7 min at 200 mm with a mixture of styrene 75, unsaturated polyester 25, azobisisobutyronitrile 0.8 and polyethylene glycol 3 parts. Air-dried rice straw (1000 parts) were similarly impregnated and the two compounds were heated for 4 hrs at 65° at 2 kg/cm^2. Layers of resinified chaff and rice straw 4 cm thick were heat-pressed together for 15 min at 180°C at 15 kg/cm^2 to give a moulding having sp.gr. 0.70.

304. Paturle, R.
Polymeric building materials.
Ger. pat. 2,539,195 (March 24, 1977).

The apparatus and method are described for preparing building materials from polymeric binders using straw or mineral as fillers. Chopped straw 50-60, a coating agent for the straw 2-4, any type of plastic 26-8, wt.% are homogeneously mixed at 120-180° to give a material which can be shaped by pressing or spraying. The product shows little or no shrinkage, may be reinforced and coated, does not deform on quenching, is easily workable, and shows other advantageous properties.

305. Solvay & Cie.
Process for manufacturing sheets from a mixture of vegetable fibers and polyolefins.
Fr. pat. 2,322,001 (March 25, 1977).

Panels board of vegetable fibres, e.g. sawdust, chopped straw, and polyolefins, e.g. polyethylene, with improved resistance to water absorption are manufactured by hot calendering of a composition of vegetable fibres (25-75% by weight) and melted polyolefin at a temperature at least equal to the melting temperature of the polyolefin.

Sunflower hulls

(see also abstract no. 199)

306. Gertjejansen, R.O., Haygreen, J.G., and French, D.W.
Particle board from Aspen flakes and sunflower hulls.
Univ. Minn. Agr. Expt. Station, Technical Bulletin no.290, 1972, 5 p.

Laboratory particle boards of 42 lb/cu.ft nominal density were manufactured from sunflower hulls and ½ in aspen flakes. Sunflower hull to aspen flake weight proportions were 1 : 0 (all sunflower hulls); 1 : 2, 2 : 1, and 0 : 1 (all aspen flakes). Although addition of sunflower hulls reduced board strength and stability, commercial standard CS 236-66 min property requirements for modulus of rigidity and modulus of elasticity were met by 100% sunflower hull boards. However, addition of approximately 50% aspen flakes would be required to meet the same minimum property requirements for internal bond strength and linear dimensional stability. Susceptibility to decay fungi increased with increasing sunflower hull content.

Wheat husk

(see abstract no. 213)

E. TESTING, QUALITY CONTROL, STANDARDS AND MARKETING.

General

307. Dietz, A.G.H.
Composite materials. General overview.
Proc. Conf. Theory Des. Wood Fiber Composite Mater., 1969, Syracuse, Syracuse Univ. Press: 23-48 (1972).

Laminates, sandwiches and composites containing wood or other fibre-reinforced materials, their interfaces and testing problems involved were discussed.

308. Griffioen, K.
Some notes on testing the durability of particle board.
Proc. IUFRO - 5th Meeting 2: 394-397 (Sept./Oct., 1973).

Limitations of building board and decay resistance tests are outlined, and 3 commonly used methods for evaluating fungus resistance in phenolic resin-bonded particle boards are described, viz. the Kolle flask/soil block, the flat steel vessel, and the fungus cellar techniques.

309. Jayne, B.A., Ed.
Theory and design of wood and fiber composite materials.
Syracuse, Syracuse Univ. Press, 1972, 418 p.

The revised, edited and indexed proceedings of a conference held in 1969 at the University of Washington. 15 chapters are contributed by different experts, dealing with the various types and components of composite materials and their properties.

310. Lavren'tev, S.P., Chernousov, Yu.I., Startsev, V.S., Kolmogortsev, V.A., and Dmitriev, S.N.
Composition for the manufacture of hardboards.
USSR pat. 537,843 (Dec. 5, 1976).

Hardboards with high hardness and improved properties are obtained if 1-15% of hydrothermally treated activated sludge is used as an adhesive additive.

311. Pawlowski, T., Baranowski, P., and Mikulicz, G.
Special type particle boards.
Pr. Zakresu Towarozn Chem., Wyzsza Szkola Ekonom, Poznan. Zesz. Nauk. 53 Ser. 1: 119-124 (1974). (Pol.)

Particle boards made of flax or hemp shives are porous and sensitive to the action of water, radiation, temperature variations, and micro-organisms. These boards are usually bonded with urea-formaldehyde resins and this presents the additional problem of formaldehyde evolution. The purpose of the present study was to determine the possibility of imparting water and flame resistance in boards made from flax shives and to make them odourless. Control boards containing urea-formaldehyde binder had 14.6-22.9%, swelling when immersed for 24 hours in water, were flammable, and evolved 11.9 μg/formaldehyde/ml solution. The replacement of the urea-formaldehyde binder by Rezokol phenol-formaldehyde binder (neutralized with NaOH) reduced swelling only slightly (to 10%). A reduction of swelling to 6.2% was obtained with Izocyn TP-40 polyurethane binder when hardened at room temperature, and to 1.83% when hardened at 120°C. Among the flameproofing agents used (12% boric acid + mineral fibres, asbestos fibres added to the board core, 12% borax, and mineral fibres) the best results were obtained with the mixture of boric acid and mineral fibres. A substantial reduction of formaldehyde evolution was obtained by the addition of 1% alamask Formol deodorant; the evolution of formaldehyde from boards bonded with Rezokol was only 0.4 μg/ml.

312. Takahashi, H., Moriyama, M., and Osawa, K.
Dry-process manufacture of fiberboard from waste pulp.
Rinsan Shikenjogeppo, no.1: 16-20 (1972). (Jap.)

The possibility of utilizing precipitated pulp waste as a fibreboard material was investigated. Precipirated pulp waste gave a high-density board but the mechanical properties of the board per unit weight were inferior to those of an ordinary fibreboard. Wood pulp in combination with other material could improve the properties of the board.

313. Tranvan, A., Sakai, K., and Kondo, T.
Studies on the holo pulp - III. A comparative study of the holo pulps prepared from certain woody and non-woody plants.
J. Fac. Agric., Kyushu Univ. 22, no.1-2: 53-63 (1977).

The common characteristics of holo pulps prepared from woody (beech, red pine and lauan) and non-woody (rice & barley straw, bagasse and moso-bamboo) plants by peracetic acid digestion were lower than those prepared from the same plants by $NaClO_2$ treatment. Holo pulps of rice straw had the lowest strength and highest optical properties among the other holo pulps from non-woody plants.

Bagasse

(see also abstract no. 313)

314. Lasmarias, V.B., and Escolano, J.O.
Mechano-chemical soda pulping and corrugating medium production studies on sugar-cane bagasse.
Forpride Digest 3, no.1 & 2: 69-81 (1974).

Good quality experimental corrugating boards were prepared from the depithed fibres of sugar-cane (Saccharum officianarum L) bagasse, using the mechano-chemical soda process at fairly low concentrations of 6.6-8.0 g/litre (gpl) and 40-60 minutes hydrapulper time.

