

Carbon Farming in WA

Fact sheet No. 16

PRACTICE: **Liquid biofuel as a replacement for fossil fuels**

Description of practice

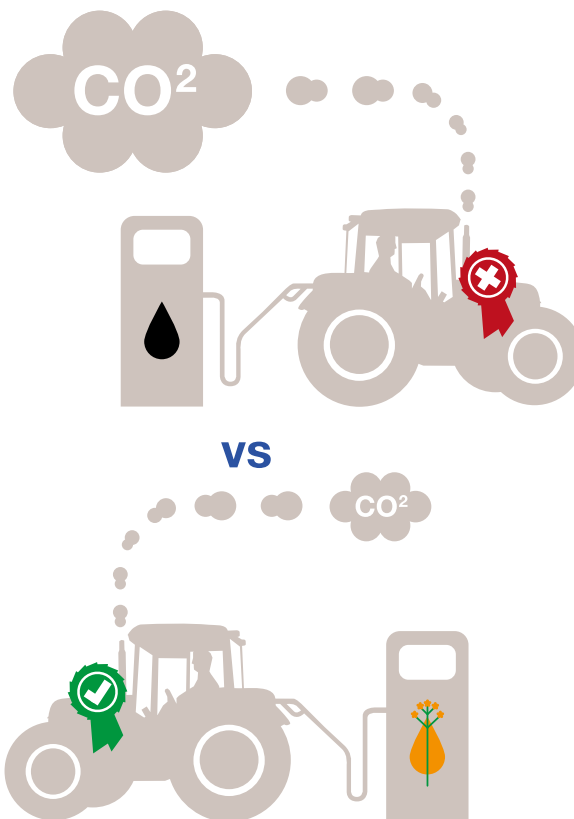
The sustainable use of biofuel as a replacement for fossil fuels presents a major opportunity for farmers to assist in reducing global greenhouse gas emissions (GGHE)—mainly carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). Practically all biofuel systems deliver reduced emissions where they replace high GHGE fossil-based energy. Additional greenhouse gases can be prevented from entering the atmosphere—biosphere by:

- reducing the use of fossil fuels by introducing biofuels
- reducing the use of fossil fuels by shifting to less carbon-intensive fossil fuels
- avoiding fossil carbon emissions to the atmosphere while using fossil fuels.

Outline of procedure

Liquid biofuels are liquid transportation fuels that substitute for petroleum products such as gasoline or diesel. They include ethanol and biodiesel (usually a vegetable oil product) made from agricultural crops and residues or other kinds of plant-based feedstocks. These fuels can be used in conventional engines with little or no modification.

The impact of biofuel systems on greenhouse gases should be evaluated by direct comparison with the energy systems that they replace. So far, agricultural feedstocks have dominated biofuel production, and future feed sources are likely to be from land-based production systems with high water



The Department of Agriculture and Food is the lead agency and is working with the Department of Regional Development and Lands to deliver this Royalties for Regions funded project.

For more information please refer to agric.wa.gov.au

More Information

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requirements. Therefore, for the foreseeable future, the agricultural sector will continue to be affected more than any other sector. Meanwhile, liquid biofuel is expected to have the highest potential for agricultural use and the greatest impact as a substitute for food production.

Liquid fossil fuels vary in the amount of energy and greenhouse gases they produce. Ethanol and biodiesel are the two most common forms of liquid biofuels currently in use and are referred to as first generation biofuels. First generation ethanol is made from sugarcane, maize and starch crops, and typically substitutes petrol (100% or, more likely, as a blend). Biodiesel is made by chemically reacting methanol with plant oils. Research done on perennial oilseed plants in the rangelands of Western Australia showed promising results. The trials also positively sequestered CO₂ (achieved under irrigation on a wide range of soil types and water qualities). Second-generation biofuels are still under development (not commercially viable yet or likely in the short to medium term) and cover a variety of feedstock and liquid fuels. An example is cellulosic ethanol produced from the fermentation or hydrolysis of non-food crops, such as straw and timber. Another option is the development of dedicated biomass crops for use in stationary electricity generation.

Biodiesel has several benefits: 1) it is relatively easy to manufacture; 2) it does not require large capital layouts; 3) it is renewable; and 4) it has better lubricating and environmental properties than mineral diesel. However, the volumes of feedstock required to produce biodiesel are extremely large. Biodiesel can be made from a range of plant and animal oils, including palm, soy, canola and tallow. The viability and potential for expansion of the biodiesel sector in Western Australia depends critically on the availability, price and dependability of supply

