SOME ECONOMIC CONSIDERATIONS IN THE IMPLEMENTATION OF A NON-WOOD PULP AND PAPER PROJECT

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ABSTRACT

Non-wood fibers are good raw materials for the production of pulp and paper in many regions where wood supply is limited or costly. And non-wood fibers are well suited for smaller mills required for the limited markets in developing countries.

Unfortunately, many non-wood mills have problems or have failed. These problems are usually economic and financial, rather than technical.

This paper discusses the pitfalls and errors that can lead to financial and economic problems, and gives some guidelines on how to avoid these to arrive at more profitable projects.

INTRODUCTION

Often, people who have just discovered that pulp and paper can be produced from non-wood fibers become enthusiastic promotors of projects based on non-wood fibers. And governments of developing countries that have little or no wood look at such projects as the solution to their paper supply problems. Most projects do not proceed once the promotors also discover that the cost of even a very modest project is in the tens of millions of dollars; however, quite a few proceed. Unfortunately, quite a few projects that are implemented are not financially successful for a variety of reasons and are shut down or converted to other raw materials - wood, wastepaper or purchased pulp.

This paper attempts to identify various economic factors and considerations that affect the viability of non-wood pulp and paper projects and to establish some guidelines for the establishment of economically viable non-wood pulp and paper projects.

RAW MATERIAL SUPPLY

The first and primary consideration in the implementation of a pulp and paper project is the selection of the raw material to be used and whether or not there are sufficient quantities available on a sustained annual basis. Government statistics on growth areas and raw material availability are usually of only limited value as the figures may include inaccessible areas, or may be the total figures for many small areas scattered too far apart to make raw collection economical.

Another factor is the current and future use of the raw material by other industries or competing projects. Recently, in response to government "free zone" encouragement, ten small straw pulp and paper mills with capacities of 8,000-20,000 tons/year were built within a radius of 5 miles - several of them side-by-side. As each mill went on-stream, the demand for straw increased and the price increased far beyond the figures used in the original project financial evaluations. The area, that could have provided an adequate sustained supply of straw for two or three mills of modest size, was simply inadequate for ten mills, and straw had to be drawn from more and more remote areas.

Also, in the case of wild plants such as grasses and reeds, it is necessary to determine whether or not the plants will regrow if cut or will regrow to the same yield per hectare per year. Several reed pulp mills have had to close because, on cutting at the scale required to supply a mill, regrowth of the reeds stopped or declined to the extent that it was no longer possible to supply the mill.

Although it seems obvious that an adequate and sustained supply of raw material for the mill is essential, it is surprising how often it is discovered, a relatively short time after the mill is built, that the supply of raw material is quite inadequate.

RAW MATERIAL COSTS

The next important factor is the cost of the raw material. The raw material cost has several components as follows:

a) the base price to be paid to the owner of the land on which the non-wood fiber is grown;
b) the cost of harvesting;
c) the collection and transportation cost;

d) the cost of fiber preparation;
e) the cost of storage.

Of course, the cost distribution varies considerably depending on the raw material. In the case of straw, the land (and the straw) is owned by farmers or cooperatives, and the base cost and the cost of harvesting usually are lumped together.

Inasmuch as the pulp and paper mill does not own the land and must purchase the straw, the mill does not have direct control of the basic raw material costs and must adjust to going market prices. Prices may be subject to considerable variation, depending on the size of the harvest for a particular year. This is another reason why a new mill should be based on a growing area large enough to compensate for poor crop yields in certain years. This is also true for many agricultural residues and crops. Only in a few rare cases are certain crops, such as hemp, flax, abaca and sisal, grown specifically for pulp and paper production on land owned by the pulp and paper mill.

Bagasse differs from straw and other agricultural residues in several ways. The base price to farmers for growing sugarcane (or the cost of growing cane on the sugar mill's own plantations), as well as the cost of harvesting and collection, are already paid by the sugar mill. The other major difference is that the bagasse is used by the sugar mills as a fuel for the mill operation. If sugarcane bagasse is to be used for the production of pulp and paper, it must be replaced by oil, coal or natural gas, which can establish the source price of bagasse. Cotton linters and flax tow are somewhat similar in that the processing plants have already paid the base price and the cost of harvesting and collection. These raw materials are available at the processing plants and not from the fields.

Non-wood raw materials are bulky and voluminous and, consequently, are costly to transport over long distances. For this reason, and with few exceptions, non-wood pulp and paper mills must be located as near to the source of the raw material as the source of water will permit. In the case of straw, which must be collected and transported from many points, the transportation costs are the major cost component, and the success or failure of a straw pulp mill depends on the efficiency and effectiveness of straw collection and low transportation costs. This also holds true for reeds, bamboo and grasses, though to a lesser degree as the harvesting of these raw materials is also a major cost component. In fact, the size of a straw pulp mill is limited by the economic radius of straw collection and transportation to a capacity of circa 50,000 - 75,000 T/A.

In the case of bagasse - where the raw material is available, already harvested and collected at a few points - the cost of fuel replacement is the major cost component and transportation costs are a relatively minor component if distances to the pulp and paper mill are relatively short. However, if bagasse is shipped moist (50% moisture) and distances are over 20-30 km, the transportation costs begin to become a large component of the total cost and cannot be overlooked. The ideal situation is to locate the pulp and paper mill adjacent to a sugar mill which permits delivery of bagasse by flume or conveyor.

The prices of cotton linters, flax tow, hemp, abaca and sisal, at the source, are generally so high that transportation costs are usually an insignificant component. Flax tow is shipped from Egypt to Europe and Scandinavia, and abaca is shipped from the Phillippines and Ecuador to the eastern U.S.A. and England for the production of pulp for high-end specialty papers.