315. Sefain, M.Z., Fadl, N.A., and Rakha, M.
Effect of thermal treatment on the properties of sugar-cane bagasse hardboard.
J. Appl. Chem. Biotechnol. 28, no.2: 79-84 (1978).

Bending strength was reduced but water resistance was improved by thermal treatment of sugar-cane bagasse hardboard manufactured with or without formaldehyde-phenol copolymer. The strength decrease was attributed to thermal degradation and the improved water resistance to the removal of hygroscopic materials or resinification of furfural. Boards with a high resin content had bending strength behaviour different from that of boards from cotton stalks or rice straw.

316. Wang, U.P.
Gamma-ray induced gaseous phase polymerization and copolymerization of vinyl monomers bagasse.
J. Chin. Soc. (Taipei) 21, no.4: 255-261 (1974).

Bagasse particle boards saturated with vinyl chloride were irradiated with gamma rays. The mechanical strength of the boards was not improved due to the poor bonding between the polymer and the board. Although mixtures of vinyl chloride-vinyl acetate when polymerized in the board showed better bonding than the vinyl chloride alone, the copolymer was not present in significant quantities to improve strength. No graft polymerization occurred between the bagasse and vinyl chloride. At a dose rate of 4.5 x 10^4 rads/hr., the grafting degree of vinyl chloride-vinyl acetate mixtures was 0.12-0.38%.

Bamboo

(see also abstract no. 313)

317. Lo, N.P., and Tsai, C.M.
Experiment on the manufacturing of bamboo particle board (1) splinter board.
Experimental Forest of National Taiwan University, Bulletin no.116: 527-544 (1970).

Particle board manufactured from hammermilled splinter type bamboo particles was evaluated by testing water evaporation during hot pressing, spring back, moisture content, specific gravity, water absorption, thickness swelling, modulus of rupture in static bending, tensile strength perpendicular to the surface, and hardness. The best properties were obtained with splinter type particles and fine particles, 8 parts phenol-formaldehyde resin solids per 100 parts dry particles, and a hot press time of 15 min. lengthening press time from 10 to 15 min. accelerated water evaporation and reduced internal stresses as well as moisture content and spring back or thickness swelling of the test panel. 9% or more resin solids content is recommended to improve qualities of bamboo splinter board.

318. Suzuki, H., Moriyama, M., Takahashi, H., and Taisei, K.
'Nemagaritake' - hardboard digested in sulfuric acid: II - Addition of resin and quality of the board.
Rinsan Shikenjo Geppo, no.8: 22-25 (1970). (Jap.)

The quality of hardboards made of a H_2SO_4-cooked bamboo pulp is improved by incorporating pulps of lauan or softwood bark as well as a phenolic resin. With the softwood bark pulp, hardboards having density 1.0 and bending strength 350 kg/cm^2 were obtained from more than 45, 30, 20% of the bamboo pulp containing 0, 0.5, and 4% of the resin, respectively. Resistance of the hardboards to H_2O absorption was also improved by heating at 140-180° for less than 6 hr. Similar qualities were observed for hardboards prepared by mixing the wood chips or by mixing pulps.

Coconut husk and coir

319. Kristnabamrung, W., and Takamura, N.
Suitabilities of some Thai hardwoods and coconut husk fibre for manufacturing hardboards by wet and dry process.
Thai Jour. of Agri. Sci. 5, 101-125 (1972).

The hardwoods tested were Sterculia campanulata, Tetrameles nudiflora, Shorea curtisii, Anisoptera glabra, Tectona grandis, Dipterocarpus alatus and Hevea brasiliensis. Of these, T.nudiflora, S.curtisii, A.glabra and D.alatus were the most suitable, giving both wet- and dry-processed hardboards of the quality required by Japanese Standards. S.campanulata hardboards were of satisfactory strength; but their water resistance was insufficient. H.brasiliensis gave a very low pulp yield. T.grandis was suitable for dry but not wet processing. Coconut fibres (Cocos nucifera) wet-process hardboards, though not very strong, were extraordinarily flexible.

Corncobs and corn stalks

320. Chow, P., Walters, C.S., and Guiher, J.K.
pH measurements for pressure-refined plant-fiber residues.
For. Prod. J. 21, no.12: 50-1 (1971).

A study of the pH of shavings, chips, sawdust and bark of various hardwoods and various non-woody residues, indicated that processing in a Bauer No.418 steam-pressurized refiner tended to raise or lower the pH of the residue. This suggests that pH determinations for selection of the appropriate type of adhesive for particle board manufacture should be made after refining. Apart from refined maple shavings, unrefined cotton wood shavings (not tested refined) and corn-stalks, all residues had a pH less than 7. The pH of the cold-water extract was only slightly higher than that of hot-water extracts.

Flax and hemp

(see also abstract no. 311)

321. Deppe, H.J.
Manufacture and testing of protected flax boards bonded with phenolic resin.
Holz Roh- u. Werkstoff 32, no.10: 411-13 (Oct., 1974). (Ger.)

The difficulties in manufacturing particle board from flax shives and phenolic resin could be overcome, but experiments with wood preservatives showed that experience in protecting corresponding wood boards against microorganisms is not immediately applicable to flax board. In addition to protection against Basidiomycetes, which destroy wood, protection against Ascomycetes is also necessary. Combined preservatives must be developed to protect phenolic flax particle board.

322. Fadl, N.A., and Sefain, M.Z.
Coating of finished flax particle boards with insoluble gelatin.
J. Appl. Chem. Biotechnol. 27, no.8: 389-92 (1977).

The water resistance of the flax boards coated with gelatin was improved by crosslinking the coatings at high temperature with hexamine. Best results were obtained using 2.5-5% aqueous gelatin solutions and high hexamine concentrations (about 10% based on the gelatin).

323. Heller, L.
Quality control in the production of laminated flax chaff boards.
Drevo 31, no.9: 277-278, 288 (Sept., 1976). (Czech.)

Quality control in laminated flax chaff board manufacture included laboratory chemical and mechanical-physical testing of materials used for the production, as well as testing of the final product. Raw materials used for the manufacture of laminated flax chaff boards include chemicals such as formaldehyde, monoethylene glycol, butyl alcohol, and melamine; flax chaff boards; resins for the impregnation of the decorative paper; and the decorative paper for the lamination. The decorative paper, after impregnation, also has to be tested. The sampling frequency, testing, and analysis of the listed materials as well as the final product are described.

324. Nedbal, F.
Current and future quality of wood particle and flax boards.
Drevo 29, no.6: 185-6 (June, 1974). (Czech.)

A summary graph is given showing that the quality of wood particle and flax boards manufactured in Czechoslovakia is generally in the lower half or below the tolerance limits given by the Czechoslovak quality standards. Out of the boards studied, the best were those manufactured on imported machines. The boards manufactured using domestic machinery are generally of low quality because of the high degree of wear of the machines. The importance of quality testing is stressed.

325. Pecha, L.
Surface treatment of wood particle and flax boards with melamine film.
Drevo 29, no.8: 232-5 (Aug., 1974). (Czech.)

