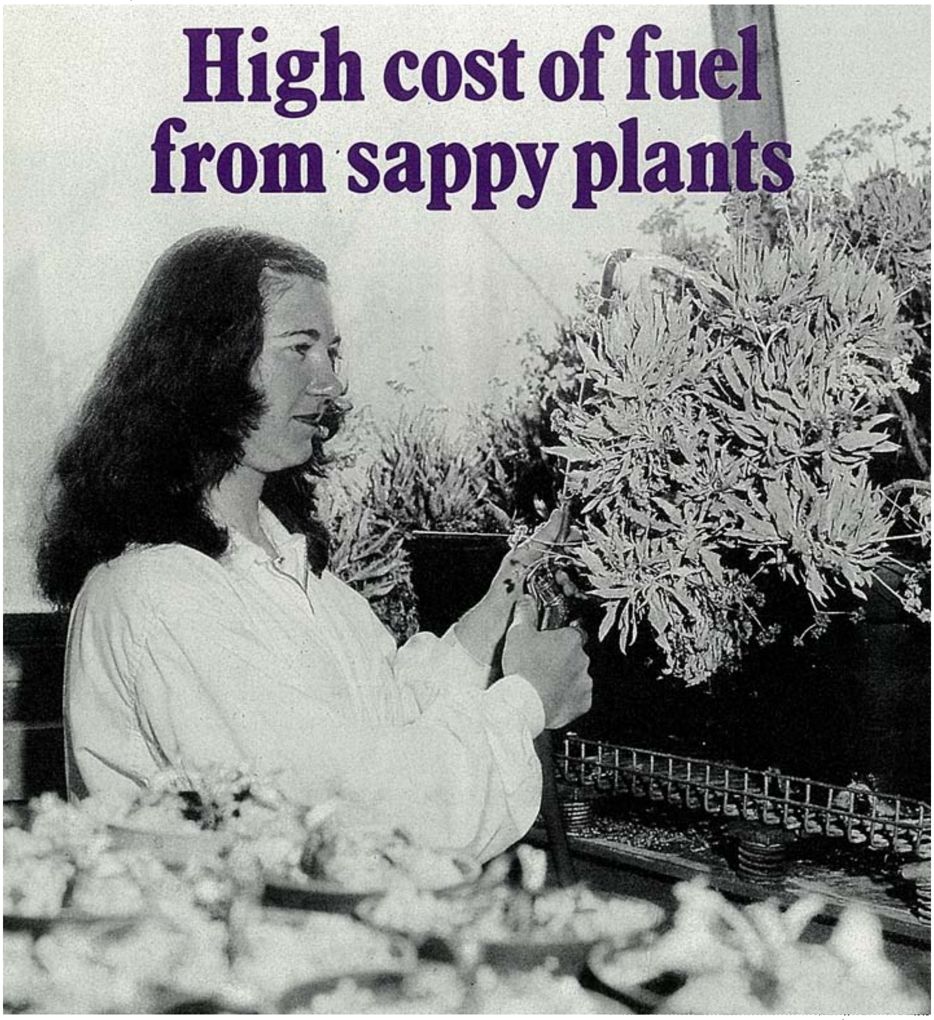
High cost of fuel from sappy plants



The commercial prospects for guayule look good, due to the high value of the rubber it produces. As a by-product, its resin could be turned into fuel.

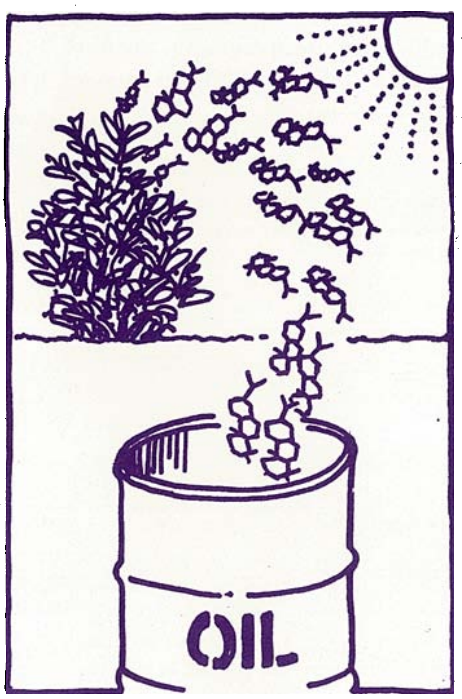
Sappy plants suffer in comparison with established oilseed crops.

The milky sap that flows from the broken stems of some thistles and other weeds and shrubs is reputed to cure warts; according to recent speculation, it may also provide a remedy for dwindling petroleum reserves.

One enthusiast for the concept believes five to eight million hectares of milkweed could provide Australia's entire petrol requirements.

It is too early to know for certain how practical such a scheme may be: much more research and planting trials need to be done. Nevertheless, a recently released report by a CSIRO team, funded by the National Energy Research Development and Demonstration Council (NERDDC), casts a less-than-rosy light on the economic viability of cropping most of the sappy species so far put forward.

The outstanding exception is the desert shrub guayule (pronounced wy-ool-ie), which stands to prosper due to the high value of the rubber that can be extracted from its sap. Indeed, the plant should be regarded as primarily a rubber-producer, with the resin it also produces regarded as a by-product that can be turned into fuel.