Transportation costs often are not given proper consideration in establishing the price of raw materials delivered to the mill, and this can lead to financial problems.

Fiber preparation is an essential step in the processing of non-wood plant fibers for the production of pulp and paper. Straw must be cut, and dry or wet cleaned, or both. Bagasse must be moist and wet depithed, and washed. Cotton linters may require both dry and wet cleaning; reeds must be chopped and dry cleaned, and bamboo must be chipped and screened.

Flax, hemp, abaca and sisal differ in that extensive fiber preparation is carried out prior to shipment to the pulp mill. The bast fibers must be removed from the woody core in the case of flax and hemp. And, in the case of abaca and sisal, the long leaf fiber strands which are imbedded in the pulpy flesh of the leaves are removed by a costly semi-manual stripping or scrapping operation and fiber preparation at the mill is limited to cutting and dedusting.

All of these steps involve losses and consequent costs. Fiber preparation losses and the cost of fiber preparation often are overlooked in the preparation of manufacturing cost estimates of non-wood plant fiber projects. Losses before cooking are frequently forgotten, which results in too low a figure for the raw material that has to be purchased. And, the source or base price of raw material often only includes a general rate for transportation, and the other cost components are forgotten. As a result, both the quantities of raw material to be purchased and the raw material unit prices are too low, and the financial analysis will show a return on the investment which, in fact, cannot be achieved. Figures 1 and 2 show fiber handling and preparation losses for bagasse and rice straw. Obviously, if a figure of 2.1 tons is used (instead of 2.5) for the purchased bagasse per ton of pulp and 2.9 in the case of rice straw (instead of 3.9), the economics of the project will be wrong.

Reeds, bamboo, sisal and abaca are usually harvested continuously, if conditions permit. Consequently. raw material storage at the mill is minimal. However, in most cases, the crops are annual and seasonal, and storage of raw materials is required to supply the mill throughout the year.

Cereals are usually harvested in 6 to 8 weeks, and straw to supply the mill for a whole year has to be collected within this period of time. In the case of sugarcane, the harvesting season may be longer but with few exceptions (i.e. Peru, which has an 11-month harvesting season); substantial storage is still necessary.

Depending on the raw material and the storage system used, losses in storage and in handling to and from storage can range from 3% to 20% and cannot be ignored in determining the total raw material costs.

In addition to the capital required to construct the storage facilities, storage of raw materials means that working capital must be tied up in inventory. The amount of working capital required depends on the amount of raw material that must be stored to keep the mill running, and there has to be some leeway as there are seasonal variations in harvesting times.

Although the working capital necessary to meet the requirements for raw material storage can be very substantial, these costs are frequently ignored in project studies with the result that the mill has insufficient working capital when it goes into operation. This can seriously affect the mill's ability to remain in operation.

In the development of many non-wood pulp and paper projects (even when undertaken by firms with extensive wood-based pulp and paper experience), most of the emphasis is expended on the pulping technology and the mill design. Little attention is given to raw material supply and delivery. The emphasis should be the reverse as most mistakes and technical and financial problems in non-wood pulp and paper projects occur in the growth, harvesting, collection, transportation, fiber preparation and storage aspects of non-wood pulp and paper projects.

PULP AND PAPER MARKETS

Often, paper import statistics in many developing countries are not reliable, especially if duty rates differ according to the type and grade of paper.

Some importers may try to have the paper they import classified as a type or grade that carries the lowest duty, and customs inspectors often lack the expertise to know the difference.

Consequently, what may appear to be a substantial market for a certain type or grade of paper, in fact, may be a false figure which, in addition to the type or grade covered, may include a much larger quantity of a large variety of quite different papers. If the design and economics of a mill is based on such figures, there can be serious problems in the operation and profitability of a project.

As there are fewer types of pulp on the market, there are far fewer customs classifications and applicable duties. Also, the different types of pulp are easier to identify. Consequently, there are not the same opportunities for importers to import pulps under more advantageous classifications. Consequently, government statistics on pulp imports are usually correct. However, some care must still be exercised as often there is no differentiation between sulphite and kraft pulps, or, in some cases, between hardwood and softwood pulp.

The most common error in determining markets for pulp, for a country or region, seems to be a lack of appreciation of the difference between softwood pulp and hardwood pulp.

Most of the non-wood plant fiber pulps used for the production of common papers are short-fibered pulps, and what is usually required is the admixture of some long-fibered softwood pulp to provide the necessary strength. Hardwood pulps are short-fibered pulps, with strengths similar to that of straw, bagasse and reed pulp, and are not of much value in countries and regions where there is an abundance of short-fibered non-wood raw material.

Yet, recently, several hardwood and other short fiber market pulp projects have been proposed to supply India and South East Asian paper mills (almost of which are integrated with short fiber non-wood pulp mills) because the market survey showed that "there is a large market for woodpulp" in these regions. There is a large demand for woodpulp in these regions - but it is mostly for softwood pulp.

It is essential that any market study on market pulp distinguishes between softwood and hardwood pulp and, in developing countries, any market study on paper consumption should be backed-up by direct surveys of consumers. It is also advisable that any market studies are carried out by firms that know the pulp and paper industry.

SELECTION OF PRODUCTION PROGRAM

The most common error that leads to the construction of mills that are not profitable is the attempt to produce all of the pulp and paper that a country or region requires in one mill. In the first place, the country or region may not have the raw material suitable for the production of some of the types of pulp and paper the country or region lacks or the consumption of some papers may be so small that production would be uneconomical. And, in some cases, this approach overlooks export possibilities.

