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# INTERNATIONAL FORUM ON APPROPRIATE INDUSTRIAL TECHNOLOGY

New Delhi/Anand, India 20—30 November 1978

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**WORKING GROUP No.10**

**APPROPRIATE TECHNOLOGY  
FOR THE MANUFACTURE OF  
PULP AND PAPER PRODUCTS**

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**APPROPRIATE TECHNOLOGY FOR PULP AND PAPER PRODUCTION**  
Discussion Paper

Appropriate Technology for  
Pulp and Paper Production \*

Issues and Considerations

Note prepared by the secretariat of UNIDO

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Pulp and Paper Production\*

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\* This Note has been based on the background documentation on the subject, which is attached.

## INTRODUCTION

1. Paper is considered as one of the pre-requisites of modern existence. Reference is also made to the correlation between the consumption of paper and the standard of living of a given country. The importance of pulp and paper industry has long been recognized and the developing countries are desirous of establishing their own industry to meet their growing domestic needs. Many of the developing countries depend on imports of paper as well as pulp for conversion into paper from countries that produce pulp from coniferous wood, to meet their domestic needs. Supply of paper in the international market is, however, becoming increasingly uncertain and this is particularly so in respect of the common varieties of writing and printing paper, newsprint, etc. due to:

- (a) Reduced availability and high cost of traditional raw materials rendering production of common varieties of paper unremunerative in relation to the cost of investment, as well as to the profitability of other grades of paper;
- (b) Decline in investment due to:
  - (1) increasing cost intensity of conventional paper making, and
  - (11) low profit margin;
- (c) Increasing cost of transportation due to rise in fuel cost; and
- (d) Balance of payment problems, particularly of the developing countries.

2. It is, therefore, considered as a matter of prime-importance not to rely, on a long-term basis, on imports for meeting the growing demand for critical items for mass consumption varieties of paper. Establishment of paper industries has thus become one of the basic elements of industrial development programmes of most of the developing countries.

3. Disparity of consumption levels: For developed countries, consumption levels exceed 100 Kg/cap/annum and are steadily increasing at around 5% per annum. The corresponding levels of the developing countries range from 20 Kg/cap/annum to as low as 2 Kg/cap/annum. The rates of increase in these areas are negligible. The population growth quickly absorbs such production increases as can be afforded from the limited resources available. It is difficult to determine where the minimum for reasonable development should be set. It is, however, estimated that a level of 30 Kg/cap/annum is a minimum to achieve full literacy, adequate communication and educational levels while 40 Kg/cap/annum would be a desirable objective because some element of packaging should be present for industrial purposes. The minimum rate suggested is, in fact, equivalent to that which was attained in developing Western countries by early 1900's and cannot, therefore, be regarded as over-ambitious.

4. At the current levels of increase, it is difficult to foresee how the under-developed countries, particularly in Africa and the Far East, will attain even a level of 10 Kg/cap/annum within 2000 AD. In the FAO projections of world increase in production, only about 20% is predicted to be available for the under-developed countries.

5. The problem: To achieve a minimum target of 30 Kg/cap/annum, the developing countries would need around 100,000,000 tonnes of additional production. Assuming that the greater use for such an increase would be for writing and printing paper grades and newsprint, approximately 30,000,000 tonnes/annum of long-fibre pulp and 70,000,000 tonnes/annum of short-fibre, hard-wood or similar pulp would be necessary. The implications in terms of fibre requirements and investment needed are staggering. Raw materials required for short-fibre, hard-wood pulp would present no insuperable difficulties in availability, but considerable problems in orderly exploitation. The capital intensity for the exploitation operations by modern standards would be prohibitive for most developing countries. The scale accepted as economic for production, cannot be absorbed domestically while export as finished materials can

be ruled out as a practical alternative because of the intense competition from developed countries producing for export. Even otherwise, the scale and sophistication of paper production have advanced to levels where, conventional pulp mills based on wood have become almost prohibitive in terms of capital investment involved. The standard size of new plants, working on wood fibres, ranges from 500 t/d to 1000 t/d and costs over \$300,000 t/d or \$150 to \$300 million for a complete plant. The tendency in developed countries is to instal increasingly larger pulp mills mainly to reduce the operational costs per unit of production, which have increased steeply in conjunction with the sophistication and requirements necessitated to improve the quality of products, chemical recovery and efficiency in pollution control, in the pulp production process. Developing countries having long-term plans to establish paper production capacities are thus faced with problems originating on the one hand, from the compelling need for development of indigenous production capacity and on the other, from the size, sophistication and cost of the conventional technology.

