A strategy for the development of a kenaf-based pulp and paper industry

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A new kenaf production and separation facility will help determine if this alternative to wood fiber is economically feasible.

As a result of a feasibility study completed in 1991, a commercial-scale kenaf production and separation facility is expected to commence operations in East Charleston, MS in early 1992. The intent of this installation is to determine whether kenaf is a suitable substitute for the conventional woodchip and woodyard operations in a pulp mill, using the separated long- and short-fiber components of the kenaf plant. It will be the first facility of its kind anywhere in the world.

In order to proceed with the project, a farmers' cooperative was formed in Mississippi in early 1991, and approximately 2000 acres of kenaf was planted by the members. This crop was expected to be harvested near the end of 1991.

The commercial development of a kenaf-based pulp and paper industry depends on confirming the feasibility of the following:

1. Agricultural production and fiber processing
2. Pulping of the kenaf fiber
3. Development of a range of pulp and paper products
4. Market development for the product range.

Kenaf is a fiber which in recent years has been the subject of a great deal of research, investigation, and commercial analysis. Earlier papers (*1–3*) described the agricultural production, storage, transportation, and separation of the fiber components. The technical data demonstrates the pulping and papermaking characteristics.

Sufficient knowledge and experimental data are available to indicate that the pulping of the kenaf fiber is feasible. The economics will be conditioned by mill capacity, which will be influenced by the location of the mill.

This article presents a strategy for developing a kenaf-based pulp and paper industry which will depend on:

1. The establishment of a commercial-scale fiber production and processing facility
2. A substantial research commitment to find a suitable range of pulp and paper products based on the use of kenaf fibers.

Agricultural production and fiber processing

Kenaf growing and related research goes back many years in the United States and in other parts of the world, but most of the work in developed countries was conducted by research or government organizations on relatively small plots of land. During this phase, the agronomy and agricultural management practices were well established. However, the harvesting, materials handling, and storage technologies essential for commercial operations did not receive the same attention.

The combination of the necessary engineering and agricultural skills has taken place mainly during the last five or six years. Most of this work in the United States was sponsored by the U.S. Department of Agriculture (USDA) and private development, the Mississippi Agricultural and Forestry Experiment Station, and by Ankal Pty. Ltd. in Australia. The financial and technical effort spent on this phase of the work was conditioned by the expectations of commencing commercial-scale operations. In addition, the need to involve the pulp industry in developing alternative fiber processing technologies has further complicated the emergence of practical and operating technologies.

The kenaf fiber may be processed by the pulp and paper industries as whole stems or separated into the long- and short-fiber components. At present, there is no commercial kenaf fiber processing facility operating anywhere in the developed countries, as the demand for the separated bark fiber is satisfied by imports from developing countries.

To establish the demand for the kenaf fiber, it is necessary to be able to offer to potential users adequate

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I. Pulp and paper market data

Pulp Del. in U.S. (U.S. $/metric ton)	*2nd Quarter, June 1*							*Variation Peak*
	1985	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	
Bleached softwood kraft	400 (Can/U.S.-Northern)	450 (Can/U.S.-Northern)	575 (Can/U.S.-Northern)	700 (Canadian)	800 (Can/U.S.)	830 (Can/U.S.)	575 (Can/U.S.)	0.518
Bleached hardwood kraft U.S. Southern	350	380	530	650	735	620	435	0.524
Paper Del. in E. U.S.	*2nd Quarter, June 1*							*Variation Peak*
Newsprint (30 lb) East (U.S. $/metric ton)	485	485	540	610	575	570	540	0.205
Coated publications No. 3 60 lb (rolls) (U.S. $/sh. ton)	980	980	945	1,060	1,220	1,270	1,070	0.256
Uncoated white offset, 50 lb (rls) (U.S. $/sh. ton)	630	680	640	810	900	820	640	0.300

quantities for commercial-scale evaluation trials. Historically, the capital funds to establish such an operation were too large to raise from conventional sources, and the pulp industry did not have the incentive to commit resources for such developments.

Until a project such as the one prompted by the 1991 feasibility study can be completed, it will not be possible to provide sufficient evidence about the new technologies required to build a kenaf-based pulp and paper industry.