Non-wood specialty pulp mills for the production of flax, hemp, sisal, abaca, and cotton pulps for the production of high-grade specialty papers can sell their production profitably on the international market, and this opportunity should not be overlooked.

On the other hand, non-wood market pulp mills based on straw, bagasse, reeds and bamboo (which yield common pulps) would have very considerable difficulties in competing with hardwood market pulp mills on international markets because of mill size limitations. Export oriented projects based on these raw materials are only rarely economically feasible.

In most cases, straw, bagasse, reed and bamboo market pulp mills are limited to national and close-by regional markets, and, even then, it is usually more profitable to integrate the pulp mill with a paper mill.

Paper mills in developing countries based entirely on imported pulp are rarely profitable unless the customs duty structure provides sufficient protection to import substitution projects. About the only exception is a sanitary tissue mill because sanitary tissue is bulky and costly to ship.

Paper mills in developing countries based largely on locally collected wastepaper can be profitable, but the types and grades of papers and boards that can be produced are usually limited and of lower quality. For high quality papers, high quality wastepaper is required, which is not usually available in developing countries in significant quantities.

For the profitable production of good quality common papers and boards, it is almost essential that a paper mill is integrated with a pulp mill that can provide all or more than 70% of the pulp required. Usually, the greater the local pulp content of the papers produced, the greater the profits.

However, if the non-wood pulps are short-fibered pulps, it is not possible to produce good quality papers of all types, using a high proportion of non-wood pulp.

Where strength is important, for example, the content of long-fiber softwood pulp must be high if paper quality is to approach international standards.

The types and quality of the papers to be produced will depend on the raw materials and, in some cases, the pulping processes used. Thus, in order to establish the production program, it is necessary to examine the types of papers that can be produced from various non-wood fibrous raw materials.

Although there are very many different types and grades of paper on the market, they can be roughly classified in main groupings as follows:

Cultural Papers:

a) printing and writing, bond and book papers
b) newsprint, directory, high groundwood content magazine papers, and school exercise books

Packaging Papers and Paperboard:

a) wrapping envelope and bag papers, sack kraft
b) linerboards
c) solid paperboards and corrugating medium
d) multiply boxboards, test liner

Sanitary Papers:

a) toilet and facial tissues
b) sanitary tissues
c) napkin and toweling papers

Specialty Papers:

a) currency and security papers
b) high-grade bonds and permanent record papers
c) cigarette and condenser papers
d) tea bag, porous and strong absorbent papers

Most papers fall into the first two categories. Strength is not an important factor in the case of cultural papers, and straw, bagasse, reed, and bamboo pulps are well suited for the production of chemical pulps for the production of good quality printing and writing, bond and book papers. Only bagasse has been used for the production of newsprint and high groundwood content papers, and with limited success. Non-wood fibers are not very suitable for the production of these papers.

As strength is of prime importance in most cases, straw bagasse and reed pulps are not very suitable for the production of high quality packaging papers. The only exceptions are certain solid paperboards and corrugating medium, where stiffness rather than strength is of greater importance. Bamboo pulps are somewhat better suited for the production of packaging papers and board than straw, bagasse or reeds, as bamboo pulp strength is higher, especially the tear strength.

Good quality sanitary papers of all types can be produced from bagasse and reed pulps.

Specialty papers are produced in small quantities and require specialty pulps.

Although a pulp and paper mill could be designed to produce pulp for many of the above papers, several pulping lines would be required, or frequent shifts in pulp production and different stock preparation systems and a lot of high density storage would be required so that the mill could produce, for example:

- low-yield chemical pulp for bleached papers
- intermediate-yield chemical pulp for stronger unbleached papers
- high-yield chemical pulp for packaging paperboards
- lower yield semi-chemical pulp for paper for school exercise books
- high-yield semi-chemical pulp for corrugating medium
- high-yield CTMP line for bleached groundwood paper substitutes

A large mill can afford to have several pulping lines but for smaller mills, the added complexity and cost becomes prohibitive. It is preferable and more economical to produce only one or, at most, two types of pulp, and preferably either bleached or unbleached and not both.

Obviously, if the number of types of pulps to be produced are limited, then the number of types of paper also becomes limited.

Most smaller mills can afford to produce only one type of pulp, and although a mill that produces bleached pulp can also produce unbleached pulp, this is not as efficient as producing one or the other. The financial charges per ton of pulp for bleaching are higher because of reduced bleached pulp production.

Sometimes the production of a small amount of long-fibered non-wood pulp (cotton, flax, hemp, or sisal) is proposed in addition to the main short fiber pulp production (straw, bagasse, reeds) in order to avoid the importation of long-fibered softwood pulp. However, unless the mill produces some specialty papers in addition to common papers, this approach is usually not economical with few exceptions. Cotton, flax, hemp and sisal pulps are expensive to produce as raw material prices are very high, and this high price can be borne only by the production of high-priced specialty papers. It is almost always cheaper to import long fiber pulp. Exceptions are the use of sabai grass and some bamboos if the mill uses batch digesters.

The same fault of trying to produce too many types of paper in one mill is often repeated at the paper machine level. Although it is possible to build a single paper machine, with a fourdrinier plus cylinder moulds or multiple formers, and fitted with a dryer section that includes yankee cylinders, breaker stack, size press, Clupak unit, coaters, and an additional reel, in addition to the conventional dryer cylinders; so that the machine can produce almost any type of paper - newsprint, printing and writing papers (coated and uncoated), sanitary tissue, MG papers, toweling, multiply board, solid board, wrapping paper, sack kraft, etc., etc.; this approach is not to be recommended.

