Editorial

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But what if that multitude of energy slaves started to slip away into the night?

Worldwide oil supplies are the "energy slaves" referred to by University of Adelaide professor Barry Brooks in this biofuels edition of *Issues* (p.4). The crux of his question relates to "peak oil" – when the rate of oil production is at its maximum – and our response to it. How are we going to meet future world energy needs, in particular our need for fuel? Enter biofuels.

The explanation for our thirst for biofuels is not limited to dwindling fossil fuel supplies. Other drivers include the contribution of fossil-fuel combustion to climate change and the opportunity to supplement farm incomes by increasing demand for agricultural commodities (p.9).

Supporting farmers sounds promising, but there are complicating factors. Consider Australian production of ethanol from sugarcane. As Ian Lowe from Griffith University explains (p.6): "... growing sugar leads to other environmental problems. In Australia, its production pollutes the waters around the Great Barrier Reef, while clearing lowland rainforest for farming destroys habitat and thus threatens biodiversity."

And agricultural problems don't end there. Lowe urges us to consider the "ethical dilemma of whether it is appropriate to use food-growing land to produce transport fuel in a world where millions go hungry". First-generation biofuels are produced from crops that could otherwise be used for food.

Lindsay Falvey of the University of Melbourne elaborates the ethical view (p.15): "Climate change is inevitable, but biofuels replacing food production, and thereby increasing food prices further, is not. In such cases, scientists easily offend their own morals and support inequitable commercial ends." He also acknowledges that "if biofuel crops were grown on non-agricultural land, the food versus fuel argument would cool, although an environmental argument may well heat up".

In Australia, the food versus fuel debate hasn't yet been relevant to the biofuels industry because the industry isn't large enough to be in competition with food crops. But waste products would not be enough to meet demand for biofuels if the Australian industry was to expand significantly.

Will the Australian biofuels industry grow? The ability of biofuels to deliver on some of its purported benefits can be questioned, according to a recent report on government subsidies for ethanol and biodiesel. According to Derek Quirke (p.22): "Biofuels can have unintended effects that undermine the fiscal and environmental goals they are purported to support. Scrutinising the extent of government support for biofuels highlights the opportunity cost of financial assistance to biofuel industries over other options available to policy-makers."

The food versus fuel debate has spurred the search for non-food crops as feedstocks for biofuels such as biodiesel and ethanol. "First-generation technologies have been a useful first step in a transitioning away from oil, but to go forward relying only on these technologies would require new sources of oil, sugar or starch," explains Andrea Wild of CSIRO (p.18).

The so-called second-generation biofuels are derived from lignocellulose, the woody parts of plants. Steve Schuck of Bioenergy Australia (p.11) says that the search for these second-generation biofuels "has been driven by the need to find a broader range of feedstock and to allow production at a much greater scale to provide a greater proportion of future energy needs". Biofuels from second-generation technologies can be produced from "feedstocks such as garden waste, forest and sawmill waste, or

even plantations dedicated to energy production," says Wild.

Glenn Tong at the Molecular Plant Breeding Cooperative Research Centre (p.29) cites consistency and quality of supply and cost as constraining factors on second-generation biofuel production. The types of improvements required call for technologies such as genetic modification, he says. In turn, "substantial amounts of time, effort and money will be needed to gain regulatory approvals and market acceptance".

Tony Vancov describes the work of an alliance between the NSW Department of Primary Industries and the University of New England to identify issues associated with development of a second-generation biofuels industry using novel feedstocks. "The challenges of producing fuel ethanol from lignocellulosic biomass hinge on making technological breakthroughs in key process fields and slashing infrastructure costs," Vancov explains (p.34). Plants with potential include some eucalypts and modified grass species. As with Tong's work, genetic engineering is being used to tailor possible feedstocks.

In South Australia, the Algal Production Group at the South Australian Research and Development Institute is examining microalgae as a second-generation biofuel feedstock. Researchers Kriston Bott and Sasi Nayar (p.39) say that microalgae "are more efficient converters of solar energy due to their simple cellular structure. For these reasons, microalgae have the capacity to produce 30 times the amount of oil per unit of land compared with current terrestrial oilseed crops." Their sustainable business model aims to overcome the

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efficiency and cost problems associated with mass production by integrating "bioprocessing and chemical processing to produce high-value bioproducts and chemicals concurrently with biodiesel production."

Rebecca Lesic and Thomas Maschmeyer at the University of Sydney (p.42) explain that biodiesel synthesis is starting to take a greener approach, including the choice of catalyst. Supercritical fluids and heterogeneous catalysts offer significant improvements in effectiveness of biodiesel production.

At the Australian National University, Warwick Hillier's interest also lays in catalysis, but he too has his eye on solar conversion. He hopes that his research group's synthetic protein will one day catalyse the splitting of water, as is done naturally during photosynthesis, and enable the production of hydrogen. "Our artificial catalyst – assuming that we are ultimately up to the task of copying nature – could be used in an electrode to make molecular fuels," he writes (p.46).