The appearance of wood-particle board or flax board can be substantially improved by laminating the board with several layers of paper impregnated with MF or PF resin. The paper used should have the following properties: basic wt. of 80-130 g/sq.m. dry and wet tear of 3.5-4.5 and 0.4-0.5 kg respectively, pH of 6.5-7.5, and pigment content of 6-22%. The outer layer is usually printed. The impregnation of paper with MF resin is carried out in two stages and the lamination takes place during the final press-forming of the board.

326. Truc, R.
Experience with the use of laminated flax shive boards for the manufacture of furniture.
Drevo 27, no.5: 131-3, 141 (May, 1972). (Czech.)

The utilization of laminated boards made of flax shives in the manufacture of furniture can bring a substantial increase in the productivity by eliminating the following technological processes needed in the classical wood based furniture manufacture: board thickness adjustment, veneer lamination, and finishing. On the other hand the finished flax shive board used for the manufacture of furniture has the following disadvantages: relatively high cost, unsuitable size, low bending and perpendicular to the surface tensile strength, difficult repair of surface damages, little use for the remnants, and relatively unattractive surface finish. The advantages and disadvantages of the laminated flax shive board for the manufacture of furniture are discussed and it is concluded that the advantages are predominating.

Jute Fiber

327. Khandaker, A.W., Shahabuddin, Md., and Bakshi, M.T.
Rupture mechanism of jute fiber.
Pakistan J. Sci. Ind. Res. 14, no.4-5: 426-7 (1971).

The stress-strain properties of jute (bast fibres in which the tiny cellulose ultimates are embedded in a cementing matrix including hemicelluloses, lignin and pectin) at different strain rates, i.e., 0.04, 0.10, 0.20 and 0.60 cm^2/min at standard condition, are reported.

328. Sen Gupta, S.R.
Jute shellac boards: Their use as containers.
Packaging (India) 6, no.2: 20-2, 24 (Jan./March, 1974).

Investigations of ways to improve the water resistance of jute shellac boards were carried out with laboratory prepared 3-ply boards (0.15 inch thick) containing 40-50% shellac (board basis). The results showed that the water resistance of the boards was increased by painting them with waterproof paints. It is suggested that the water resistance might also be improved by chemical modification of the shellac.

329. Sridhara, S., Kumar, S., and Sinave, M.A.
Fiber reinforced concrete.
Indian Concrete Journal 45, no.10: 428-30 (1971).

The impact strength of concrete was improved by reinforcing with nylon coir jute fibres having a specific diameter. There was an optimum content of reinforcing fibres beyond which the impact strength decreased, e.g. 30% in case of jute. The alkali resistance of fibres was in the order nylon > coir > jute.

Kenaf

330. Bagby, M.O., Cunningham, R.L., and Clark, T.F.
Kenaf pulp, soda vs sulfate.
Tappi 58, no.7: 121-3 (1975).

Strength properties of kenaf soda pulps were equal to those of their respective sulfate pulps and the drainage of the soda pulps was slightly better than that of the sulfate pulps. Chemical and physical properties of soda pulps from green, field-dried and stored kenaf and kenaf's bark and woody core were compared with those for sulfate pulps from the same raw material.

Palm

331. Deppe, H.J., and Hoffman, A.
Utilizing catole palm for particle board production.
Holz Roh- u.Werkstoff 35, no.3: 91-94 (March 1977). (Ger.)

The investigations were aimed at testing the suitability of Brazilian Catole palm for the production of particle board. The material obtained by ring chipping was characterized by a needle-shaped structure and a high content of dust. The investigations revealed that using commercial adhesives, particle board can be produced which fulfills the requirements for the board types V 20 and V 100 according to German Standard DIN 68763. To meet these requirements, however, density must be increased by 15 to 20%, as compared with common particle board from wood. Regarding durability against weathering and fungal attack, boards from Catole palm are inferior to those from wood.

Pineapple fibre

332. Kurita, T.
Current status of pineapple fibre pulping research.
JITA Nyusu 91, 1977, 15 p. (Jap.)

The methods for pulping pineapple fibres and the mechanical property of the pulped fibres are discussed.

Pine needle

333. Negi, J.S., and Chawla, J.S.
Utilization of Pinus caribaea needles for fibreboard.
Symposium on Production and Utilization of Forest Products, Jammu-Tawi, March 5-7, 1979.

This paper reports the findings on P.caribaea needles for possible uses in fibreboards. The density of boards ranges from 0.8 to 1.1 g/cm^3, modulus of rupture ranges from 202 to 228 kg/cm^2. Further improvement in strength properties could be done by addition of 33% pinewood pulp to P.caribaea needle pulp. The modulus of rupture goes up to 412 kg/cm^2.

Rice husk and rice hull

(see also abstract no. 313; 340)

334. Chandramouli, P.
Comparative properties of rice husk board, particle board and wafer board: Interim Report.
Cor Tech 2, 1973, 39 p.

Mechanical, physical and chemical properties of rice hull boards have been tested. The test results available to-date are compiled and presented here. In the light of these test results, a comparison of the properties of the rice husk boards is made with the properties of well established, commercially available, wood-based composite boards and with the requirements of the US and Canadian Standards for mat-formed boards. Such a comparison shows that rice husk composite boards made by using this new process are potentially usable for most applications where wood-based, mat-formed composite boards are currently used.

335. Hancock, W.V., and Chandramouli, P.
Comparative properties of rice husk board, particle board, and waferboard.
J. Indian Acad. Wood Sci. 5, no.1: 18-27 (Jan./June 1974).

Experimental rice husk boards were compared with wood particle boards and waferboards. The properties compared included strength properties (moduli of rupture and elasticity, internal bond, screw-holding ability and hardness), dimensional stability, resistance to termites, fire, and rodents, and machineability. The properties of the rice husk boards are sufficiently similar to those of the wood-based boards which suggests that they can be used in many applications. The rice husk boards have high resistance to termites and fire. The production of rice husk boards in developing countries should be seriously considered.

336. Kamp, Van der, B.J., and Gokhale, A.A.
Resistance of rice husk board to decay fungi.
J. Indian Acad. Wood Sci. 5, no.2: 106-107 (July/Dec. 1974).

The decay resistance of rice husk board and some wood-based boards were examined. Four fungi, Polyporus versicolor, P. hirsutus, P.palustris and Lenzites trabea were used for the test. The following weight losses were recorded: ¼-inch rice husk board, 7.7%; 5/8-inch rice husk board, 7.3%; 5/8-inch rice husk board treated with copper naphthenate, 4.4%; 5/8-inch rice husk board treated with pentachlorophenol, 8.9%; ¼-inch aspenite (PF-bonded Populus tremuloides board), 43.9%; 5/8-inch Douglas-fir plywood, 19.3%; and 5/8-inch UF-bonded Douglas-fir/western hemlock particle board, 21.5%. Statistical analysis showed that the performance of the rice husk boards was significantly better than that of the other wood products.