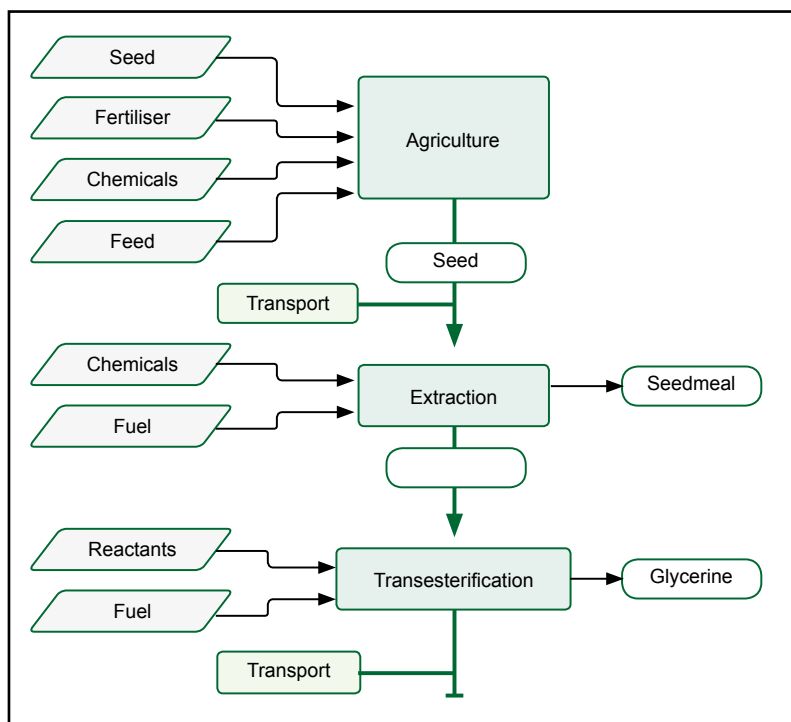


Figure 1 **The LCA process of calculating GHGE for a canola production system**

of appropriate feedstock. Used cooking oil (UCO) and tallow are cheaper feedstock but already appear fully committed. Canola is currently (and in the foreseeable future) the only likely feedstock for Western Australia. However, a report from the Centre for International Economics published in 2007 found that biodiesel from canola was not cheaper than mineral diesel. The state's main export markets for canola are China (mainly cooking oil) and the EU (where a large proportion of canola is used for biodiesel production).

Another factor in this equation is the energy used (and thus greenhouse gases produced) in the process of manufacturing inputs, on-farm activities to grow canola, and processing afterwards. This is referred to as life cycle analysis (LCA). This type of analysis is used to quantify the environmental impacts of products or services. It includes the GHGE of all the processes along the supply chain of the product or service.

The contribution to GHGE, or avoidance thereof, is developed by comparing the LCA of fossil diesel and biodiesel production (Figure 1 & tables 1 and 2).

Table 1 CO₂ emissions for diesel fossil fuel*

GHGE activity of diesel production	GHGE
Crude oil extraction	7%
Crude oil transport	1%
Refining	10%
Finish fuel transport	1%
Combustion of fuel	81%
Well-to-tank CO ₂ emissions (A)	19.31 kg CO ₂ -e/GJ
Combustion of fuel (B)	76.7 kg CO ₂ -e/GJ
Total (A + B)	96.01 kg CO ₂ -e/GJ

* US DOE–NETL, 2008

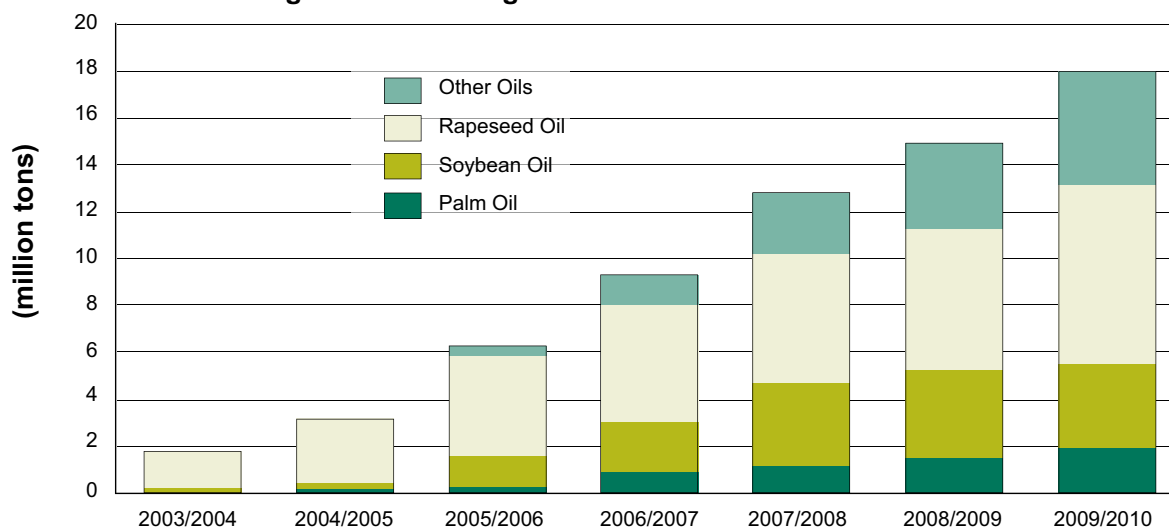
Table 2 The contribution of on-farm and off-farm activities to total GHGE from a canola production system in WA (Barton et al., 2009)