The Mississippi experience

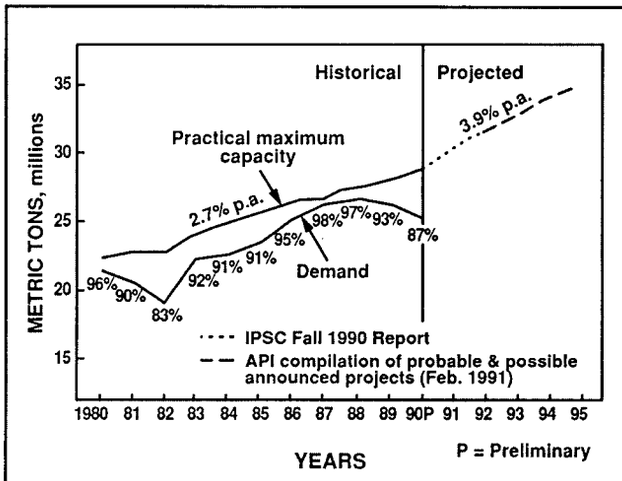
Kenaf research at the Mississippi Agricultural and Forestry Experiment Station (MAFES) is entering its fifth year. An interdisciplinary team of scientists has been contributing to the evaluation of kenaf as a potential alternative crop in Mississippi. Research has ranged from applied agronomic studies evaluating varieties, row spacing, fertility, nematodes, and weed science to the processing and marketing of separated fiber. Two key components were important in designing and carrying out kenaf research:

1. The potential or success of kenaf should not be achieved at the expense of not providing a fair return to all factors of production.
2. Research should be centered around the use of existing technology and cultural practices for crops currently propagated.

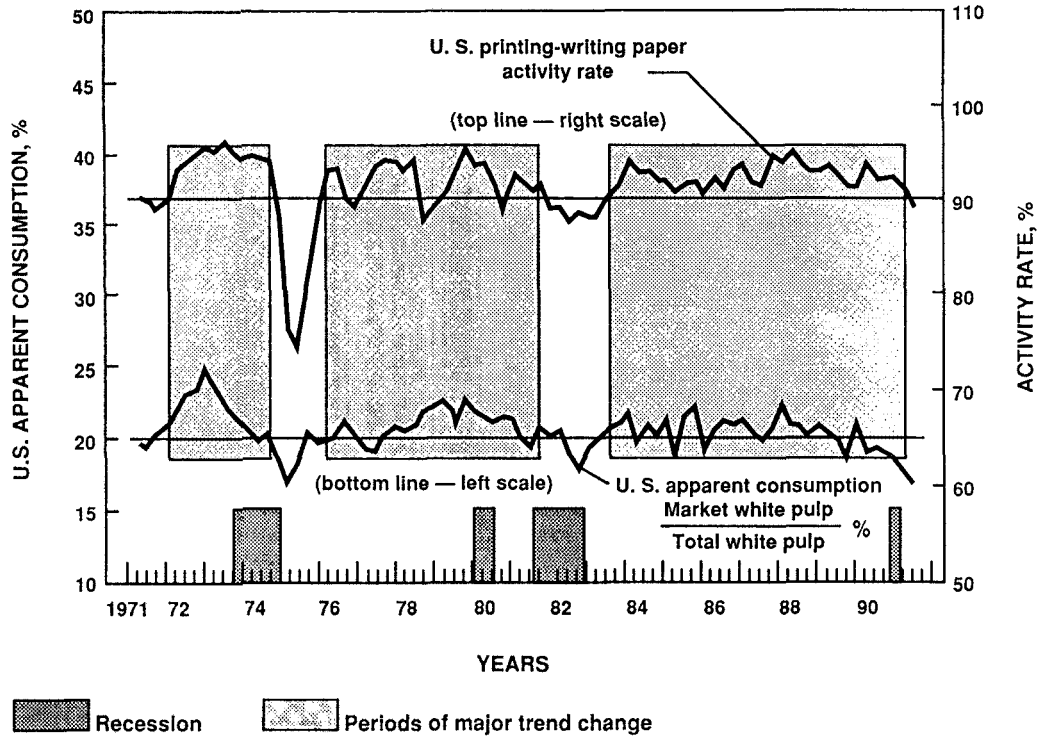
The results of this work established an efficient production, harvesting, and transportation system for the growing of kenaf in the Mississippi area. It was apparent that for kenaf to become commercially viable, some value must be added to the raw product. At this point, the potential of increasing returns through fiber separation were addressed.

With technical and financial assistance from the Tennessee Valley Authority (TVA), a feasibility study was

1. Capacity and demand trends for chemical pulp



2. U.S. printing/writing paper activity rate vs. ratio of market pulp to total white pulp consumption



conducted to evaluate the potential of a fiber separation facility. In general, the study concluded that a fiber separation facility could be successful as a pilot plant using commercial-scale equipment.

Based on the results of the feasibility study, commercial plans were developed which included the formation of a farmers' cooperative.

A cooperative is defined as a business that is organized, capitalized, and managed for its member-patrons, furnishing and/or marketing goods and services to the patrons at cost (*4*). In this case, the cooperative is organized as a processing and marketing entity. In doing business, cooperatives attempt to derive a profit called "net savings." These savings or patronage dividends are returned to the member patrons in proportion to their business transactions with the cooperative. Therefore, in a cooperative, the primary purpose is to make a "profit" for the patron-owners and not for investors as in a corporation (*5*). The Capper-Volstead Act allows farmer cooperatives to bargain collectively for favorable terms of exchange in the product and input market. This exempts cooperatives from most antitrust legislation (*6*).