337. Marsh, R.E.
Norway rat test of rice hull composite boards gnawability.
Univ. of California (March 1973).

338. Texas Forest Products Service.
Texas Forest Products Laboratory, Lufkin, Texas.
Termite resistance of Cor Tech Research Limited's rice husk boards. (Nov. 1972).

Sisal

339. Chaudri, M.A., Jamal, N.A., Sandila, D.M., and Shamim, M.
Physical properties of indigenous sisal fibers under various conditions.
Pakistan J. Sci. and Res. 15, no.6: 405-12 (1972).

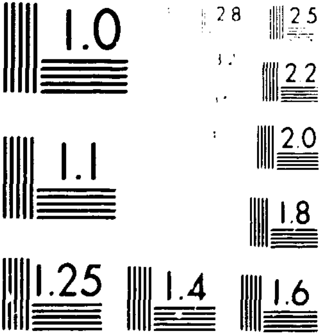
The decrease in breaking strength for the sisal fibres from dry to 24 hr soaking was of the order of 30.4, 33.4, 34.1 and 27.6% for soaking in distilled water, 0.1 N HCl, NaOH, and sea-water respectively, while corresponding decrease after soaking in sea-water for one week was 39.6%. The strength significantly depended on the linear density and percentage elongation.

Straw

(see also abstract no. 313)

340. Fadl, N.A., Sefain, M.Z., and Rakha, M.
Effect of thermal treatment on Egyptian rice straw hardboard.
J. Appl. Chem. Biotechnol. 27, no.2: 93-8 (1977).

Bending strength fell with increase in heating time and temperature for samples containing 1.5% resin, whereas hardboards


1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

containing 3% resin showed an initial improvement in bending strength after heating at 140, 160 and 180°C. Heating all samples at 200° reduced bending strength. Water resistance was improved by heating.

Sunflower

341. Gertjejansen, R.O.
Properties of particle board from sunflower stalks and aspen planer shavings.
Technical Bulletin, Agricultural Experiment Station, University of Minnesota, no.311: 1977, 8 p.

Sunflower (Helianthus annus) stalks were satisfactorily broken down into particle board furnish by hammer milling or disc-refining. Ring flaking was unsatisfactory. Laboratory scale tests on boards made from sunflower stalks and/or aspen (Populus tremuloides) planer shavings, modulus of rupture, internal bond strength, thickness, dimensional stability and durability decreased with an increase in sunflower stalk content, while modulus of elasticity and linear dimensional stability increased. Low internal bond strength, which was the most serious deficiency, could be improved sufficiently by increasing the resin content or density of the board or removing the pith from the sunflower stalks, or adding aspen shavings.

SUBJECT INDEX

Note: The numbers refer to the numbered entries in the bibliography and not to the page numbers.

LIST OF STANDARDS RELATED TO FIBREBOARD AND PARTICLE BOARD

(Standards are in the language of their country of origin, unless otherwise mentioned)

Standard	Title
INTERNATIONAL ORGANIZATION FOR STANDARDIZATION	
ISO DATA 3:1977	Dimensional stability of hardboard.
ISO 766:1972	Fibre building boards. Determination of dimensions of test pieces.
ISO 767:1975	Fibre building boards. Determination of moisture content.
ISO 768:1972	Fibre building boards. Determination of bending strength.
ISO 769:1972	Fibre building boards. Hard and medium boards. Determination of water absorption and of swelling in thickness after immersion in water.
ISO 818:1975	Fibre building boards. Definition. Classification.
ISO 819:1975	Fibre building boards. Determination of density.
ISO 2695:1976	Fibre building boards. Hard and medium boards for general purposes. Quality specifications. Appearance, shape and dimensional tolerances.
ISO 2696:1976	Fibre building boards. Hard and medium boards for general purposes. Quality specifications. Water absorption and swelling in thickness.
ISO 3340:1976	Fibre building boards. Determination of sand content.
ISO 3546:1976	Fibre building boards. Determination of surface finish (roughness).
ISO 3729:1976	Fibre building boards. Determination of surface stability.
ISO 5638:1978	Solid fibreboard. Determination of grammage of single layers.
ISO/DIS 3373	Fibre building boards. Determination of paint absorption.
ISO/DIS 3712	Fibre building boards. Sanded hard and medium boards. Determination of fibre raise after painting.

ISO/DIS 4836	Fibre building boards. Determination of dimensions and shape of panels.
ISO/DIS 3931	________________; Transversal internal bond.
ISO 820:1975	Particle boards - Definitions and classification.
ISO 821:1975	Particle boards - Determination of dimensions of test pieces.
ISO 822:1975	Particle boards - Determination of density.
ISO 823:1975	Particle boards - Determination of moisture content.
ISO/DIS 5606:1977	Particle board thickness.

ARGENTINA

IRAM 11532:1964	Fibre building board and wood chipboard. General definitions.
IRAM 11533:1974	Fibreboard (General Title).
IRAM 11545:1974	Fibreboard (General Title). (1967 available)
IRAM 11533:1966	Particle board. Method of physical testing.
IRAM 11545:1967	Particle board. Method of mechanical testing.
IRAM 11546:1972	Particle board. Sampling.

AUSTRALIA

AS 0 114:1968	Hardboard.
AS 1859:1976	Flat pressed particle board (Medium density).

AUSTRIA

ONORM B 3002:1975	Particle boards. Types and specifications.

BELGIUM

NBN 661-1:1967	Particle board. Methods of testing.
NBN 661-2:1969	Particle board. Type I Specification.
NBN 661-3:1968	Particle board. Type II Specification.

BULGARIA

BDS 5122:1970	Fibre building and particle boards. General rules of testing of physico-mechanical properties.
BDS 5124:1974	Fibre building and particle boards. Method for determination of bending strength transversely to the flatness of board.
BDS 5125:1974	Fibre building and particle boards. Determination of transverse tensile strength.
BDS 7854:1970	Fibre building and particle boards. Method of determination of moisture content.
BDS 7855:1970	Fibre building and particle boards. Method of determination of water absorption after immersion.
BDS 7856:1970	Fibre building and particle boards. Method of determination of swelling in thickness after immersion in water.
BDS 7857:1970	Fibre building and particle boards. Method of determination of density and mass per unit of area.
BDS 8035:1973	Hard and very hard wood fibre boards. Technical requirements.
BDS 8460:1971	Laminated hard fibre boards.
BDS 10718:1973	Varnished fibre boards. Technical requirements.
BDS 12518:1974	Ornamental relief fibre boards.
BDS 12520:1974	Relief surfaced varnished fibre boards for linings.
BDS 2968:1965	Particle board.
BDS 260:1974	Extruded veneered particle boards.
BDS 7085:1968	Plates of wooden particles - Construction elements. Basic function.
BDS 7086:1974	Single layer plates of wooden particles. Technical requirements.
BDS 7855:1977	Fibre building and particle boards. Method of determination of water absorption after immersion in water.
BDS 9855:1972	Laminated plates made out from wooden particles.

