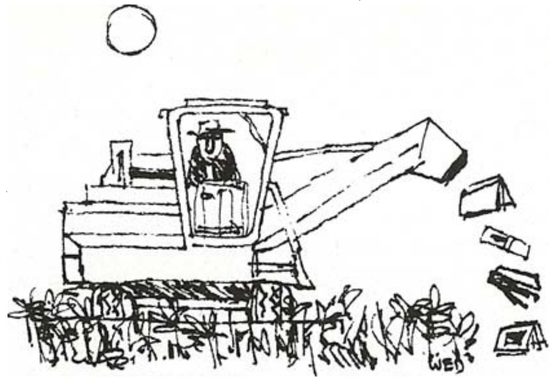
Spectrum



A paper crop

Although trees provide the raw material for about 95% of the world's paper production, many other plants can also be used in paper-making. Sugar cane, bamboo, and wheat and rice straw, which are now pulped in some parts of the world, are just a few of the alternatives. In most places timber is more attractive economically. But, as growing demand for paper puts increasing pressure on the world's limited forest resources, crop plants may become more important pulp sources.

A problem with growing agricultural crops for pulp is that suitable land may be needed for growing food. If both fibre and food, and possibly other products as well, can be obtained from the same crops, this problem is reduced.

Scientists from a number of CSIRO Divisions are now looking at ways to make the greatest possible use of agricultural production. They call the concept Integrated Photosynthetic Product Industries (IPPI), and are investigating production of energy and chemicals as well as food and fibre.

One plant being studied, primarily as a source of paper pulp, is kenaf, an annual that takes 4–8 months to reach a mature height of about 4 metres. The stem, which makes up the bulk of the plant, contains the fibre that would be used for paper-making. But in addition, the leafy tops could provide protein-rich stock feed comparable with lucerne, juice squeezed from the stem is rich in protein and could also be used in stock feed, and kenaf seed contains oil that could be used in salads, cooking, and margarine manufacture.

In 1973 Mr Ian Wood of the CSIRO Division of Tropical Agronomy began growth trials on kenaf at the Kimberley Research Station in the Ord River Irrigation Area of northern Western Australia.

He has found that two crops can be grown there in a year; this should also be possible in other tropical areas where irrigation is available. Rates of fibre production achieved per hectare have been comparable with those from eucalypts grown on highly productive land with intensive management, and much greater than those from natural eucalypt forests.

A drawback is the need for large amounts of nitrogenous fertilizer. Mr Wood, and Dr John Angus of the Division of Land Use Research, calculate that fertilizer would account for something like 35% of the cost of growing irrigated kenaf. An alternative way to keep up the soil nitrogen supply would to be grow legumes in rotation with the kenaf. Mr Wood recently began research on legume species that may be able to provide both fibre for paper-making and nitrogen for the kenaf.

The pulping potential of kenaf is being studied by Mr Alf Watson and Dr Geoff Gartside, at the Division of Chemical Technology in Melbourne. Pulping involves removal of lignin, the substance that binds the cellulose fibres in wood. Various chemical and mechanical methods are used.

The fibrous stem of kenaf consists of an outer bark, comprising 35–40% of the weight of the stem, and an inner woody core.

The bark is made up of fibres about 3 mm long. These are long cellulose fibres—comparable in length with those of softwoods such as *Pinus radiata*. Long fibres give high tearing strength, and are needed in products such as high-strength wrapping papers and fibreboard liners. Paper-makers also mix them in with short-fibre pulps to strengthen other types of paper, including newsprint. The fibres in the woody core are about 0·6 mm long—somewhat shorter than those usually found in hardwoods such as eucalypts.

The scientists have found that crushing kenaf stems to remove the sap increases pulping efficiency. They have also found that the wood section breaks up during crushing, and that the wood and bark can then be readily separated by screening.

Kenaf bark has responded well in the pulping tests. All methods tried have produced high-quality pulp, and the scientists say very little technical development would be needed to enable the bark to be used in commercial paper mills.

The kenaf wood, unfortunately, does not behave so well. When the lignin is removed, the material remaining is cellulose fibre and cells, known as parenchyma cells, that are the energy stores of the growing plant. The cellulose fibres are very short—shorter than most eucalypt fibres used for paper-making—but the strength properties of the pulp are reasonably satisfactory. However, the cells create problems that seem likely to make the pulp unusable on its own.

In paper-making, wet pulp is poured onto a screen, which catches the fibre but allows the liquid to drain through. The dry product is paper. To achieve a satisfactory production rate the pulp has to drain quickly, and this is where the problem lies with kenaf wood. The parenchyma cells fill spaces between the

Harvesting trial plots of kenaf at Kimberley Research Station.

cellulose fibres, holding back the water, and the pulp takes much too long to drain.

The problem would be solved if the parenchyma cells could be removed, but there doesn't seem to be any simple way to do this. Alternatively, the kenaf wood pulp could be mixed with fast-draining pulps to produce a workable composite. Dr Geoff Irvine, also of the Division of Chemical Technology, is examining what happens when other fibres, including kenaf bark fibres, are mixed with the kenaf wood pulp.

Tentative calculations by Mr Wood and Dr Angus indicate that kenaf grown in the Ord Irrigation Area could compete in price on the export market with wood chips from southern Australia, assuming that the whole kenaf stem is usable.

The scientists estimate that about 150 000 ha of irrigated land in northern Australia, planted with kenaf, could produce as much paper pulp as can be obtained from the wood chips now exported from Australia. But more research is needed to check that kenaf crops would not be seriously damaged by insects or diseases and that high yields could be maintained. And a way has to be found around the parenchyma cell problem.

One solution may be to grow sugar cane with kenaf. Bagasse, the fibrous residue remaining after the cane has been crushed to extract the sugar, is used commercially for paper-making in Peru, Brazil, India, and other countries. In Australia it is usually burnt to generate steam and electricity for sugar mills. If kenaf and sugar were grown together, the bagasse and kenaf bark could be pulped and the kenaf wood burnt to produce the power.

One big advantage of crops over forests as a source of paper pulp is a rapid return on invested capital. Trees have to be years old before they can be harvested, while crop plants mature in a few months. Another is the ability of many of them to produce food as well as fibre.

But crops also have inherent disadvantages, an important one being that they have to be harvested within a certain period whereas the rate of timber-cutting can be adjusted to meet demand. If a mill was to operate continuously, it would be best if planting could be arranged so that harvesting could go on throughout the year; growing and pulping would then have to be very closely integrated.

Many plants besides kenaf are potential paper producers. One that pulps well is elephant grass, a high-yielding tropical plant that is being investigated as a potential protein and fibre source by CSIRO's Agro-Industrial Research Unit.

An increase in paper production from crops would have the important advantage of reducing demands on the world's forests. On the other hand, it could give rise to competition between paper- and food-producers for agricultural land.

A review of prospective crops for the Ord Irrigation Area. II. I. M. Wood and J. F. Angus. *CSIRO Division of Land Use Research Technical Paper* No. 36, 1974.

Pulping and paper-making properties of kenaf. A. J. Watson, G. W. Davies, and G. Gartside. *Proceedings, 29th Appita Conference, Launceston, 1975* (in press).