The 35 members that comprise the cooperative have planted approximately 2000 acres of land with kenaf seed. They will be the sole providers of the raw product to the new fiber separation facility.

Several goals have been set for the cooperative in its initial year of operation. Obviously, any technical or operational problems in the separation facility must be solved. Because the facility is the first of its kind, it is expected that minor modifications may be necessary. Secondly, the market potential and development of kenaf must be evaluated. Accurate assessment of the projected bark and core sales are extremely important, because acres planted in May supply the raw product for the following year. It is anticipated that market development will take place and the acreage planted will need to be increased substantially in 1992.

As can be seen, the commercialization of kenaf in Mississippi is a result of combined efforts in the public and private sector. A comprehensive research program by MAFES, coupled with the valuable technical and financial support from USDA and TVA and an innovative, hardworking, select group of producers in Mississippi, has resulted in the commercial planting and processing of kenaf. Without the input and dedication of all these groups, there would be no commercial acreage in Mississippi.

Pulping of the kenaf fiber

Data from commercial- and laboratory-scale pulping of kenaf (*1, 2, 7–9*) support the conclusion that pulping of the kenaf fiber should not present a barrier to the implementation of a commercial-scale pulp mill operation in developed or developing countries. Laboratory trials have been conducted in Australia, Japan, and Canada on the chemical pulping of the separated long- and short-fiber components. The pulping of the whole stalk plant was developed on a commercial scale in a continuous chemical pulping operation in Thailand. In North America, mill-scale trials were conducted on the chemithermomechanical pulping of whole stalk kenaf. Extensive pulping

experience with other nonwood fibers further indicates the technical feasibility of pulping kenaf fiber on a commercial scale.

The Phoenix Mill in Thailand produces market pulp. Other development projects considered for kenaf pulping were proposing to enter the marketplace as suppliers of chemical market pulp. Most of the proposals for the development of a new kenaf-based pulp mill originated between 1983 and 1991 and were justified on the increasing cost of market pulp. **Table I** provides data indicating that this cost cycle may have peaked in 1990 (*10*). During the period from 1985 to 1991, there was a wide variation in the range of costs shown in Table I.

The peak variation for the period (comparing the highest and lowest values) for bleached softwood kraft pulp was 51.8%, and the same indicator for bleached southern hardwood kraft pulp was 52.4%.

Comparing three grades of paper over the same period results in a peak variation range of 20.5% to 30.0%. These indicators show that the paper markets have a lower volatility.

Figure 1 provides data for the comparison of the Global Practical Maximum Capacity for chemical paper grade market pulp and demand. Both on a historical and a projected basis, the global market pulping capacity is expanding at a steady and somewhat predictable rate.

The demand has a cyclic pattern, influenced by overall economic activity. This pattern is supported by the U.S. printing and writing paper activity rates shown in **Fig. 2**, indicating the coincidence of recessions with a downturn in activity rate. (Activity rate is calculated by a formula based on the comparison of the theoretically available machine hours to the hours actually used.)

Figure 2 provides further information about the level of integration in the pulp industry in the United States. It seems that not more than 20% of the total white pulp produced is sold as market pulp.

Figure 3 indicates the historical and projected supply and demand pattern for mechanical market pulp.

From the data in Table I, it can be concluded that papermakers relying on the supply of market pulp will find their return on investment will be exposed to larger fluctuations than those operating as an integrated pulp and paper manufacturing unit.

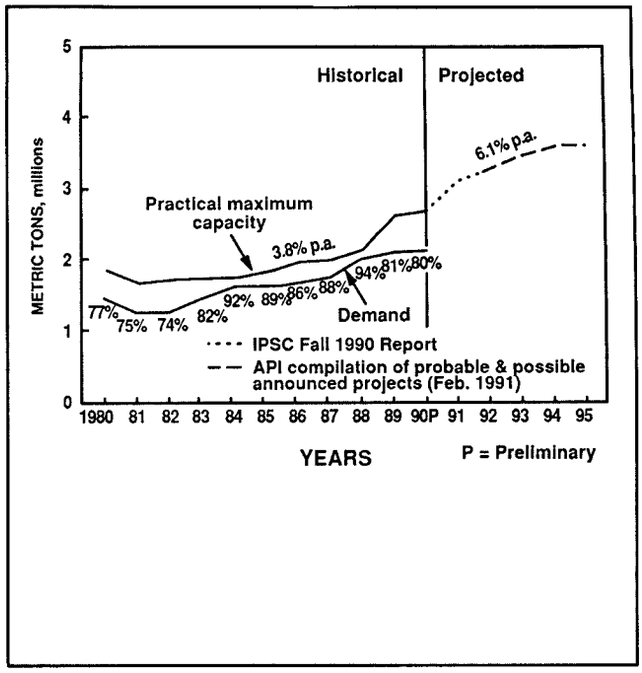
Figures 1 and 3 show a steadily expanding market pulp supply with a matching but fluctuating demand. Figure 2 shows the ratio of market white pulp to total white pulp fluctuating around 20%.