CANADA

CSA A 247M:1978	Insulating fibreboard.
11-GP-3M:1976	Hardboard.
11-GP-5Ma:1978	Hardboard, for exterior cladding.
CSA 0188:1968	Mat formed wood particle board.
CAN 3-0188.0-M78:1978	Test methods for mat formed wood particle boards. Wafer board.
CAN 3-0188.1-M78:1978	Interior mat formed wood particle board.

CHINA, PEOPLE'S REPUBLIC OF

CNS P 2022:1970	Structural fibreboards (for export).
CNS P 3012:1963(1972)	Method of test for fibreboard.

CUBA

NC 43-05:1968	Fibreboards. Definition and classification.
NC 43-08:1969	Particle board and fibreboards. Sampling and preparation of test pieces.
NC 43-09:1969	Particle boards and fibreboards. Determination of density.
NC 43-10:1969	Particle boards and fibreboards. Determination of moisture content.
NC 43-11:1968	Particle boards and fibreboards. Determination of bending strength.
NC 43-12:1968	Particle boards and fibreboards. Determination of water absorption and swelling in thickness after total immersion in water.
NC 43-13:1970	Particle boards and fibreboards. Tensile strength parallel to the surface.
NC 43-14:1970	Particle boards and fibreboards. Tensile strength perpendicular to the surface.
NC 43-07:1969	Particle board. Terminology.

CZECHOSLOVAKIA

CSN 49 0141:1975	Testing of physical and mechanical properties of hardboards and chipboard. Common regulation.
CSN 49 0142:1975	Testing of physical and mechanical properties of hardboards. Volume weight and square weight.

CSN 49 0143:1975	Testing of physical and mechanical properties of hardboards. Moisture.
CSN 49 0144:1975	Testing of physical and mechanical properties of hardboards. Water absorption at full immersion in water.
CSN 49 0146:1975	Testing of physical and mechanical properties of hardboards. Thickness swelling at full immersion in water.
CSN 49 0147:1975	Testing of physical and mechanical properties of hardboards. Static bending strength.
CSN 49 0151:1975	Testing of physical and mechanical properties of hardboards and chipboards. Tensile strength perpendicular to hard plane.
CSN 49 0152:1969	Determination of physical and mechanical properties of agglomerated wood boards. Determination of bending strength of agglomerated wood boards.
CSN 49 0153:1960	Compressibility and elasticity.
CSN 49 0154:1960	Impact strength (Impact test).
CSN 49 0155:1960	Wood screw holding test.
CSN 49 0156:1960	Nail holding test.
CSN 49 0158:1964	Boards of agglomerated wood. Resistance of boards to concentrated stress.
CSN 49 0170:1970	Sampling and preparation of test specimens.
CSN 49 2612:1961	Fibre building boards.
CSN 49 2654:1975	Determination of surface finish (roughness) of wood-fibre building boards.
CSN 49 2655:1975	Determination of sand quantity of wood-fibre building boards.
CSN 49 2656:1975	Determination of surface stability of wood-fibre building boards.
CSN 50 0351:1971	Determination of the puncture resistance of container board.

CSN 49 0141:1969	Testing of boards of agglomerated wood and similar materials.
CSN 49 0144:1969	Determination of physical and mechanical properties of agglomerated wood boards. Determination of absorption moisture and swelling capacity of agglomerated wood boards.
CSN 49 2614:1972	Wood particle boards for general use.

EGYPT

ES 1088:1971	Fibre hardboard.
ES 906:1967	Wood chip boards and other particle boards.
ES 976:1967	Flax shives for particle board.

FINLAND

SFS 2190:1967	Fibre building boards. Types and designations.
SFS 2191:1967	Fibre building boards. Methods of tests.
SFS 0-IV.2:1964	Wood particle boards.
SFS 3315:1975	Wood particle boards. Specifications.
SFS 3516:1975	Wood particle boards. Methods of test.

FRANCE

NF B 51-120:1971	Fibre building boards. General testing requirements.
NF B 51-121:1971	Fibre building boards. Determination of humidity.
NF B 51-122:1971	Fibre building boards. Determination of density.
NF B 51-123:1971	Fibre building boards. Tensile test parallel to faces.
NF B 51-124:1977	Fibre boards. Bending test.
NF B 51-125:1975	Fibre building boards 'Mounin' Hardness test.
NF B 51-126:1976	Fibre boards 'Brinell' hardness test.
NF B 51-127:1977	Fibre boards. Dynamic punching test.
NF B 51-140:1971	Fibre building boards. Measurement of dimensions, of straightness and of squareness of panels.
NF B 51-150:1971	Fibre building boards. So called tensile test perpendicular to the faces (Test piece with blocks).
NF B 51-151:1971	Fibre building boards. Tensile test perpendicular to faces (Test piece "Brodeau").
NF B 51-152:1972	Fibre building boards. Determination of water absorption and dimensional variation after immersion.
NF B 51-190:1971	Fibre building boards. Sampling faserplatten Probenahme.

NF B 54-050:1971	Fibre building boards. Definitions. Classification. Designation.
NF B 55-001:1962	Fibreboard for packing.
NF B 51-224:1972	Particle boards. Bending test.
NF B 51-225:1972	Particle boards. "Mounin" hardness test.
NF B 51-226:1971	Particle boards. "Brinnel" hardness test.
NF B 51-227:1977	Particle board dynamic punching test.
NF B 51-240:1971	Particle boards. Measurement of dimensions of straightness and of squareness of panels.
NF B 51-252:1972	Particle boards. Determination of water absorption and dimensional variation after immersion.
NF B 51-255:1972	Particle board. Dynamic bending test.
NF B 51-256:1972	Particle board. Test for withdrawal of nails.
NF B 51-260:1972	Particle board. Test for withdrawal of screws.
NF B 51-261:1972	Particle board. Shear test.
NF B 51-262:1972	Particle boards accelerated ageing by boiling water (so-called test "V 100").
NF B 51-263:1972	Particle boards. Accelerated ageing by test so-called "V-313".
NF B 51-264:1972	Particle board. Determination of dimensional changes due to atmospheric humidity.
NF B 54-100:1971	Particle boards. Definitions, classification and designation.
NF B 54-110:1971	Particle boards. Dimensional characteristics of boards.

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DIN 52 2351:1956	Testing of fibreboard: Estimation of moisture content: Absorption of water and increase of thickness by swelling.
DIN 52 352:1973	Test of fibreboards.
DIN 68 750:1958	Wood fibre building boards specifications of quality (in English).
DIN 68 751:1976	Decorative laminated fibre building boards, terms, properties.

DIN 68 753:1976	Terms of fibreboard.
DIN 68 754:Teil 1:1976	Hard and medium hard fibreboards for the building; grade 20 of derived timber products.
DIN 68100:Bbl.4:1978	Tolerances for linear measure and angular dimension in the woodworking and wood processing industry: change of dimensions due to the influences of moisture in the direction of thickness, width and length of particle board, plywood and fibreboard.
DIN 68760:1973	Particle board, dimensions.
DIN 68761:1973	Particle board; flat pressed boards FPY for general purposes; terms, properties, testing.
DIN 68762:1973	Particle boards for special purposes for the building; terms, properties and testing.
DIN 68763:1973	Particle boards; flat pressed boards for the building; terms, properties, testing, supervision.
DIN 68764:Bl.1:1974	Particle boards; extruded boards for the building; terms, properties, testing supervision.
DIN 68764:Bl.2:1974	Particle boards; extruded boards for the building; laminated extruded boards for building in boards.
DIN 68765:1976	Particle boards; decorative laminated flat pressed boards for general purposes; terms, properties.