Production activity	Kg CO ₂ -e/GJ	% of total
<u>Pre-farm:</u>		
Fertiliser	10.7	30
Pesticide	0.5	1
Herbicide	5.8	16
Farm machinery	0.2	< 1
Transportation	0.3	< 1
Total A	17.5	48+
<u>On-farm</u>		
N ₂ O emissions from paddock	4.7	13
CO ₂ emissions from urea hydrolysis	9.2	26
Farm machinery fuel use	1.3	4
Total B	15.2	43
<u>Post-farm</u>		
Conversion canola seed to oil	1.3	4
Conversion canola oil to biodiesel	0.5	< 1
Transportation	1.3	4
Total C	3.1	8+
Total production to tank D = (A+B+C)	35.8	100
Combustion of fuel (E)	54.0	–
Total (D + E)	89.8	

Notes: 1) Using the international default value for N₂O emissions from land, rather than local data, would have overestimated GHGE from biodiesel by 63 per cent.

2) Annual loss of 0.13 kg N₂O-N/ha from N fertilised soil and 0.08 kg N₂O-N/ha from non- fertilised soil were found in a canola production system.

Growth in Vegetable Oils Usage for Bio-Fuels Production



- All oils usage in bio-fuels production have more than nine-fold
 - Since 2003/04, palm oil's usage in bio-fuels production has gone from zero to 1.8million tons
 - 15% of all oil is taken out of the food chain due to bio-fuels, causing the need for more palm oil for all usage
- Source: Oil World

The comparative greenhouse gas emissions with diesel and biodiesel (tables 1 and 2) show biodiesel production and combustion produced less 7.2kg CO₂-e/GJ than diesel. However, the advantage decreases as biodiesel is blended with mineral diesel. For example, the total CO₂-e/GJ emissions from the production and combustion of BD50 (i.e. 50% biodiesel and 50% diesel), BD20 (20% biodiesel and 80% diesel) and mineral diesel were 58%, 94% and 117% higher than from biodiesel (BD100), respectively.

Work done to date

Biswas & John (2008) found that the net life cycle global warming impacts of 1,000 litres of biodiesel production from the *Moringa oleifera* seeds (irrigated, Carnarvon) would be minus 8,168 kg of CO₂-e (sequestering 8t CO₂-e).

Current level of adoption

Diesel use in Western Australia is about 3.2 billion litres per year (Brockman 2007), meaning that a 10 per cent blend (B10) will require 320 million litres of oil per year. Current production from existing feedstocks (converting all canola produced to biodiesel) cannot supply the quantities required.

Global production of liquid biofuels has been growing rapidly, driven primarily by

a combination of blending or consumption mandates and subsidies. World production of fuel ethanol rose from 17 billion litres in 2000 to 66 billion litres in 2008. During the same period, fuel ethanol trade rose from 440 million litres to 5.1 billion litres. Biodiesel production rose even faster—although from a low base—from less than one billion litres in 2000 to 12 billion litres in 2008 (World Bank, 2010).

The International Energy Agency (IEA) estimates that liquid biofuels accounted for 1.5 per cent of global transportation fuel, and the volume of liquid biofuels supplied could double by 2015 (IEA 2011). The US and Brazil accounted for about 90 per cent of global fuel ethanol and the EU for about 70 per cent of global biodiesel production in 2008. Biofuel manufacture in the US and the EU are heavily subsidised and, in the case of ethanol, protected by large import tariffs.

Ethanol as a replacement for petrol may become less influential on GHGE in the medium and long term as the development of electric vehicles will most likely replace the need for petrol and therefore ethanol. There is, however, no commercially viable replacement for biodiesel—an important fuel option for rural and urban Western Australia.

While the use of biodiesel is increasing globally, availability of biodiesel in Australia

is limited, mainly due to limited feedstock availability and the current high price of feedstock.

Industry activity

The commercial production of biodiesel in Western Australia is limited and feedstock is mainly used for cooking oil and tallow, with limited amounts of plant oils (e.g. palm oil) imported. The only commercial biodiesel blend available is a B5 (5% biodiesel blend with mineral diesel) through Gull.

Carbon benefits

- Avoidance of CO₂-e emissions from production practises; using bio-diesel instead of fossil diesel

Co-benefits

- Production and use of biodiesel feedstock for own use
- Using by-product (oilcake) for animal feed
- Using canola as a break-crop for weed control
- Security of supply: avoiding 'peak oil' which could limit or interrupt supply
- Rural development, job creation, and support to agriculture

Opportunities

- The production of biofuel feedstock is applicable to most of the wheatbelt areas of Western Australia, as well as the wet tropics or areas with sustainable irrigation potential (e.g. aquifers) in the rangelands. Commercial production of biodiesel feedstock offers diversification options, with the potential to stabilise price volatility of crops.

Risks

- World fossil oil price variations
- Price of biodiesel feedstock (raw materials). It is not economically viable to produce biodiesel.

Key contacts – Western Australia

- Dr Henry Brockman (DAFWA)

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