6. The size and sophistication of conventional paper making machines have grown in response to the pulp yield of the conventional 'modern' pulp mills. The need for mass scale production as a way of survival in international paper trade has more or less compelled the paper production technology to add on to the size and speed of paper machines. Over the past several decades, the paper machine has increased in width from 2 metres to around 10 metres and the operating speeds have increased from about 100 metres/minute to 900 metres/minute. In terms of annual production capacity, the single machine has moved from approximately 500 tonnes/annum to upward of 150,000 tonnes/annum. As a result, paper production based on conventional processes has become prohibitive for developing countries in terms of both the production in relation to domestic market and cost.

I. OBJECTIVES

7. Because the difficulties of establishing paper production capacities based on modern conventional technology have proved so intractable, the idea has grown that the only other option - to build small, viable mills - should be possible. The need of developing countries to establish their own production capacities is so compelling while the negative factors of establishing production capacities based on modern available technologies are so consequential, that the feasibility of establishing small, viable mills based on local available raw materials needs serious consideration.

8. What may be more appropriate for most of the developing countries, with low consumption base and limited domestic market, would probably be a process system designed around a small, simple, low-cost installation, reasonably fast and flexible, to be operated with average expertise and producing low pollution levels and capable of using all practical sources of non-wood fibrous material to produce paper. Paper and associated products must be cheap to be available in sufficient quantities to the poorest.

9. The need for development of low-cost standard, but versatile paper machines capable of multigrade paper production is extremely urgent. But the established machinery manufacturers and leading consultants cannot be expected to develop the production of such equipment because the concept is contrary to their present production structure. It is, therefore, imperative that capacities to fabricate such machinery would need to be developed as far as possible within the developing countries themselves.

10. Wood-based fibre resources of developing countries which are mainly tropical hard-woods, are difficult to exploit and, from the pulping point of view, less self-sufficient. Exploitation of hard-wood resources on the conventional scale requires a considerable infrastructure and is highly capital intensive. The use of corrosive chemicals, high temperature and pressures in many stages of the process also requires the installation of expensive and highly sophisticated equipment. The strategy for development of paper industry in developing countries should, therefore, be based



primarily on utilization of alternative non-wood fibre resources on an appropriate scale.

11. The objective of any strategy for development of paper production in the developing countries is, immediately, to create domestic availability of the varieties of paper like writing and printing and newsprint grades and essential industrial grades of paper like packing and wrapping paper and boards, within the following parameters:

- (a) Capacity of plant and machinery should match with the small and scattered nature of domestic market, which is again difficult to integrate due to internal transport bottlenecks;
- (b) The technology selected for production of paper should be accessible in terms of the capital cost involved, cost of resultant product, local endowment of raw materials, skill and expertise, and domestic engineering capabilities; and
- (c) The resultant products should be cheap both absolutely and in relation to the comparable products now imported.

## II. TECHNOLOGICAL OPTIONS

12. Sophistication of the conventional paper technology has advanced to a level where it has practically no immediate solution to offer for the specific problems and constraints of the developing countries. The conventional technology, which is based entirely on wood fibre and producing highly bleached and sophisticated products, has no satisfactory answer for the technological needs of the use of non-wood fibres. But successful operation of small plants, some of even 20/25 t/d capacities, and using non-conventional fibres like paddy straw, reeds, bagasse, etc., of the types in Brazil, Egypt, India, etc. perhaps, provides an option and may be seriously considered for wide-spread use in the developing countries.

13. By and large, it might be advisable for the developing countries, to concentrate on alternative raw materials such as wastes from associated timber or agricultural industries and alternative fibre sources like reeds, bamboo, straw. Pulp produced from these raw materials would, however, need to be blended with coniferous

wood pulp and other long-fibre pulp to improve their runability and to obtain the required strength properties while manufacturing light-weight printing and writing paper, Kraft paper, etc. Secondary fibre can also be obtained from waste paper and used as part of the fibrous furnish for the production of all grades of paper board like cardboard and carton-board and also for the manufacture of substitute flutings and liners for case making.