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TGL 11367:1969	Testing of particle boards and fibreboards. Description, sampling, sample preparation, analysis.
TGL 11368:1969	Testing of particle boards and fibreboards. Determination of moisture content.
TGL 11369:1969	Testing of particle boards and fibreboards. Determination of thickness, angularity, surface density, oven-dry density.
TGL 11370:1968	Testing of particle boards and fibreboards. Determination of swelling in thickness.
TGL 11371:1969	Testing of particle boards and fibreboards. Determination of bending strength.

TGL 11374:1962	Examination of fibreboard. Determination of bending strength.
TGL 18977:Bl 5:1974	Wood-based materials. Definitions of fibreboards.
TGL 6072:Bl 1:1973	Wooden particle board. Flat pressed particle boards of medium gross, density of boards made of shavings.
TGL 6072:Bl 3:1970	Wooden particle boards. Flat pressed boards. Extruded pressed particle boards without cavities and plank coverings.

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MSZ 7086:1974	Wood fibre board, hard.
MSZ 7087/1:1972	Testing of fibreboards. General prescriptions.
MSZ 7087/2:1972	Testing of fibreboards. Determination of moisture content.
MSZ 7087/3:1972	Testing of fibreboards. Determination of static bending strength.
MSZ 7087/4:1972	Testing of fibreboards. Determination of water absorption.
MSZ 7087/5:1973	Testing of fibreboards. Determination of swelling in thickness.
MSZ 7087/6:1973	Testing of fibreboards. Determination of density.
MSZ 13356:Sheet 1:1968	Testing and classification. Laminar fibre board.
MSZ 13356:Sheet 2:1969	Laminar fibreboard. Testing. Qualification. Fibreboards for waggon. Building.
MSZ 13357:1969	Grain, printed fibreboard, testing, qualifying.
MSZ 6784/1:1974	Particle boards. General requirements.
MSZ 6784/2:1975	Particle board for general purposes.
MSZ 6784/3:1977	Particle boards with fine surfaces.
MSZ 6784/4:1981	Cement bonded particle boards.
MSZ 13336/1:1972	Testing of particle boards. General purposes.
MSZ 13336/2:1972	Testing of particle boards. Determination of humidity content.
MSZ 13336/3:1972	Testing of particle boards. Determination of the static bending strength.
MSZ 13336/4:1972	Testing particle boards. Determination of water absorption.

MSZ 13336/5:1972	Testing of particle boards. Determination of thickness swelling.
MSZ 13336/6:1972	Particle boards. Determination of internal bond.
MSZ 13336/7:1972	Testing particle boards. Determination of density.
MSZ 13336/9:1977	Testing of particle boards. Determination of flexibility.
MSZ 13336/11:1977	Testing of particle boards. Determination of compression strength.
MSZ 13336/13:1977	Testing of particle boards. Laminar particle boards, testing and classification.

INDIA

IS:1658-1966	Fibre hardboards.
IS:3348-1965	Fibre insulation boards.
IS:2771(Part I)-1977	Fibre board boxes. Corrugated fibreboard boxes.
IS:2771(Part II)-1975	Solid fibreboard boxes.
IS:7151-1973	Corrugated fibreboard boxes of internal dimensions 890 x 380 x 560 mm for para-dropping of supplies.
IS:7149-1973	Fibreboard boxes for canned seafoods for export.
IS:6481-1971	Guide for principal uses and styles of fibreboard containers.
IS:7063(Part I)-1973	Methods of test for corrugated fibreboard. Thickness of board.
IS:7063(Part II)-1976	Methods of test for corrugated fibreboard. Edgewise crush resistance of board.
IS:7063(Part III)-1976	Methods of test for corrugated fibreboard. Water resistance of glue bond by immersion.
IS:7063(Part IV)-1976	Methods of test for corrugated fibreboard. Determination of substance of the component papers after separation.
IS:7601-1975	Fibreboard drums for general purposes.
IS:2191(Part II)-1966	Wooden flush door shutters (Cellular & Hollow core type). Particle board face panels. (First Revision).
IS:3129-1965	Particle board for insulation purposes.
IS:3097-1965	Veneered particle boards.

IS:3087-1965	Wood particle boards (Medium density) for general purposes.
IS:3478-1966	High density wood particle boards.
IS:2202(Part II)-1966	Wooden flush door shutters (Solid Core type). Particle board face panels. (First Revision).

IRAN

ISIRI 557:1969	Definition and classification of pressed fibreboard.
ISIRI 807:1973	Fibre building boards. Determination of bending strength.
ISIRI 08:1973	Fibre building boards. Determination of density.
ISIRI 809:1973	Fibre building boards. Determination of water absorption and of swelling in thickness after immersion in water.
ISIRI 810:1973	Fibre building boards. Determination of dimensions of test pieces.
ISIRI 811:1973	Fibre building boards. Determination of moisture content.
ISIRI 1290:1976	Standard method of test for ply separation (wet) of solid and corrugated fibreboard.
ISIRI 1739:1976	Standard method of test for edgewise compressive strength of corrugated fibreboard.
ISIRI 812:1973	Particle board. Determination of dimension of test pieces.
ISIRI 813:1973	Particle boards. Determination of density.
ISIRI 814:1973	Particle boards. Determination of moisture content.

IRELAND

I.S 62:1955	Wood fibre building boards.

ISRAEL

SI 324:1959	Soft fibreboards.
SI 328:19591	Hardboard.

ITALY

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UNI 3747:1956	Tests on wood fibre panels: Tensile test.
UNI 3748:1956	Tests on wood fibre panels: Compression test.
UNI 4369:1969	Wood fibreboard: Determination of moisture absorption and of variation in thickness through exposure to moist air.
UNI 4370:1959	Compressed wood fibre board: Method of test for resistance to electrical voltages.
UNI 4371:1959	Compressed wood fibre board: Determination of electrical resistance between contact pins.
UNI 5062P:1962	Test of wood fibre panels. Tolerances.
UNI 5063P:1962	Test of wood fibre panels. Taking of samples and conditioning.
UNI 5066P:1962	Test of wood fibre panels. Determination of moisture content.
UNI 5067P:1962	Test of wood fibre panels. Determination of resistance to flexure.
UNI 5068P:1962	Test of wood fibre panels. Determination of absorption of water.
UNI 4866:1961	Wooden particle boards. Dimensions and tolerances.
UNI 4867:1961	Wooden particle boards. Classification.
UNI 4868:1961	Tests on wooden particle boards: Sampling and preparation of sample.
UNI 4869:1961	Tests on wooden particle boards: Determination of thickness.
UNI 4870:1961	Tests on wooden particle boards: Determination of weight for unit surface and gross density.
UNI 4871:1961	Tests on wooden particle boards: Determination of moisture.
UNI 4872:1961	Tests on wooden particle boards: Determination of moisture absorption capacity and consequent swelling.

