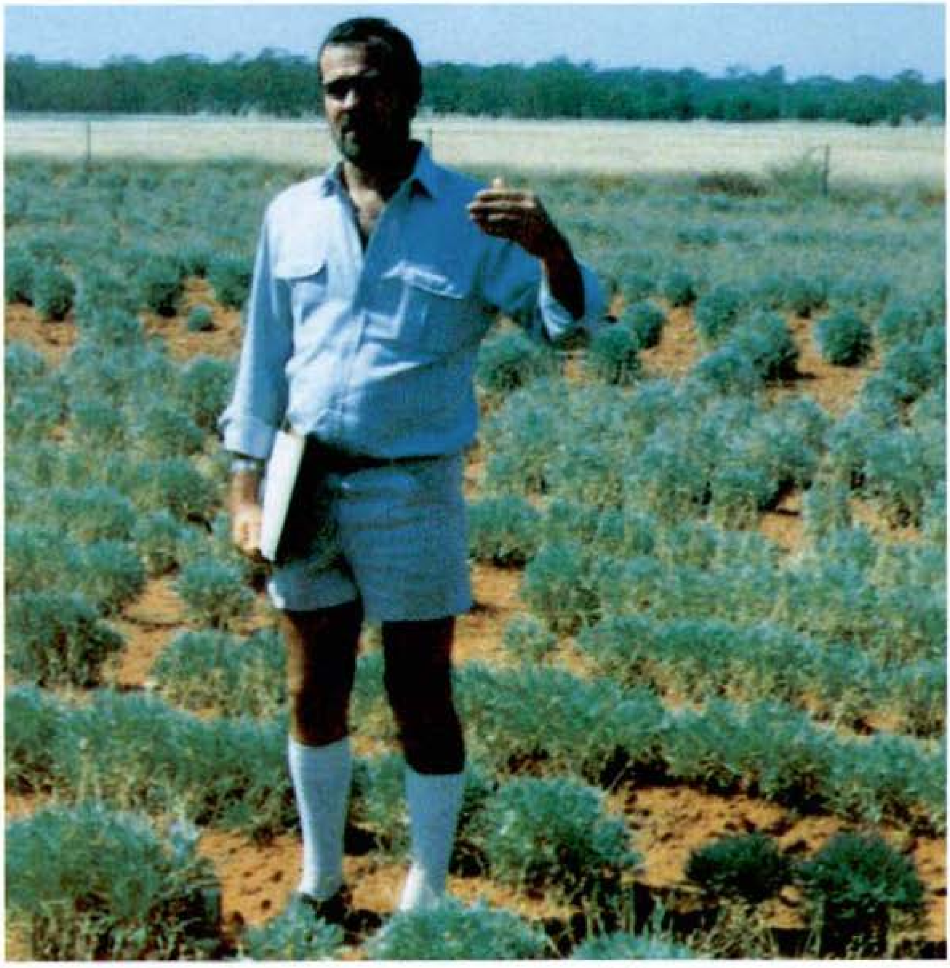
A natural rubber industry for Australia?

According to a CSIRO report, Australia could become a significant producer of natural rubber from the Mexican desert plant guayule.



Mr Peter Milthorpe of the New South Wales Department of Agriculture amid his trial planting of guayule at Hillston, N.S.W. The plants are 7 months old.

Natural rubber continues to be in great demand for its unique properties, and the area of Australia that appears climatically suited to the shrub is large compared with that in other countries.

Foreseeably, half a million hectares of guayule could be grown in those parts of eastern Australia's cereal belt that receive an annual rainfall of 500 to 700 mm, says the report. At an estimated annual yield of 2/3 tonne of rubber per hectare, the crop could, after 5 years, produce about 300 000 tonnes of rubber, with a current value of $420 million. That amount is equivalent to 9% of the 1982 world consumption of natural rubber, or 3% of total world rubber consumption. Looked at another way, it is nine times the current Australian usage of natural rubber, and its current value would rank guayule fourth among our agricultural crops after wheat, sugar, and barley.