14. Developing countries are usually deficient in coniferous species such as spruce, pine, fir, hemlock, etc. to produce the commercially developed long-fibre pulp. There are a few agricultural crops that could provide the long-fibre pulp for developing countries such as sunn hemp, sisal, common hemp, abaca stem, banana stem, jute, etc. But economic factors such as limited availability in terms of quantity, low yield of fibre per acre, and the high cost of preparing the raw material limit the use of these raw materials to only speciality grades of paper like cigarette tissues, carbonising tissues, etc., at present.

15. In recent years, work done on Kenaf indicates the possibility of substituting this pulp in place of long-fibre and wood pulp. But further investigation of the suitability of this raw material would be required before it could be adopted on a commercial scale for production of long-fibre pulp. Considering the present state-of-the-art of the development of alternative long-fibre pulp sources, it would be necessary for the developing countries to import long-fibre pulp to produce writing, printing and speciality grades of paper as well as certain industrial grades of paper.

16. A shift from wood to non-wood raw materials for production of pulp is necessary not only for its own sake but also to provide an alternative to the conventional technology involving installation of high-cost, sophisticated plant for the production of wood pulp.

17. For achieving pulp brightness in small-scale operation, the bleaching sequence can be simpler and avoid the use of expensive chlorine-dioxide necessary to obtain high brightness. A simple system using hydro-chlorite in chest bleaching could, in many cases, produce pulp with sufficient brightness. It is possible to think of

a viable pulp mill of 50/80 tonnes/day capacity without the use of chlorine and caustic soda.

18. Recovery of cooking chemicals used for production of wood pulp involves highly capital-intensive processes and equipments. No satisfactory answer has been found to this problems for application in small-scale pulp plants and therefore, although it involves higher energy and chemical cost, some of the existing small-scale 50/100 tonnes/day pulp mills still use the old-fashioned low heat economy chemical recovery systems.

19. Processes using soda and batch digester have been found to be particularly expedient for use in small-scale pulping plants based on non-wood fibre resources. The soda process may be particularly relevant to the needs of developing countries due to its simplicity, low capital requirement and sulphur free cooking. The use of batch digesters enable better flexibility of operation, particularly where different types of raw materials are intended to be used. Soda and lime cooking is successfully practiced in small-scale pulp production in Egypt, India and a few other developing countries, using straw, reed, bagasse and other non-conventional fibre materials.

20. There are, however, serious technical and economic limitations of the known processes for small-scale pulp making and these would need specific attention of R+D in future. There is no proven process for recovery of cooking chemicals used in small-scale pulp making. This means that the black liquor containing as much as half of the raw material feed and all of the cooking chemicals have to be discarded. If chemical recovery were possible, dissolved organic material could be burnt and steam generated or recycled for cooking.

21. Many developing countries have plans to develop sugar production based on sugar cane. Small-scale paper mills based on surplus bagasse produced in cane crushing (about two thirds would be required by sugar mill for captive use) can be established in conjunction with sugar mills. This will provide a commercial outlet for the surplus bagasse produced in sugar mills and also yield a cheap source of raw material for paper mills. The fibrous constituent

of bagasse is an excellent raw material for production of pulp and paper and a number of paper mills based on bagasse are in operation in Egypt, India and a few Latin-American countries. With the simple soda process chemical recovery is practical at pulp production levels of 50 tonnes/day upwards and paper production viable at about the same level.

22. Technologies have been developed and are available using process systems designed around small, simple, low-cost installations, and capable of using all practical sources of fibrous materials to produce paper making fibre. Machinery and equipment needed for such small-scale plants ranging from 15 tonnes/day to 100 tonnes/day are fabricated in some of the developing countries and can be, with advantage, installed, and operated in other developing countries. The advantages of these processes - which are not available in large-scale modern pulp plants - are that they:

- (a) Are labour-intensive;
- (b) Are simple in operation and maintenance;
- (c) Can be linked with other agricultural operations and industries;
- (d) Can be integrated with the existing levels of technological development; and
- (e) Facilitate profitable use of materials for which there is no other economic use.