JAPAN

JIS A 5905:1977	Fibre insulation boards. (1961 available).
JIS A 5906:1975	Semi hardboards. (1961 available).
JIS A 5907:1977	Hard fibreboard. (1961 available).
JIS A 5910:1975	Dressed hard fibreboard for exterior use (In English).

JIS A 5912:1977	Insulation fibreboard sandwich TATAMIDOKO (In English).
JIS A 6304:1972	Soft fibreboards for acoustic use (1967 available).
JIS A 5909:1973	Particle boards (In English).
JIS A 5909:1972	Dressed particle boards. (In English).

KOREA

KS F 3201:1976	Insulation fibreboards (1965 available) (In English).
KS F 3202:1976	Semi-hard fibreboards (1964 available)
KS F 3203:1976	Hard fibreboards (1964 available)
KS F 3206:1976	Soft fibreboard for acoustic use.

NETHERLANDS

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NEN 2121:1968	Particle board for wood industry.
NEN 3217:1967	Particle board. Physical and mechanical properties.

NEW ZEALAND

NZS 1104:1953	Fibre building board (other than hardboard).
NZS 3608:1975	Resin bonded wood particle board.

NORWAY

NS 1600:1969	Fibre building boards. Test methods.
NS 1601:1969	Fibre building boards. Determination of tensile strength perpendicular to the surface.
NS 1602:1969	Fibre building board sampling.
NS 1603:1967	Fibre building boards. Definition and types.
NS 1604:1971	Fibre building boards. Determination of surface finish (roughness).
NS 1605:1971	Fibre building boards. Determination of paint absorption.
NS 1606:1971	Fibre building boards. Determination of sand quality.

POLAND

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PN D-04225:1968	Physical and mechanical properties of fibreboard. Determination of hygroscopicity.
PN D-04231:1969	Fibre building boards. Determination of lateral tensile strength.
PN D-04233:1970	Fibreboards flat pressed particle boards and flaxboards. Determination of static bending strength and modulus of elasticity in bending.
PN D-04234:1976	Fibre building boards, pressed particle boards and flaxboards. Determination of water absorption.
PN D-04235:1970	Fibreboards, flat pressed particle boards and flaxboards. Determination of swelling.
PN D-04245:1976	Fibre building boards. Determination of sand content.
PN D-79401:1973	Paper board and fibreboard packaging. Requirements and testing.
PN D-02001:1974	Particle boards from lignocellulose material. Terminology.
PN D-04204:1973	Physical and mechanical properties of particle boards and flaxboards. Determination of screw holding strength.
PN D-04205:1963	Physical and mechanical properties of particle boards and flaxboards. Determination of swelling.
PN D-04206:1969	Particle board and flaxboard. Determination of the static bending strength and modules of elasticity in bending.
PN D-04207:1963	Physical and mechanical properties of particle board and flaxboards. Determination of tensile strength in the direction perpendicular to the surface of the board.
PN D-04208:1963	Physical and mechanical properties of particle boards and flaxboards. Determination of tensile strength in the direction parallel to the faces of board.
PN D-04209:1964	Particle boards and flaxboards. Determination of specific gravity.
PN D-04211:1964	Particle board and flaxboards. Determination of hygroscopicity.
PN D-04212:1964	Particle boards and flaxboards. Determination of shearing strength parallel to board face.

PN D-04220:1975	Tubular particle boards. Determination of density.
PN D-04221:1967	Physical and mechanical properties of particle boards and flaxboards. Determination of water absorbing capacity.
PN D-04222:1967	Physical and mechanical properties of particle boards and flaxboards. Determination of moisture content.
PN D-4233:1976	Fibre building boards flat pressed particle boards and flax boards in static bending and of modulus of elasticity in bending. Determination of strength.
PN D-4234:1976	Fibre building boards flat pressed particle boards and flax boards in static bending and of modulus of elasticity in bending. Determination of water absorption.
PN D-4235:1975	Fibre building boards flat pressed particle boards and flax boards in static bending and of modulus of elasticity in bending. Determination of swelling.
PN D-97004:1972	Particle boards.

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STAS 6964:1973	Building fibreboards. Classification and terminology.
STAS 7156/1:1971	Fibre building boards medium-hard. Hard and extra-hard boards. Determination of water absorption and swelling in thickness after total immersion in water.
STAS 7156/2:1971	Fibre building boards. Determination of water absorption and swelling in thickness, after total immersion in water.
STAS 7157:1971	Wood fibreboards. Extra-hard, hard and medium hardboards. Static bending test and determination of modulus elasticity.
STAS 7197:1965	Wood fibreboard: MDN hardness test.
STAS 7577:1971	Enamelled wood fibreboards.
STAS 7578:1971	Plastics faced wood fibreboard.
STAS 7660:1976	Wood fibreboards. Determination of the transversal internal bond.
STAS 7808:1973	Enamelled and plastic-faced wood fibreboard. Methods for physical and mechanical testing.

STAS 7809:1973	Enamelled and plastic-faced wood fibre boards. Plastic faced wood chipboards and decorative laminated paper boards (HDS). Determination of resistance of decorative layer to spotting.
STAS 7898:1967	Fibreboard. Determination of nail holding capacity.
STAS 8023:1967	Softwood fibre board treated with bitumen and fungicide. Determination of degree of fungicide treatment.
STAS 8071:1967	Fibre board: Accelerated ageing technique.
STAS 8762:1970	Lignocellulosic boards. Wood fibreboards. Soft boards (porous) static bending test.
STAS 9339:1973	Wood fibreboards and chipboards. Determination of resistance to the attack of insects.
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STAS 10478:1975	Hardwood fibreboards. Determination of the behaviour of boards to the direct-action of meteorological factors.
STAS 10715:1977	Fibreboards. Determination of the resistance to cleavage.
STAS 652:1974	Wood, plywood, wood particle boards, wood fibre boards. Determination of efficiency of fire proofing.
STAS 1037:1977	Wood particle boards. Boards for external use, pressed perpendicular to the faces.
STAS 6159:1969	Panels made of wood particles and other lignocellulosic materials. Determination of resistance to tearing out of nails and screws.
STAS 6292:1976	Wood particle boards. Determination of transverse internal bond.
STAS 10261:1975	Wood particle boards. Plastics faced wood particle boards.
STAS 10299:1975	Plastics-faced wood particle boards. Methods for physical and mechanical tests.
STAS 10371:1977	Wood particle board, boards for external use, pressed perpendicular to the faces.

SOUTH AFRICA

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SPAIN

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UNE 56 709:1971	Particle board. Testing. Determination of specific gravity.
UNE 56 710:1971	Particle board. Determination of humidity.
UNE 56 711:1971	Particle board. Determination of resistance to bending and modulus of elasticity.
UNE 56 712:1971	Particle board. Determination of resistance of tension perpendicular to the plane of the board.
UNE 56 713:1971	Particle board. Determination of swelling and water absorption by total immersion.
UNE 56 714:1971	Particle board. Physico-mechanical characteristics.
UNE 56 715:1971	Particle board. Wooden.