The report, 'The Potential Production of Natural Rubber from Guayule in Australia', was prepared by a group of seven CSIRO scientists headed by Mr Alan Stewart of the Division of Chemical and Wood Technology. It is the result of several years' investigations into many aspects — scientific, economic, and technical — of the feasibility of guayule production in Australia.

The scientists conclude that growing guayule could return an attractive profit, and that we have sufficient suitable land to establish a major new industry. But further research is needed to find the sites with the best combination of soils and climate, to determine the most appropriate crop management practices, and to test various processing technologies. The team has drawn up a research and development plan for the next 10 years.

Rubber from the desert

Guayule is a perennial shrub that grows wild in semi-arid north-eastern Mexico and western Texas. Pronounced wy-*oo*-lee, its common name is a Spanish corruption of an Aztec word; its scientific name, *Parthenium argentatum* Gray, comes from the silvery sheen of drought-protecting white hairs that cover its grey-green leaves.

The plant belongs to the sunflower family, but it is the only member to produce, for some unknown reason, rubber latex within its stems and roots.

Guayule's drought resistance makes it ideally suited to Australia's climate.

Its drought resistance makes it ideally suited to Australia's climate. Guayule develops a deep root system that may penetrate up to 6 m into the soil. When all the soil moisture is used up, the plant sheds its leaves and becomes dormant.

Indeed, repeated dry periods are necessary to raise the rubber content in the plants. Most of the rubber, up to 80%, is laid down in the bark. Under periodically dry conditions, up to 18% of the dry weight of stems and roots can, in some strains, be turned over to rubber. If water is readily available, however, the percentage generally lies between only 4 and 8%, an uneconomic level.

Interestingly, the plant does not use the rubber, which continues to accumulate over the years.

When the conquering Spaniards reached what is now Mexico in the 1500s, they discovered Aztecs playing a sort of basketball with a solid rubber ball. One of the sources of this rubber was guayule, derived by chewing the stems and spitting out the rubber and vegetable matter separately. The Aztecs also used guayule to fire smelters for extracting silver from ore, since the rubber and resin of the dried plant burn fiercely.

Guayule rubber is virtually identical to that of the rubber tree, *Hevea brasiliensis*, which grows in the tropics.

Significantly, natural rubber shows little likelihood of being rendered obsolete by man-made rubber; in fact, it is in ever-increasing demand. It is preferred in

Guayule tyres for the nosewheels of jet fighters. Under test they performed as well as conventional tyres. The United States Defense Department is financing production of guayule as a safeguard against interruption of supplies of *Hevea* rubber.

Newly transplanted guayule seedlings in a trial at Kingaroy, Qld.

applications that demand elasticity, resilience, tackiness, and low heat build-up. Some 40% of the rubber used in Australia comes from this source, and most of this is used to make tyres.

Tyres normally contain 40–50% rubber (the remainder comprises fillers, chemicals, and fibre or steel cords). The larger the tyre, and the more demanding its application, the higher is the proportion of natural rubber it normally contains. The rubber in aircraft tyres is almost entirely natural rubber; in truck and bus tyres the proportion is 60–80% while in car tyres, which account for most natural rubber use, it's about 15–40%, with radial types requiring the higher levels.

Guayule bounces back

Guayule is not grown commercially anywhere today, but from 1903 to 1950 production of guayule rubber was more than 100 000 tonnes. In 1909, 14 Mexican factories were producing 10 000 tonnes a year — 10% of the world's natural rubber.

However, this effort relied on the harvesting of wild stands, which could not be sustained. Cultivation of guayule began in the 1930s in California, which produced about 3000 tonnes of rubber, but the natural rubber market was dominated by the rubber tree plantations in South-east Asia. Research and plant-breeding experiments in Malaya also increased the yield per hectare of *Hevea* rubber by up to tenfold.