23. Further, some of the raw materials available in developing countries like hemp, flax, cotton, jute, etc. can be processed in small-scale plants for production of special pulp grades which have great export potentiality.

24. Paper making machinery and processes: Studies of the economics of operation of large-scale paper machines have revealed that there is no special commercial advantage of mass production plants over smaller plants. On the other hand, these studies reveal that paper machines in width at 2.5 to 4 metres depending on the paper grades required and designed for speeds unpto 300 metres/minute can be most economical as well as technically viable. Such machines based on a few standard designs and rated to capacities of 25 to 100 tonnes/day can be produced in a number of developing countries and might, in general, be ideally suited to the needs of developing countries intending

to produce paper mainly for substitution of imports. Such machines installed in 1930's and even earlier are still in operation in a number of developing countries and have proved to be extremely versatile. The design and specifications have, however, in many cases, been adapted to suit local conditions and might, with further modification, be profitably adopted for local fabrication in other developing countries. It is also possible and would, indeed, be desirable to take advantage of genuine improvements achieved in paper technology in subsequent years, like the combi-press pick-up, grooved or fabric presses, substance and moisture control. The advantages of such small machines include:

- (a) economy of capital cost;
- (b) simplicity of operation;
- (c) labour-intensity;
- (d) adaptability to the substance range required;
- (e) suitability in terms of decentralization and regional dispersal of paper industry; and
- (f) facilitating for installation of additional paper machines sequentially with cash flow and operating cost benefits as well in response to the expansion of demand for paper.

### III. POLICY MEASURES

25. The conventional technology for production of pulp and paper has developed to a stage at which it has ceased to be of immediate relevance to the developing countries. To accept import of paper as a solution on a long-term basis could be self-defeating. Costs will be higher, availability of paper far less and the balance of payments implications unmanageable. Establishment of paper production capacity has quite appropriately been assigned a high priority in industrialization programmes of developing countries aimed at import substitution. Considering the specific situation of these countries, constrained as they are by limited domestic market, which itself is scattered and yet unintegrated, scarcity of expendable resources, successful operation and prospects of small-scale, cheap and labour-intensive, pulp and paper technology based on non-wood fibres comprising of agricultural and industrial wastes and materials which have no alternative commercial use or value, provide a viable technological option.

26. Wood-based fibre resources of developing countries are mainly tropical hard-woods, which are difficult to exploit and are less self-sufficient from pulping point of view. Conventional technology for wood pulp production is also incompatible with the needs and resources of developing countries. The emphasis would therefore need to be on pulp production based on non-wood fibre resources. For achieving self-sufficiency in pulp requirements, however, plantation of long-fibre species like poplar, pinus species, etc. should be integrated with afforestation and forest development programmes. Experimental plantations in growing of these species have shown encouraging results.

27. Domestic requirements and not demands of the quality specifications to international standards should guide the process of decision making in regard to production targets, the product priorities and location of plants. The emphasis would need to be on establishment of small, self-sufficient integrated plants nearer consumption centres.

28. Paper and associated products should be cheap to be available to the poorest sections of the population. Decentralization of the paper industry in consuming centres, integration of paper mills with agricultural and industrial operations, availability of cheaper alternative materials, availability of manpower and other positive factors are expected to result in considerable economy in the production costs. Nevertheless, the small-scale units would need to be supported, at least initially, though a rational scheme of subsidies and fiscal incentives and protection against imported products, to be viable.

29. Newsprint requirement would need to be met through imports or, if feasible, through regional schemes involving a number of similarly situated and motivated countries. The requirements of long-fibre pulp to be used with locally produced non-wood pulp for production of writing and printing and other special grades of paper also would need to be met through imports while efforts would have to be made to develop plantation of coniferous species to establish local availability of long-fibre pulp.

30. R+D: For the last 50 years, R+D in paper industry has been mainly concerned with the requirement of the basic processes and innovations in machinery and equipment, particularly from batch to

continuous operations, introduction of computerized process control systems, the automation of various phases, recovery and recycling of chemicals used, etc. The aim has been to improve the product quality, eliminate losses, and increase production.