Such a machine is costly, is inefficient (due to the many paper run changes for each type of paper), is difficult to operate, and in many cases, the paper produced will not be of the best quality.

It is better to reduce the number of types of paper to be produced or use more than one paper machine. A Yankee machine should be used for the production of sanitary papers. Multiply paper boards should be produced on multi-former machines and lightweight papers on machines designed for the production of lightweight papers.

A Fourdrinier paper machine, fitted with a top former, can produce a variety of cultural papers and can also be used to produce wrapping and bag papers, solid boards and linerboard with reasonable efficiency and quality, provided that the basis weight range is not too great. A four to one ratio is a reasonable figure; i.e. if the lowest weight of the paper to be produced by the paper machine is 60 gm/m², then the upper limit should be about 240 gm/m².

Selection of the production program has a very large effect on the design and economics of the pulp and paper mill, and the general rule is to keep it as simple as possible and avoid trying to produce small quantities of many types of paper.

Often (if the price is right), it is possible to get customers to change the types of papers they have been using and thus reduce the number of types to be produced.

MILL SIZE

The most common and controversial question is "what is the minimum economic size for a pulp and paper mill?" There is no simple answer, for the minimum economic size depends on:

1) the type of pulp or paper to be produced and type of mill,
2) the market the mill is to supply,
3) the raw material used, and
4) local conditions.

Some papers such as newsprint, and sack kraft are produced in integrated pulp and paper mills on large, fast, wide machines, in a very few "standard" grades. Mills to produce such papers have to be relatively large to be competitive even if they are intended for the supply of only local markets, and all, or a large portion, of the pulp required has to be produced in-house, in an integrated operation. On the other hand, mills that produce specialty papers such as sanitary tissues, cigarette papers, currency papers and tea bag papers, can be quite small and still be profitable, even if they purchase all or most of their pulp.

Market chemical pulp mills have to be relatively large to be competitive. Market mechanical, chemimechanical and chemi-thermomechanical pulp mills can be much smaller and still be profitable.

A major factor is the market a mill is to supply. If the mill is to sell to the international market, the mill has to be very large. Mills intended for a regional market can be substantially smaller, and mills to supply local markets can be quite small.

Table I provides some typical order of magnitude figures for mills for various end products and markets. However, these figures should not be taken as definitive as other factors can have a considerable effect. There are profitable mills smaller than given in the table and mills larger than indicated that have failed.

If the raw material is wood, the effect of the raw material on the economics of plant size is small if the mill has an adequate wood supply to draw on. In the case of non-wood fibers, the story is different.

The most economical chemical pulp mill is the largest single-line mill that can be built. In the case of wood, with the equipment currently available, single-line mills with capacities of over 1200 metric tons per day can be built. However, in the case of straw, because of the low drainage rate, the same washers that will wash 1200 tons per day of woodpulp will only be capable of washing 250-300 tons per day of straw pulp. Also, even if the mill is centered in a large grain growing area, the economics of collecting the straw and bringing it to the mill will probably limit the size of the pulp mill to 200-250 tons per day. Most "large" straw pulp mills have capacities of 140-180 tons per day.

The same holds true for bagasse. Although collection of raw material is not necessarily a limiting factor, the slower drainage of bagasse pulp limits the size of a single-line pulp mill to 350-450 tons per day. From this, it can be seen that it is unlikely that a market pulp mill based on straw or bagasse could be competitive on the international market and would be limited to regional or in-country markets.

Because of the relatively high price of the pulps, non-wood specialty pulp mills can be small and still be profitable. Cotton linters is the lowest priced specialty pulp and, consequently, cotton linters pulp mills tend to be considerably larger than mills producing hemp, flax or abaca pulps which usually command a higher price.

Because paper commands a higher price than pulp, paper mills (especially integrated pulp and paper mills) can be smaller than market pulp mills and still be profitable. The only exceptions are "bulk" papers such as newsprint, sack kraft and linerboard. Specialty paper mills producing high-priced specialty papers can be quite small.

Local conditions; raw material costs, fuel and power costs, chemical costs, labour costs, tax and duty structure, and local requirements can also have a strong effect on the mill size. In the end, the only way to determine the minimum economic size or the optimum mill size is to carry out a study. The results are often quite surprising.

DESIGN, CONTRACTING, AND PROJECT IMPLEMENTATION

The design of the mill affects capital costs, and maintenance and operating costs, all of which affect the economics of a project. Because the capital cost per ton of end product (and financial charges) increases rapidly as the capacity decreases. it is essential that smaller mills are designed to achieve as low a capital cost as possible, even at the expense of additional labour and operating costs. In large mills, the reverse is true; the capital costs per ton are low, and the objectives in the design of a large mill are to reduce labour and operating costs. even if the capital cost must be increased. Scaling down a large mill is not the way to design a small mill.

Unfortunately, many promotors of pulp and paper mills in developing countries visit large mills in the developed countries and then demand that their project must include the latest technology and state-of-the-art equipment as used in these large mills.

Unfortunately, what is overlooked is that much of the latest complicated (and expensive), state-of-the-art equipment used in the newest mills, in most cases, does not really perform process-wise any better than the equipment used previously and does not produce a better product. The big difference is that the latest state-of-the-art equipment has very high capacities; many times, the unit capacities of equipment used previously. The latest equipment may also have lower energy requirements or lower process losses. These factors are of prime importance in the case of large mills, but are not very important in the case of smaller mills. Simpler, less expensive equipment will serve the requirements of a smaller mill without affecting the basic pulping process technology adversely.