Nevertheless, guayule production was revived in 1942, when World War II cut off North America from major world supplies of natural rubber. The United States government began a major Emergency Rubber Project, and guayule plantings were rapidly expanded to 12 000 ha in California, and cultivated and wild shrubs in Texas were harvested and processed. Some 1400 tonnes of rubber were produced.

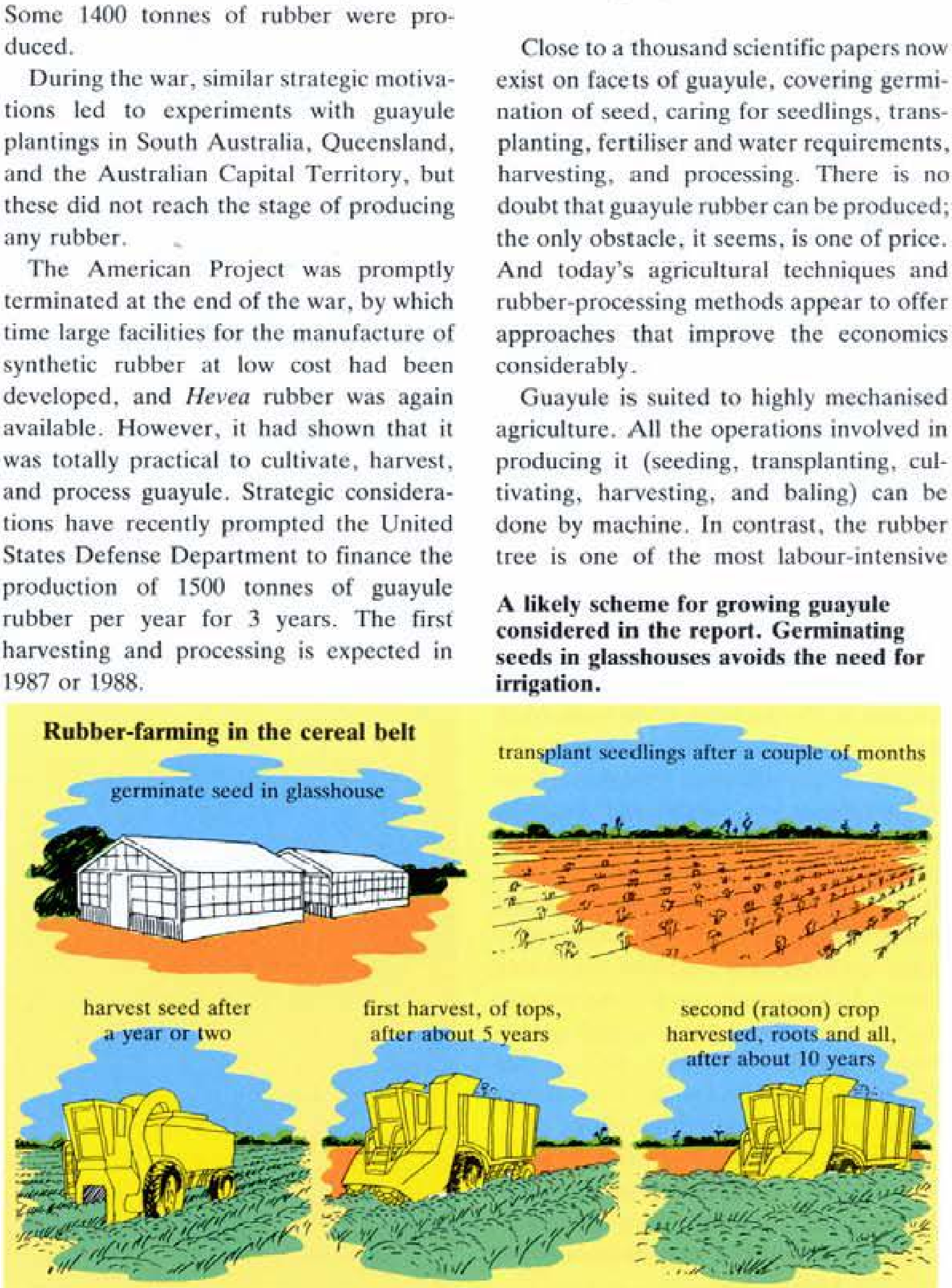
During the war, similar strategic motivations led to experiments with guayule plantings in South Australia, Queensland, and the Australian Capital Territory, but these did not reach the stage of producing any rubber.