SWEDEN

SIS 235111:1975	Fibre building boards. Properties.
SIS 235113:1975	Fibre building boards. Testing.
SIS 234801:1968	Particle boards.

TURKEY

TS 64:1973	Fibre board.
TS 65:1963	Sampling and testing methods of fibreboard.
TS 1770:1974	Fibreboards and particle boards surfaced with synthetic resin.
TS 2129:1975	Fibreboard and particle board (Terms and definitions).
TS 180:1964	Particle boards (Flat pressed boards for general purposes).
TS 1617:1974	Particle boards (Flat pressed particle boards for building).
TS 2199:1975	Fibreboards and particle board (Terms and definitions).

UNITED KINGDOM

BS 1142:Part 1:1971	Fibre building boards. Part 1: Methods of test.
BS 1142:Part 2:1971	Fibre building boards. Part 2:Medium board and hardboard.
BS 1142:Part 3:1972	Fibre building boards. Part 3:Insulating board (Softboard).
BS 4686:1971	Method for the determination of the flat crush resistance of single faced and single wall corrugated fibreboard.
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UNITED STATES

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ANSI/TAPPI T 40009:1975	Sampling and accepting a single lot of paper paperboard, fibreboard or related product.
ANSI/TAPPI T 81189:1970	Edgewise compression strength of corrugated fibreboard (short column test).
ANSI 08.1:1973	Methods of evaluating the properties of wood-based fibre and particle panel materials.
MIL-F-26862:1974	Fibreboard solid, non-corrosive, fungi resistant for interior blocking applications.
LLL-B-810a:1973	Building board, (Hardboard) hard pressed, vegetable fibre.
LLL-B-1188:1967	Building board, hard pressed, vegetable fibre (Laminated).

NBS PS 57:1973	Cellulosic fibre insulating board.
NBS PS 58:1973	Basic hardboard.
NBS PS 59:1973	Prefinished-hard board panelling.
NBS PS 60:1973	Hardboard siding.
SPR R 179:1963	Structural insulating board (wood or cane fibre).
NBS CS 236:1961	Mat-formed wood particle board (Interior use).
AHA IS 1-70:1970	Industry standard for hardboard.
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ASTM D 2277:1975	Fibreboard nail-base sheathing.
ASTM D 2860:1972(1977)	Adhesion of pressure sensitive tape to fibreboard at 90-deg. angle and constant stress. Test for.
ASTM D 3247:1973	Coefficient of static friction of corrugated and solid fibreboard (Horizontal plane method). Test for.
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ICBO UBC 22-1:1970	Fibreboard - insulating.
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NPA 4-73:1973	Standard for medium density fibreboard.
PI 7T-53:1953	Testing puncture and stiffness of paperboard, corrugated and solid fibreboard.
SAE J 119a:1972	Fibreboard crease bending test.
SAE J 315b:1972	Fibreboard test procedure.
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SAE J 947b:1972	Glossary of fibreboard terminology.

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AMS 3552A:1953	Fibreboard - Corrugated - Single wall, double face.
AMS 3554A:1953	Fibreboard - Corrugated - Double wall.
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AMS 3940E:1974	Fibreboard, hard-pressed, structural.
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TAPPI T 1003M:1960	Flexural resistance and deflection of insulating board.

USSR

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GOST 8904:1976	Hardboard with varnished or painted surface. Technical conditions.
GOST 8928:1970	Fibrolite boards with portland cement.
GOST 19228:1973	Fibre boards. Equipment devices. Terms and definitions.
GOST 19229:1973	Fibre boards production. Terms and definitions.
GOST 19230:1973	Fibre boards. Technology. Terms and definitions.
GOST 19592:1974	Fibre boards. Test methods.
GOST 10632:1977	Wood particle boards.
GOST 19633:1973	Particle boards. Sampling and general requirements in testing.
GOST 10634:1973	Particle boards. Methods of determination of physical properties.
GOST 10635:1973	Particle boards. Method for determination of ultimate strength and modulus of elasticity in static bending test.
GOST 10636:1973	Particle boards. Method for determination of ultimate tensile strength perpendicular to surface.
GOST 10637:1973	Wood particle boards. Methods of determination of resistivity to nail woodscrew withdrawal.
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GOST 11843:1966	Wood particle boards. Method for determination of hardness.
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GOST 19506:1974	Wood particle boards. Manufacture equipment and control devices. Terms and definitions.

YUGOSLAVIA

JUS D.A1.080.1968	Testing of fibre building boards. Sampling.
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JUS D.A1.082:1957	Fibreboard testing. Thickness measuring.
JUS D.A1.083:1957	Fibreboard testing. Humidity.
JUS D.A1.085:1957	Fibreboard testing. Weight per unit of surface and specific gravity.
JUS D.A1.087;1959	Fibreboard testing. Bending strength.
JUS D.A1.088:1964	Testing of fibreboards. Janka hardness test.
JUS D.A1.089:1970	Testing of fibre building board. Measuring of dimensions, straightness of surfaces and squareness of boards.
JUS D.A1.090:1970	Fibre building boards. Resistance to perforation by impact.
JUS D.A1.092:1970	Testing of fibre building boards. Compression strength.
JUS D.A1.093:1970	Testing of fibre building boards. Compressiveness perpendicular to faces of insulation and bitumenous boards.
JUS D.A1.094:1970	Testing of fibre building boards. Form stability.
JUS D.A1.095:1970	Testing of bitumenous fibre building boards. Determination of bitumen content.
JUS D.A1.200:1970	Testing of decorative laminated fibre building boards. Impact strength.
JUS D.A1.201:1970	Testing of decorative laminated fibre building boards. Resistance to cigarette burns.
JUS D.A1.202:1970	Testing of decorative laminated fibre building boards. Steam resistance.
JUS D.A1.203:1970	Testing of decorative laminated fibre building boards. Resistance to heated pot.

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JUS D.A1.103:1962	Particle board test. Humidity.
JUS D.A1.104:1962	Particle board test. Determination of water absorption and swelling.
JUS D.A1.105:1962	Particle board test. Surface and specific density.
JUS D.A1.106:1965	Testing of particle boards. Tensile test perpendicular to the board surface.
JUS D.A1.107:1965	Testing of particle boards. Bending test.
JUS D.A1.108:1970	Testing of particle boards. Determination of dimensions of test pieces.
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JUS D.A1.110:1970	Testing of particle boards. Compression strength.
JUS D.A1.111:1970	Testing of particle boards. Nail withdrawal resistance.
JUS D.A1.112:1970	Testing of particle boards. Resistance to screw withdrawal.
JUS D.A1.113:1970	Testing of particle boards. Form stability.
JUS D.A1.114:1972	Particle boards. Determination of volumetric density.
JUS D.C5.030:1972	Particle boards. Classification.
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JUS D.C5.032:1972	Particle boards for building purposes.

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