Large modern mills in developed countries also have a large degree of process control, automation and mechanization; largely because of the high labour costs in developed countries. Adequate good process control is essential for proper operation of pulp and paper mills, but in those developing countries, where labour costs are low, the degree of automation and mechanization can be reduced substantially, without affecting pulping and papermaking processes adversely. It is a mistake to design a small mill the same way as a large mill. The basic processes and process parameters used and the quality of the end products should be the same, but the equipment should be suitable for a smaller mill; especially from a capital cost point of view.

Secondhand equipment is rarely on the market because the equipment is worn out, or obsolete, from a process point of view. Most pulp and paper equipment have a very long useful life. Equipment comes into the secondhand market largely because the equipment capacity or size is too small for economic operation in developed countries. However, as smaller mills require equipment of lower capacity and capital costs are to be kept as low as possible, secondhand equipment is well suited for smaller mills. In fact, the use of secondhand equipment may be the only way some of the smaller projects in developing countries can be made to be viable. Unfortunately, some countries have policies prohibiting the importation of secondhand equipment to assure that new plants will be state-of-the-art. Unfortunately, in the case of smaller pulp and paper mills, it is quite possible to build an old-fashioned mill using new equipment, and conversely, to build a modern mill using many secondhand components, for the "modernity" of a smaller pulp and paper mill is largely a function of the processes and process parameters used. The use of secondhand equipment should not be ruled out without careful consideration. Developing countries can ill afford the added cost of new equipment if suitably secondhand equipment is available. Secondhand equipment, however, must be selected with care, and experienced personnel are required to do this. There are also a number of problems in utilizing secondhand equipment.

- It is usually almost impossible to obtain financing for the purchase of secondhand equipment. Banks do not like secondhand equipment.

- Purchases must be made relatively quickly, or someone else may purchase the equipment.

- Some countries forbid the importation of secondhand equipment.

- The number of contractors prepared to build a mill incorporating secondhand equipment is limited.

These factors tend to limit the use of secondhand equipment.

The method by which a pulp and paper mill is purchased can also have a considerable effect on the capital cost, and must be considered when a feasibility study is prepared. A pulp and paper mill may be purchased:

a) piecemeal purchase; that is, every piece of equipment, piping, motors, wiring, etc., is purchased separately and directly from the manufacturer

b) as a series of equipment packages, each of which includes the major equipment for a department, the ancillary and auxiliary equipment, piping, motors, wiring, etc., plus the engineering for the package

c) turnkey, with or without the civil and structural work.

For piecemeal purchase, an engineering firm would be required for the complete detailed engineering and the cost of this is part of the total cost. For method b), an engineering firm is required only for basic engineering and package specifications and some detailed engineering to interconnect the packages as the detail design would be from the package suppliers. For method c), no engineering is required except possibly specification preparation as it is done by the turnkey supplier. In all cases, the civil and structural design is usually carried out by local firms.

The cost of a mill purchased by the first method is the lowest, but often there are no guarantees for performance or total price - factors that may cause problems in financing.

Purchasing a mill on a turnkey basis results in the highest price (often as much as 30% more), but full guarantees and fixed price can be obtained, both of which make financing easier.

The second method is intermediate in cost, and guarantees can be obtained for individual sections.

The first method a) may involve as many as 1,200 purchases from 150 - 200 suppliers, which can create considerable procedural difficulties when foreign exchange regulations and import permits are required. For the second method, only 10-20 purchases are required, which makes the purchase orders much easier to process, and, of course, for turnkey supply, only one purchase, or, if the civil and structural work is separate, at most, two purchases are required.

For most projects in developing countries, the second (b) and third methods (c) are more suitable, despite the higher cost. Only a large, well established private firm with extensive industrial experience could use method (a) effectively.

The way a contract is written (especially in the case of turnkey projects) can also have a large effect on the cost of the project. Contracts, especially those from government agencies, often demand many extensive and unrealistic guarantees and time schedules, some of which may be almost impossible to meet, and many very heavy penalties. Moreover, the contracts may be written in a very one-sided manner, putting many obligations and all of the responsibilities on the supplier or contractor, and no obligations or responsibilities for the purchaser.

The intended objective of contracts written in this manner is to guarantee that the supplier or contractor delivers a good project. Unfortunately, all that such contracts guarantee is that the price will be high. For obviously, the supplier or contractor adds the cost of the penalties, obligations and responsibilities to his price. And, the higher the penalties and the harsher the contractual terms, the higher the price.

After completion, if the mill does not work properly, a contractor can just pay the penalties and walk away with a normal profit, and this is exactly what the less scrupulous contractors do. The only way to guarantee a good mill is to engage good reputable suppliers and contractors. They will rectify any problems - not because of the contractual terms, but to preserve their reputations. Reasonable contractual terms and guarantees will result in reasonable prices.

Regardless of what method is used for the purchase and implementation of the project, the faster a mill can be built and put on stream, the lower the capital cost and the more profitable the project. This is due, in part, to lower interest during construction and earlier operating profits, and, in part, because some salaries and many other costs must continue to be paid during the implementation period. Thus, every effort should be made to expedite delivery, construction and erection of the mill.

However, quite frequently, to reduce foreign exchange and encourage local industry, purchasers in developing countries may demand:

- that tanks, and some equipment parts, should be fabricated locally;
- that some locally produced equipment should be incorporated;
- that local construction methods should be used.

Basically, there is nothing wrong with this concept. But, unfortunately, the use of local fabrication and construction often can result in extensive delays in the time schedule. And even if the locally produced material has a lower cost, the cost of delay can wipe out any savings. The basic objective to build a profitable pulp and paper mill should not take second place to encouragement of local industry.