The American Project was promptly terminated at the end of the war, by which time large facilities for the manufacture of synthetic rubber at low cost had been developed, and *Hevea* rubber was again available. However, it had shown that it was totally practical to cultivate, harvest, and process guayule. Strategic considerations have recently prompted the United States Defense Department to finance the production of 1500 tonnes of guayule rubber per year for 3 years. The first harvesting and processing is expected in 1987 or 1988.

Close to a thousand scientific papers now exist on facets of guayule, covering germination of seed, caring for seedlings, transplanting, fertiliser and water requirements, harvesting, and processing. There is no doubt that guayule rubber can be produced; the only obstacle, it seems, is one of price. And today's agricultural techniques and rubber-processing methods appear to offer approaches that improve the economics considerably.

Guayule is suited to highly mechanised agriculture. All the operations involved in producing it (seeding, transplanting, cultivating, harvesting, and baling) can be done by machine. In contrast, the rubber tree is one of the most labour-intensive

A likely scheme for growing guayule considered in the report. Germinating seeds in glasshouses avoids the need for irrigation.



crops in the world. In Malaysia, rising labour costs and competition from alternative crops such as oil palm and food crops are resulting in limited new plantings of rubber.

But it is rises in the price of synthetic rubber, tied as it is to that of its petrochemical feedstock, that give the major incentive for looking again at the economics of producing guayule rubber.

Suited to Australia

Members of the research team have brought together a wealth of data on guayule in making their assessment. Most guayule research is being done in the United States, although Mexico, Argentina, India, South Africa, and Australia have research programs under way.

Dr Ross Downes of the CSIRO Division of Plant Industry visited the United States and Mexico in 1978. He imported seed of improved cultivars selected by the United States Department of Agriculture (U.S.D.A), and established small experimental plots at Canberra, A.C.T., and Narrabri, N.S.W. He has also done growth studies in controlled environments.

Dr Robert Ferraris of the CSIRO Division of Tropical Crops and Pastures began trial plantings of guayule at Gatton, Qld, in 1981, and subsequently established a major trial at Kingaroy, Qld.

Mr Henry Nix of the CSIRO Division of Water and Land Resources has been assessing guayule's climatic requirements, as evidenced from published literature, including that collected by Dr Krimhilde Henderson during a 2-year assignment to the Division, within which she visited guayule's home territory and compiled a comprehensive report.

The most extensive field experiments in Australia have been carried out by Mr Peter Milthorpe of the New South Wales Department of Agriculture. He has undertaken agronomy experiments and cultivar testing at Condobolin and Hillston in the western part of the State, and small trials at several centres in the cereal belt.

The New South Wales government has signed an agreement with the U.S.D.A. for co-operation in guayule research. The Rural Credits Development Fund of the Reserve Bank has supported the major field experiments that have been recently conducted at Kingaroy and Hillston.

It is envisaged that guayule would be grown in Australia as a dryland crop. However, guayule has a very small seed that is difficult to establish, and direct seeding would require irrigation at the time of seeding. The more reliable alternative is to transplant seedlings, and this currently appears to be the better option.

Because of the expense of irrigation, guayule production in Australia is likely to be a more economic proposition than in the United States. There, areas with suitable rainfall suffer from snow in winter, which kills guayule. Warmer areas don't have enough rain for good plant growth, so permanent irrigation would be needed.