Economics

'The Potential for Production of "Hydrocarbon" Fuels From Crops in Australia' is in large measure a tentative costing of crop production by a team led by Mr Alan Stewart of the CSIRO Division of Chemical Technology. Other team members were Mr Bill Rawlins of the same Division, Dr John Hawker of the Division of Horticultural Research, Mr Henry Nix of the Division of Land Use Research, and Dr Lyall Williams of the Chemistry Department of Macquarie University.

Contributions from the literature evaluated by the report even show work by Thomas Edison, who at one time searched for alternative plant sources of rubber.

The following plants are considered as prime candidates for resin production.

- *Euphorbia lathyris* (gopher plant) is a biennial, growing from 0·5 to 2 metres high, and has a long history of use by man. It is occasionally cultivated as an oilseed crop in parts of Russia, China, and Japan. Measurements of resin content indicate about 7% resin on a dry weight basis when the stems above ground are cropped. However, there are indications that if the plant is grown to physiological maturity (a year or more) the resin content could be appreciably higher — at least double.
- *Calotropis procera* (rubber bush), a perennial shrub growing to 3 metres high, is an introduced weed in northern Australia. Australian Biofuels Pty Ltd has seeded 20 ha of land in the Ord Irrigation area with the plant to ascertain its potential.
- *Asclepias rotundifolia* (broadleaf cotton bush) and its close relatives commonly occur in disturbed habitats such as road verges, heavily grazed pastures, erosion gullies, and waterways.

The bad news is that none of these plants, according to the team's calculations, could produce resin cheaply. They put the price of the resin at between $151 and $270 per barrel (oil equivalent). Arabian light crude landed in Australia costs $32 a barrel. A further, unknown, cost would be incurred in refining the resin into automotive fuels.

The gopher plant (*Euphorbia lathyris*) is one of the sappy plants considered in the study.

Their low proportion of recoverable resin (4–10%) means that all the crops give rise to large amounts of residues (bagasse) for which there is no existing market. It is possible to convert the lignocellulosic material to methanol; however, even if it were done at a profit, the effective price of the resin would only drop to $116 to $196 per barrel.

Really, the enterprise would be largely a methanol-producing exercise, as the energy content of the resin would only be half to one-quarter that provided by the methanol.

A special plus

Guayule is a better proposition because, as well as containing as much resin as other species, it contains twice as much rubber as resin, and rubber is worth five times more than crude oil.

Because of these plusses, the team works out that the cost to produce a barrel of resin from guayule is −$79. In other words, revenue from the rubber and other products exceeds total costs by $79 a barrel.

The rubber is as good as that from the Malaysian rubber tree, and there is a continuing demand for natural rubber even in this day of synthetics. Synthetic rubber, made from crude oil, is not as good in demanding applications, and aircraft tyres are nearly 100% natural rubber. Radial tyres for cars also contain a good percentage.

Sappy plants also suffer in comparison with established oilseed crops such as rapeseed and sunflower seeds. The report points out that the oil in these crops is concentrated in the seed (30–50% oil), rather than distributed throughout the plant. This makes harvesting easy, as only the tops are cut and collected. Subsequent transport, storage, and processing are all made easier by the seeds' compactness. Furthermore, the oilseed-meal by-product makes a good stock feed too.

These favourable factors mean that a barrel of rapeseed oil may cost about $75, giving it an economic advantage. And oilseed crops leave a plentiful supply of lignocellulose standing in the field. This could be harvested if it's in demand.

The cost of a barrel of resinous sap

crop	where grown	estimated yield (tonnes dry weight per hectare per year)	percentage of recoverable resin	cost of resin (dollars per barrel oil equivalent)
Euphorbia lathyris (gopher plant)	southern Australia	3	7	147
Euphorbia lathyris — irrigated	southern Australia	10	7	134
Asclepias rotundifolia (cotton bush)	eastern Australia	7·5	9	116
Calotropis procera (rubber bush)	northern Australia	10	4·5	190
Calotropis procera — irrigated	northern Australia	20	4·5	196
Parthenium argentatum (guayule)	Tara, Qld	5	10	−79

These are the estimates made in the report. No commercial crop has yet been grown in Australia, so the figures are tentative. The guayule figure is negative because of revenue from its rubber.

The report estimates that sappy plants would need to contain 15–20% total resins to be economically competitive with oils from oilseeds. To date, no species has given better than about 10%.

A few species of Australian eucalypts contain more than 10% of essential oils plus resins, and further data are being sought so that they can be subjected to economic assessment.

Of the hundreds of species of plants surveyed for resins, only a handful have gone on to further testing and field trials. No species is commercially cultivated, and considerable research and development would be needed to bring any to a commercial stage.

The resins such plants produce are dark solids that melt into viscous liquids. Although they haven't been tested directly as fuels in engines, it is known that they can be catalytically cracked into conventional liquid fuels such as gasoline, LPG, and distillate. They are not true hydrocarbons, in that they contain some oxygen as well as hydrogen and carbon, but that is a minor consideration.

In summary, the chances of growing sap-bearing plants to produce just fuel are slim. However, guayule — which produces another prime commodity (to wit, rubber) as well as resin — may do quite well.

A number of CSIRO scientists are studying guayule, and *Ecos* plans to report on this work in a later issue.

Andrew Bell

More about the topic

'The Potential for Production of "Hydrocarbon" Fuels from Crops in Australia.' G. A. Stewart, J. S. Hawker, H. A. Nix, W. H. M. Rawlins, and L. R. Williams. (CSIRO: Melbourne 1982.)