It can be concluded that both market pulp and integrated pulp and paper operations will be expanding their capacity at a steady long-term rate and in the process requiring an increasing amount of fiber input.

The kenaf plant could provide these additional fiber resources when a large-scale production facility is in operation and all of the parameters influencing the delivered cost of fiber have been examined in the light of the commercial-scale production experience.

However, in the light of our experiences with developing technologies and commercial strategies for the growing, processing, and pulping of the kenaf fiber during the past two to three years, we are increasingly of the view that a development strategy based on an integrated pulp and paper milling operation is likely to be more secure and

3. Capacity and demand trends for mechanical pulp



successful than a project based on market pulp production only. These are our reasons:

1. The smaller historical cost fluctuations of paper products as compared to market pulp will produce a smaller order of variation on estimating the income side of an integrated pulp and paper mill project.
2. Papermakers purchasing market pulp are generally reluctant to experiment with new fibers or pulps. However, the paper product markets (end users) are mainly concerned with the quality and cost for a given range of products, irrespective of the type of pulp or fibers used. Consequently, if an integrated project is the subject of the investigation, there will be no need to convince a diverse range of papermakers to take up the output of the pulp mill. Therefore the determination of the capacity of the plant— vital to the economy of the project—can be done purely on the objective technical and commercial merits.
3. During the feasibility study phase required for every major project, the marketability of the products produced has to be established as accurately as possible in order to secure the essential financial backing.
4. As indicated earlier, papermakers generally do not like to experiment with new fibers or pulps unless they have a strong need, incentives, or both. Therefore it follows that the most critical step in putting forward a successful strategy is the development of a range of paper products capable of meeting the needs of the end user and the general public.

Development of pulp and paper products

The separated and processed kenaf fiber is suitable for the production of a wide range of pulps in the following categories:

1. Specialty pulps capable of attracting high premiums in the marketplace
2. Long- and short-fiber pulps which may be blended for a wide range of paper products.

The optimum strategy for development is to produce an amount of specialty market pulp to satisfy and meet a limited demand. Only a relatively small proportion of the available long fiber would be utilized for this product.

The balance of the long- and short-fiber pulps would be processed in an integrated facility. However, the development of a commercially marketable product range is a prerequisite to any commitment to build such a plant.

The problem with developing such a product range is that significant resources are required to complete such a task in a convincing manner. Fortunately, in the United States, the Herty Foundation in Savannah, GA, has these facilities and the technical know-how to complete such a task under a research contract. Shortly, it will be possible to run papermaking machine trials on a 36-in.-wide machine up to a speed of 2500 ft/min.

A team of technical and marketing practitioners will be able to establish a range of optimized products and establish the merits and limitations of the long- and short-fiber pulps made out of the kenaf fibers. The finding of such detailed investigations will be acceptable to "end users" of paper products and to financial institutions providing project funding.

Sufficient quantities of sample pulp and papers can be produced at the Herty Foundation to prove the marketability of a complete product range.

The major problem with introducing a nonwood fiber such as kenaf is that the pulp and paper industry in developed countries is not accustomed to working with these fibers. Pulp processors tend to process these raw materials like wood fiber, resulting in pulp of lesser quality than otherwise would be possible.

There is little doubt that unless the results of studies of kenaf production are available to the pulp and paper industry, the matter of the real application of nonwood fibers (particularly short fibers) will be debated continuously on a subjective basis with no clear indication of direction. This conclusion is based on a number of discussions with senior technical experts in the pulp and paper industries in North America and Australia. However, the alternative is to convince a major corporation to participate in joint research on the subject, but the incentive for this to happen does not seem to be there.

Market development for the product range

Access to markets will depend on the organization contracted for the task. Negotiations to date indicate that with the backing of data from products developed at the Herty Foundation, reasonable access could be expected to such markets.

A further point may be made with respect to market acceptance of new paper products based substantially on nonwood fibers. From an environmental point of view, history has shown that the public is eager to buy products with a favorable environmental impact. This is evidenced by the recent demand and ready acceptance of non-bleached paper products in markets traditionally placing a premium on brightness.

The labeling of recycled paper products attracts sufficient marketing advantage with a segment of the public to justify the extra promotion and effort.

It would be reasonable to assume that it is possible to develop a competitive range of paper products based on kenaf. These products could appeal to a large enough segment of the population who are conscious of the need to preserve forests for environmental reasons to justify a commercial-scale papermaking operation.□

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