31. Until recently very little R+D was undertaken on alternative technologies, processes and raw materials to meet the specific needs of the developing countries. From what is known about the relative efficiencies of the small and large-scale technologies, it is clear that innovations in the small-scale technology and processes should aim at improving the quality and strength of paper produced in the small-scale plants, facilitating the use of non-wood fibres, and recovery of chemicals used. This is an area where the Working Group could present a concrete plan of action which could be taken up later by the developing countries and the international organizations like UNIDO as a part of their work programme.

32. The specific areas in which further R+D work is indicated include the development of a more versatile paper machine incorporating some of the genuine improvements since achieved in paper making technology like combi-press pick-up, grooved and fabric presses, substance and moisture control. To reduce the cost of such plant, it could be designed for modular, pre-assembled construction to minimize site assembly requirements. The entire machine house and preparation plant can also be considered as a part of the standard design for modular construction. Also, further R+D work would be needed to get round the technological problems associated with the use of paddy and wheat straw to facilitate its wide-spread use in the paddy and wheat growing areas.

#### IV. PROGRAMME OF ACTION

33. In its national dimension the programme of action might include:

- (a) Assessment of the long-term domestic requirements of paper on the basis of present consumption and growth trends taking into account increase of population, progress of education and overall development;

- (b) Identification of appropriate small-scale technologies based on non-wood fibres now in operation in some of the developing countries and assessment of their suitability to local conditions;
- (c) Establishment of indigenous capability for the fabrication of plant, equipments and components based on existing small-scale technologies and processes;
- (d) Formulation and implementation of crash programmes for the development of plantations for production of coniferous and other long-fibre species both as part of afforestation programme and independently of it; and
- (e) Encouragement, through a rational scheme of financial and technical assistance as well fiscal subsidies, of the establishment of small-scale paper mills as adjunct to the existing and future sugar and timber mills.

34. Considerable technological expertise of the sophistication appropriate to the developing countries in general, exist in a number of developing countries like Brazil, Egypt and India. Co-operation and inter-action among these and other developing countries can be greatly rewarding. Such co-operation can be fostered either on a bilateral basis or through international agencies like UNIDO.

35. UNIDO, FAO and other international organizations can greatly facilitate the establishment of paper industry in developing countries and may address themselves to the following programme of work:

- (a) Establish a comprehensive data bank on the small-scale technologies developed and are in operation in some of the developing countries using non-conventional fibres;
- (b) Participate, both financially and technically, in national R+D projects in the field of small-scale pulp and paper technologies;
- (c) Assist in establishment of regional research centres for R+D on specific alternative raw materials, which are or may be available in these regions;
- (d) Facilitate transfer and application of small-scale technologies from developing countries where such technologies are in operation to other developing countries by providing requisite advisory services to that effect, to the latter; and
- (e) Assist developing countries in formulating comprehensive production programmes which would include establishment of production capacities for critical varieties of paper and paper products.