When local facilities are considered for the supply of parts of a project, not only the abilities of a local firm should be investigated, but also the capacity and the capability to complete the work on schedule. If local firms can produce to schedule and price, then, of course, use of local firms should be encouraged. If they can't, then they should not be used unless government decrees or foreign exchange problems demand the use of as much locally produced equipment as possible.

CAPITAL COST

Capital costs for mills, as reported in periodicals, vary greatly. This variation is due largely to differences in what is included. Does the mill generate its power or purchase power? Is an electrolytic plant included or not? Is appreciable infrastructure - roads, power line, town site, etc. - included in the price or not? Also, different firms include different cost elements in the mill capital cost, and, as mentioned previously, there are design and implementation factors that can have a large effect on the capital cost. Each mill and situation is different; the capital cost has to be worked out in each case. Because of the many differences, it is only possible to give very general order of magnitude figures for pulp and paper mills.

In general, for the same extent of supply, the capital costs of non-wood pulp and paper mills are somewhat lower than that of wood-based mills; digestion is faster, and bleaching is simpler. But the differences are not great. The capital costs of non-wood mills are high, as is the case for all pulp and paper mills; even small mills will cost millions of dollars. The pulp and paper industry is a capital intensive industry.

The capital cost of all pulp and paper mills, per daily ton of capacity, rises as the size of the mill decreases, and the relationship is not linear, as can be seen from Figure 3.

The capital cost figures given in Figure 3 for integrated straw and bagasse pulp and paper mills are conservative figures for complete mills, and include:

- all pulp and papermaking equipment, motors, piping, wiring, instrumentation, etc., and ancillary materials
- steam and power generation
- chemical recovery and lime kiln
- water and effluent treatment
- mill shops and stores
- mill offices, cafeteria, first-aid station, fire protection, etc.
- trucks, cranes and other mobile equipment
- complete engineering
- freight to destination
- site preparation
- erection and installation of equipment
- construction of all buildings and civil works
- capitalized start-up expenses

The items not included are:

- infrastructure
- alternative fuel systems at sugar mills in the case of bagasse
- raw material collection and delivery equipment
- electrolytic caustic/chlorine plant
- cost of the site
- training of personnel
- cost of employee housing
- custom duties on equipment
- working capital

The costs used for Figure 3 are as of 1988, and are order of magnitude guide figures for complete, modern straw and bagasse pulp and paper mills using entirely new equipment. It is possible to build plants for up to 20% less by elimination of some of the automation, waste reduction, and fiber and chemical recovery systems, and by using simpler not-quite-as-efficient equipment. In other words, by building a "stripped down", "bare bones" mill. This is easier to do for a smaller non-wood mill than in the case of a larger wood-based mill. But as this "stripping" proceeds, the manufacturing costs rise and the return on the investment decreases. The balancing of capital charges versus manufacturing costs is always an essential feature in the design of smaller mills.

CONCLUSION

Non-wood fibers can be an economic source of raw material for the production of a large variety of papers and can be the solution for paper production in countries where wood is unavailable or too costly a raw material. Also, it is easier to build smaller mills that are profitable when the raw materials are non-wood fibers.

Consequently, the production of pulp and paper from non-wood plant fibers is of considerable interest to developing countries.

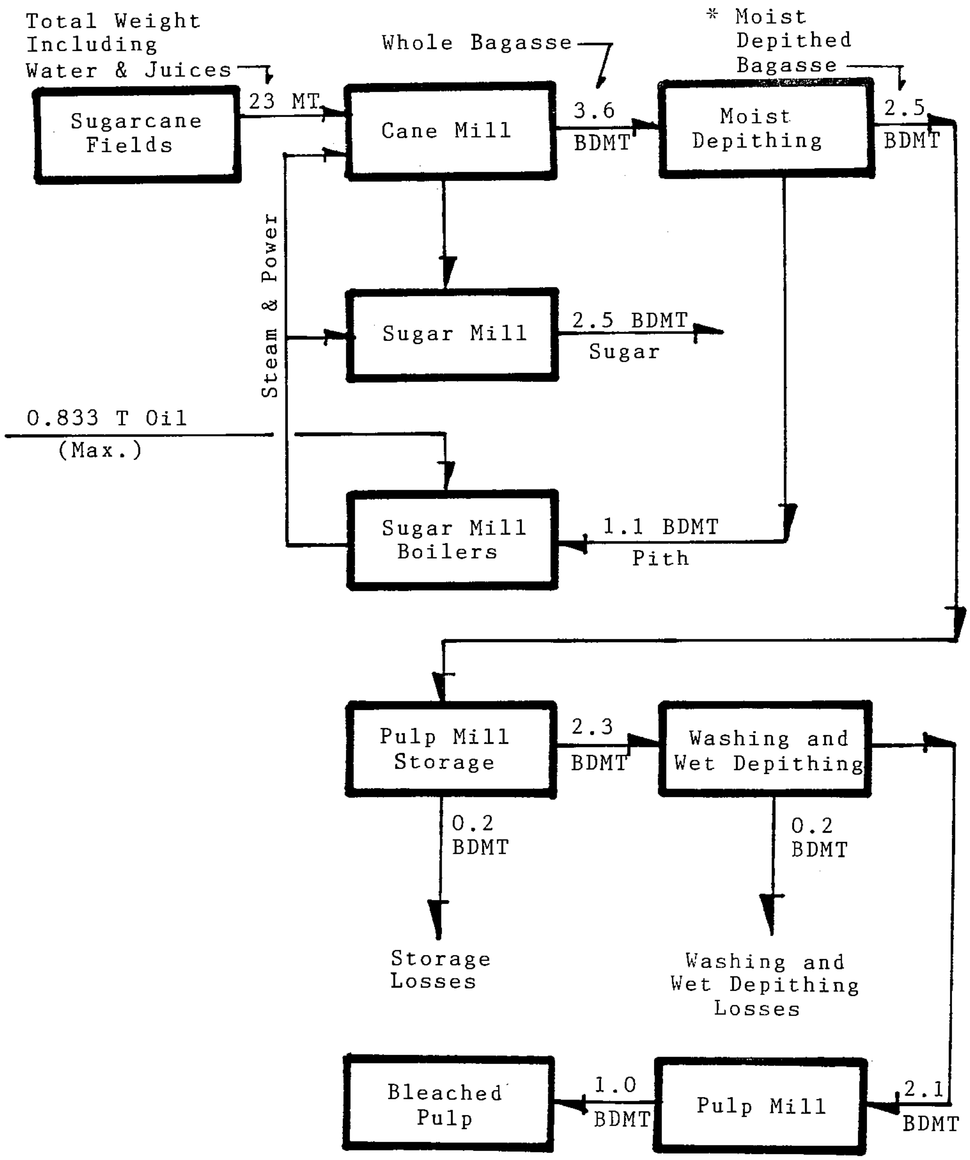
However, problems are quite common and failures are frequent. Some of the failures are due to technical reasons, but many are financial - inadequate financing, incorrect costs, and excessive financial charges. Any proposed non-wood project must be studied carefully as regards:

- raw material supply and costs
- markets
- production program
- proposed mill size
- production costs
- capital cost

It is always relatively easy to build a mill that is entirely satisfactory from a technical point of view. It is much more difficult to build a mill (especially a smaller mill) that is profitable, and it is profitability that is the criterion of success - not technological excellence.

FIGURE 1

BAGASSE REQUIRED IN BDMT/BDMT OF BLEACHED PULP

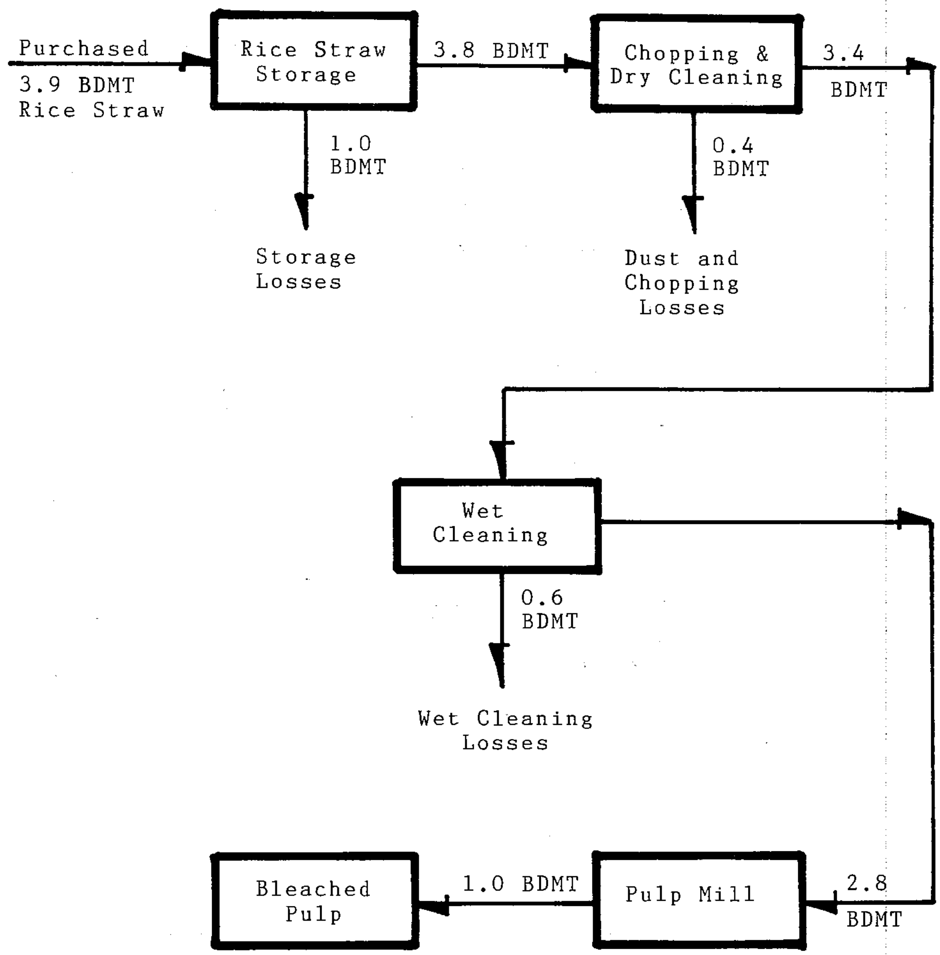


* It is usually the moist depithed bagasse that is purchased by the paper mill.