The Australian cereal belt never gets snow, and is both wet enough for adequate guayule growth (average rainfall 500–700 mm) and dry enough to give the plant the regular water stress it needs for high rubber content.

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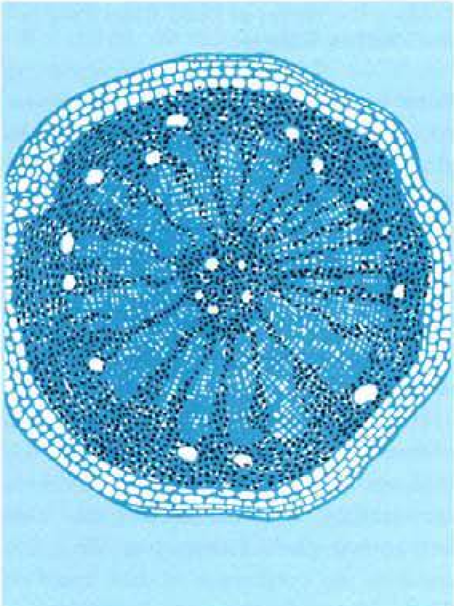
Guayule requires well-drained soils with medium to fine texture, slightly acid or alkaline, and with low salt content. The most extensive soils in the cereal zone that appear suitable are the red earths, well-drained texture-contrast soils, and some clay soils. Only 40 000 ha would be needed to replace Australia's natural rubber imports at the level prevailing in 1982.

In New South Wales, the suitable areas are already used for wheat-growing (although, given good profit prospects, some farms could probably convert to the new crop); in Queensland, large tracts are undeveloped or only partly cleared.

Some of the calcareous earths in South Australia and Victoria may also be suitable. Data on guayule growth at different locations in Australia are too limited at the moment for the team to be definite on

Rows of guayule, 2 years old, at Condobolin, N.S.W.



A cross-section of a guayule stem. The black dots are rubber.

likely performance, and much of a proposed research plan would involve closer attention to this aspect.

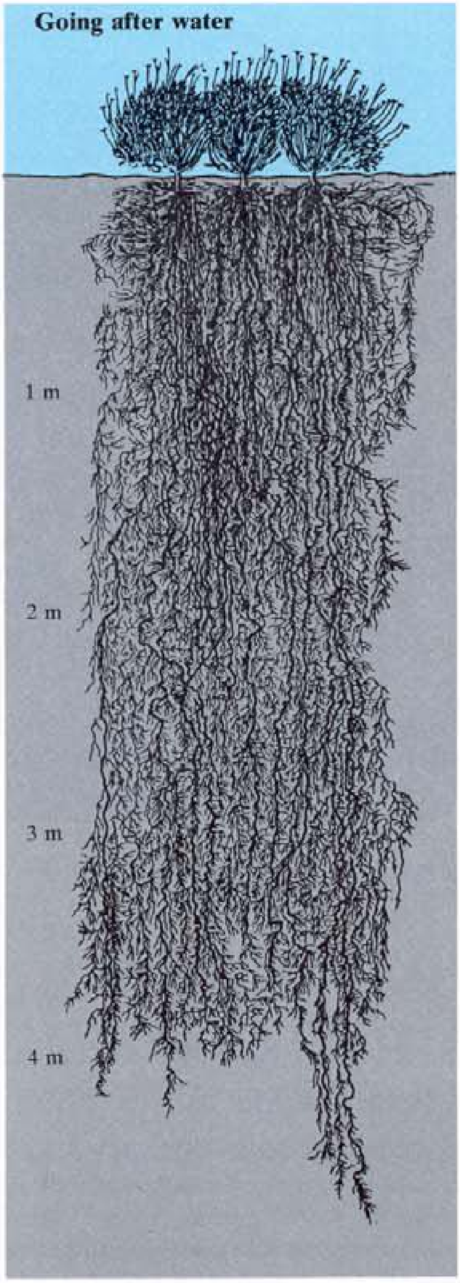
Guayule grows slowly, and needs a number of years to reach a height of 1 m. When grown on suitable soils, and with annual water stress, the rubber content is likely to reach 13–15% in 3 to 5 years. The scenario sees the tops harvested at this stage, and a second (ratoon) crop can then be grown for a similar length of time before harvesting the tops and roots.