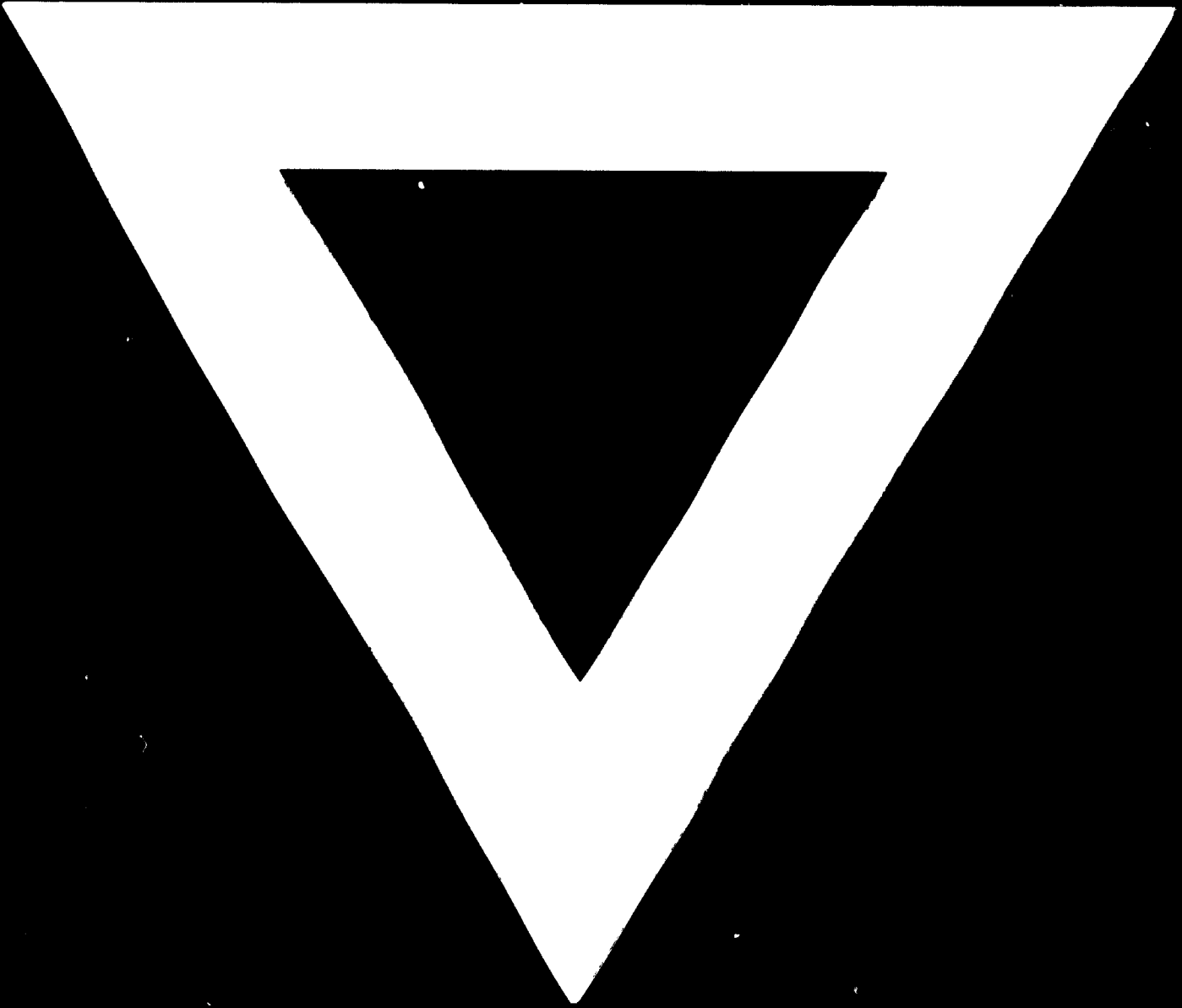


The following documents on this subject are being circulated:

Prospects for Establishing Viable Small-scale Pulp and Paper Industries in Developing Countries	ID/WG.282/5
Appropriate Technology for a Low-cost Paper Project to Boost the Rural Economy	ID/WG.282/6
Further Development of Mini-paper Technology in India	ID/WG.282/10
Strategies for Developing Pulp and Paper Industries in Developing Countries	ID/WG.282/15
Pulping Technology and Requirements and Potentialities of Developing Countries	ID/WG.282/17
The Pulp and Paper Industry in Egypt	ID/WG.282/18
Paper, Cardboard, Corrugated Cardboard, Polyethylene Shrink and Stretch Film for Better Packaging	ID/WG.282/21
Forest Industry Policy and Choice of Appropriate Technology	ID/WG.282/22
Lime Burning and Alkaline Pulping	ID/WG.282/43
Evolution of the Pulp and Paper Industry in the Philippines	ID/WG.282/51
Appropriate Industrial Technology Application in the Pulp and Paper Industry	ID/WG.282/52
Universal Pulping	ID/WG.282/62
Pulp and Paper Industry in Brazil	ID/WG.282/73
Paper, Paper Products and Pulp Mills	ID/WG.282/81
Appropriate Technology in Developing the Pulp and Paper Industry in Panama	ID/WG.282/84
The Search for Appropriate Technology for the United Kingdom Paper and Board Industry	ID/WG.282/106



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