BDMT = Bone-Dry Metric Ton

FIGURE 2

RICE STRAW REQUIRED IN BDMT/BDMT OF BLEACHED PULP



BDMT = Bone-Dry Metric Ton

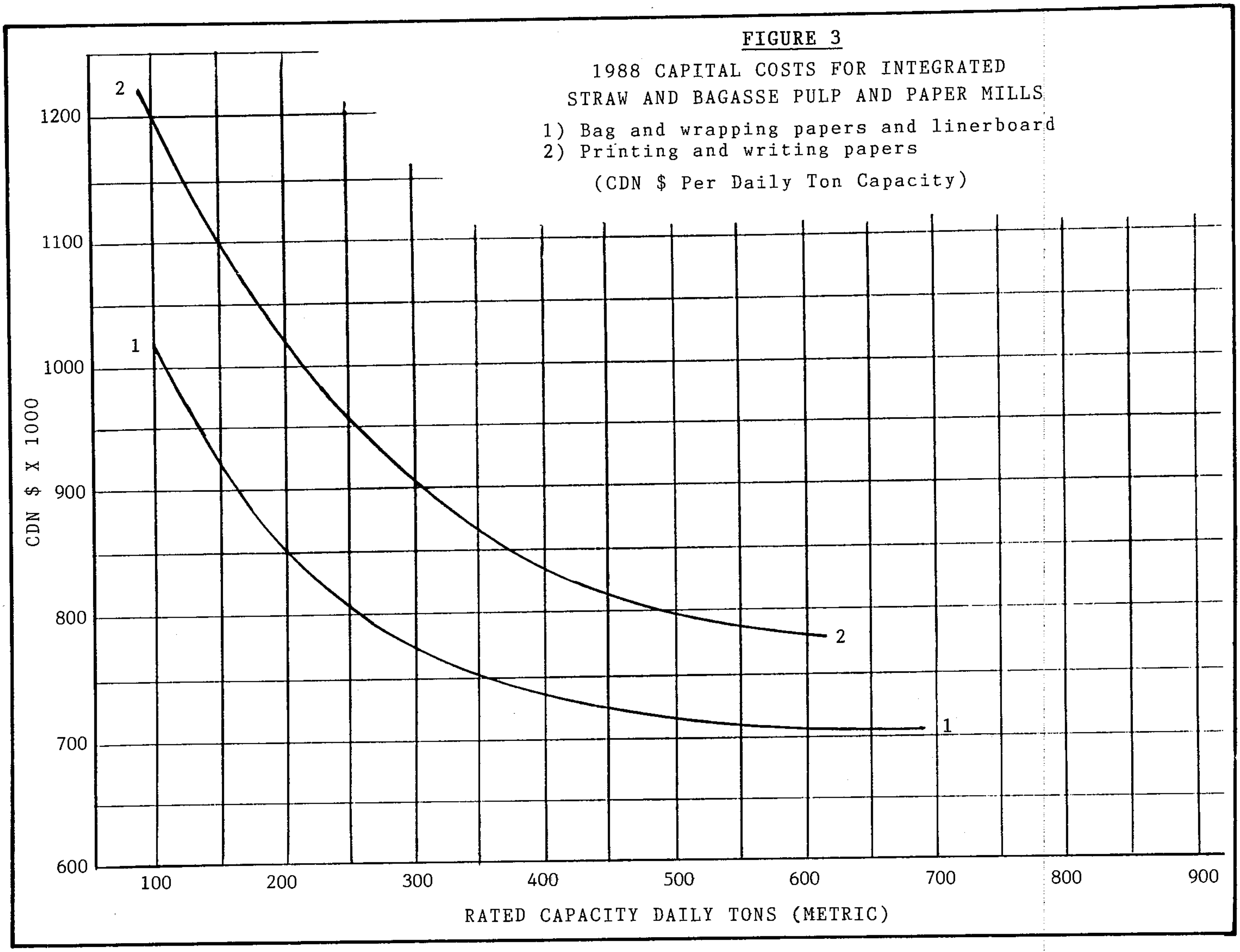


FIGURE 3
1988 CAPITAL COSTS FOR INTEGRATED
STRAW AND BAGASSE PULP AND PAPER MILLS
1) Bag and wrapping papers and linerboard
2) Printing and writing papers
(CDN $ Per Daily Ton Capacity)
CDN $ X 1000
1200
1100
1000
900
800
700
600
100
200
300
400
500
600
700
800
900
1
2
RATED CAPACITY DAILY TONS (METRIC)

TABLE NO. I

TYPICAL MINIMUM ECONOMIC SIZE OF PULP AND PAPER MILLS

(In Metric Tons Per Day)

	Type of Mill	International Market	Regional Market	LDC In-Country Market
1.	Bleached softwood or hardwood chemical market pulp	700 - 800	300 - 400	150 - 200
2.	Bleached bagasse market pulp mill		250 - 350	120 - 180
3.	Bleached straw pulp mill		200 - 300	120 - 180
4.	Bleached CTMP market pulp	300 - 400	150 - 250	60 - 100
5.	Bleached specialty pulp mill*	50 - 200	30 - 100	10 - 20
6.	Mechanical (groundwood) market pulp	250 - 300	80 - 120	10 - 30
7.	Sack kraft or kraft liner (integrated with pulp mill)	600 - 700	300 - 400	100 - 150**
8.	Corrugating medium (integrated with pulp mill)	350 - 500	200 - 300	80 - 120
9.	Newsprint (integrated with groundwood mill)	800 - 1000	500 - 750	150 - 200
10.	Woodfree fine papers - printing, writing, offset and bonds (integrated with pulp mill)	250 - 350	150 - 200	60 - 100***
11.	Multiply board (integrated with wastepaper plant)	100 - 200	80 - 120	30 - 60
12.	Tissue (no pulp mill, but integrated with converting plant)	100 - 200	50 - 100	15 - 30

NOTES:
* Flax, hemp, sisal, abaca, and cotton linters.
** Lower quality when using non-wood fibers.
*** With pulp mill using non-wood fibers.