Economics look good

Mr Stewart collaborated with Dr Ferraris of the Division of Tropical Crops and Pastures and Mr Bill Rawlins and Dr Geoff Gartside, of the Division of Chemical and Wood Technology, to look at the economics of guayule growth and processing.

Because Australian data on yields were lacking, they used data from Californian experiments to predict farm yields. They concluded that farmers in favourable environments should get 18 tonnes (dry weight) of shrub per hectare at the first harvest (5 years after planting), and double that amount at the second harvest 5 years later, when the roots were recovered too. Some 15% rubber was assumed at both harvests. The researchers defined the farming operations needed to grow such a crop, and they worked out the cost of the enterprise.

The team envisages that a single $28 million processing works, operating 24 hours a day for 300 days a year, could treat guayule to supply 17 000 tonnes of rubber per year — nearly half of Australia's natural rubber needs. To satisfy the works'



Adapted to semi-arid conditions, guayule's roots go deep in search of water. The roots of these 2-year-old plants have penetrated 5 m into the earth.

guayule demands, an area of 25 000 hectares would be required in the surrounding district.

A number of methods can be used to extract the rubber from the plant, and Dr Gartside chose the one most suited to Australian conditions. This avoids the use of water, which was required in large quantities by the extraction equipment that operated earlier this century. Instead of grinding up the guayule bush and letting the rubber float to the top of a water bath, modern technology employs an adaptation of the solvent-extraction processes used in the oil-seed industry.

Guayule bushes contain appreciable amounts of resin along with the rubber, and water processing extracts both together, as well as amounts of dirt and plant debris. To produce rubber of acceptable quality, a number of purification stages are necessary.

Dr Gartside's preferred option is removal of the resin and rubber separately; first the resin by acetone, then the rubber by hexane. Nearly all the solvent is recycled, and a high-purity rubber results. At the moment, resin and the left-over plant material (bagasse) are by-products deemed to have no commercial value.

Given this likely processing system, Mr Rawlins calculates that its economic prospects are good. Assuming that the product sells at the same price as imported natural rubber (around $1260 per tonne in 1982/83 Australian dollars), then the project's internal rate of return works out to be close to 25% per annum. Since the internal rate of return is defined as the highest rate of interest that investors in a project could afford to pay for funds and not make a loss, this is a promising outlook.

The result takes into account all funds invested in the undertaking, in both growing and processing of the crop. Costs appear equally divided between these two phases of the operation.

For purposes of comparison, Mr Rawlins repeated the calculation with a tax rate of zero (instead of 46%), and an inflation rate of zero (instead of 10%). The internal rate of return then appeared to be 15% per annum, which compares well with the figure of 2% calculated by the Bureau of Agricultural Economics for the annual real rate of return (including capital gains) for all Australian agricultural enterprises from 1978 to 1982.

Other variations to the basic calculation were made, some favourable (like a 30% increase in the rubber content of the shrub), and some unfavourable (such as a 35% increase in the cost of establishing a processing works). When the pessimistic variations were combined, the internal rate of return fell to 14% per annum, but the combined optimistic figure went as high as 34%.

Negotiations are now under way with State Departments and industry groups with a view to setting up a collaborative research program. Although a large amount of research still needs to be done, Mr Stewart is confident that guayule will emerge as a major crop in Australia.

Andrew Bell

More about the topic

'The Potential Production of Natural Rubber from Guayule in Australia.' G.A. Stewart and S.M. Lucas (eds). (CSIRO: Melbourne 1986.)