Camelina sativa - an oilseed flowering plant that originated in northern Europe - is known by many names: gold-of-pleasure, false flax, wild flax and German sesame. Cultivated as far back as the Bronze Age, the biofuel industry is focusing on the potential of its oil as a source for renewable iet fuel. Sally Roberts writes

member of the mustard family and a distant relative to rapeseed, the camelina plant's seeds produce oil that is high in omega-3 and low in saturated fatty acids, making it ideal for use as a heart-healthy oil. Over the past few years, however, biofuel producers have focused on its potential as a source for renewable jet fuel.

Taking to the skies

Between 2009 and 2012, the US Air Force and the US Navy successfully test flew the A-10 Thunderbolt II, F-22 Raptor and F/A-18 Super Hornet fighter jets on a blend of standard jet fuel and camelina-based jet fuel.

By 2016, the US Navy intends to have a carrier battle group 100% powered by camelina-based biofuel. The army has also set a target of 50% renewable fuels for its entire domestic jet fuel consumption.

Commercially, KLM Dutch Royal Airlines and Japan Airlines have also performed successful test flights using a blend of standard jet fuel and camelina.

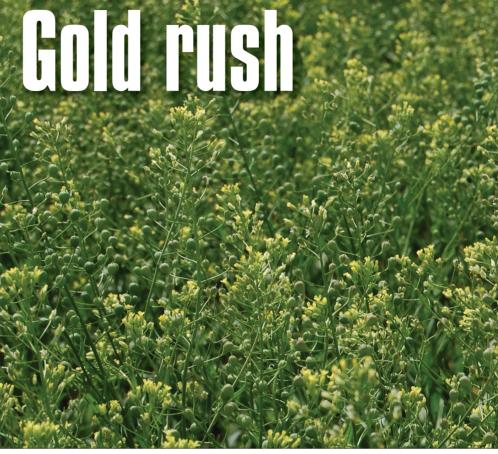
In 2009, Japan Airlines used a fuel derived from the oils of camelina (84%), jatropha (16%) and algae (one percent), blended with traditional kerosene fuel in one of the plane's four engines. After the flight, they confirmed that the biofuel was more fuel efficient than the 100% kerosene fuel, indicating that biofuels may be both carbon neutral and cheaper to run, benefiting both the environment and the airline.

KLM Airlines flew a passenger-carrying Boeing 747 jet in 2009 with one of its four engines running on a 50/50 mix of camelina-based biofuel and

In June 2011, a Gulfstream G450 business jet flew across the Atlantic on a mix of 50/50 biofuel from camelina and petroleum-based jet fuel.

Fields of gold

Camelina is produced predominantly in Austria, China, Finland, Germany, Montana (USA), Slovenia and Ukraine. It is able to grow in diverse climates and can be successfully planted in most soil types. It is a short-seasoned, fast-growing crop with a season of 85-100 days and can survive with little water, fertiliser or pesticide. It still requires management but needs less input than similar crops, and can withstand either frost or drought. If planted in spring or summer, it can be managed as an annual crop, or a bi-annual crop if grown in



ORIGINALLY GROWN IN NORTHERN EUROPE, CAMELINA THRIVES IN MOST SOIL TYPES AND IS FOUND ALL OVER THE WORLD

winter. It can also be grown as a rotation crop with wheat, displacing fallow weeds and therefore increasing yields. Experiments are currently underway to test whether it can successfully be grown alongside soyabeans.

When planted, camelina sativa will outcompete weeds for the soil's nutrients, acting as a preventative measure for farmers. Its compatibility with existing farm equipment and infrastructure makes it an easy switch for most potential

The oil produced has a variety of uses; it can be utilised as a biofuel, an edible oil and in the medical and beauty industries - the oil is said to be beneficial for those suffering from psoriasis or eczema, due to its high linoleic acid and alphalinolenic acid levels. After the oil has been pressed from the seed, the resultant camelina meal - consisting of up to 50% crude protein - can be sold as an ingredient for cattle and chicken feed, adding further value to producing camelina.

Reap what you sow

According to a report by Bryan R Moser in 2010, titled 'Camelina' oil as a biofuels feedstock: Golden opportunity or false hope?', camelina crops can provide anywhere from 336kg to 2,240kg of seeds/ha, with the lipid content of those seeds ranging from 35-45%.

Therefore, each hectare of camelina sativa can vield between 106 and 907 litres of camelina oil, a figure that gives camelina a higher yield than soyabean or sunflower oil.

This stark variation in yield depends on factors

such as climate, agricultural inputs, pests, weeds and disease. With twice the oil content of an average soyabean, the camelina seed demonstrates great potential in terms of value/yield rates.

Life cycle analysis (LCA) studies have concluded that total carbon emissions for renewable diesel and fuels derived from camelina are between 75% and 80% lower than standard petroleum emissions. Camelina-based biodiesel is also claimed to emit 78.5% less carbon than petrodiesel over its lifetime.

One concern raised is the increased nitrous oxide (N2O) emissions released as a result of biofuels. A greenhouse gas, N2O is roughly 270 times more potent than carbon dioxide (CO₂). Some environmental scientists have argued that the amount of N₂O emitted over the life cycle of a biofuel could negate the CO₂ savings made overall.

According to scientists, the amount of N2O emitted from the fertiliser required to farm sufficient quantities of biofuel is too high to make any significant savings. As camelina needs relatively low amounts of fertiliser to grow successfully, it may be possible to overcome this issue. However, other problems occur when it comes to the cost of producing biofuel compared to the cost of producing kerosene.

Currently, no operation has been able to scale up production of camelina to make it cost comparable to traditional fuel. Crucial to the industry is the fact that biofuels cultivated for use as jet fuel need to be able to be 'dropped in' to, or compatible with, standard kerosene fuel. Additionally, the biofuel source must not take up valuable agricultural land that would otherwise be used to grow



food crops. Camelina scores highly on both these factors; it can be grown on marginal lands in rotation with wheat to increase its yields, and it can be

mixed with kerosene fuel with no modifications

required to the plane's engines.

Recently, scientists from US firm Genome Prairie, and the International Service for the Acquisition of Agri-Biotech Applications, announced they had managed to sequence the camelina sativa genome, a fundamental step towards fully enabling development of camelina

Amid these developments, AltAir Fuels, a US player in the biofuels market, has announced its intention to supply the USA's United Airlines with 15M gallons of renewable jet fuel over the next three years.

Recent developments

2013 was an exciting year for camelina. In January, the USDA awarded US\$5.08M to a team of researchers to study camelina's potential. The research, led by Kansas State University professor in Grain Science and Industry, Xiuzhi 'Susan' Sun, will focus on how plant- and grain-based materials such as oils, proteins and fibres can be used to create bio-based chemicals and products like resins, adhesives and coatings that are safer, more durable and environmentally friendly than products currently in use.

In February, the US Environmental Protection Agency (EPA) issued a final rule qualifying biofuels produced from camelina oil as biomass-based diesel or advanced biofuel, Biofuels Digest reports.

In March 2013, Global Clean Energy Holdings a southern California-based renewable energy company focused on the production and commercialisation of non-food based feedstocks used for the production of biofuels, biomass and renewable chemicals - acquired Sustainable Oils, a leader in camelina genetics and production.

July saw a US\$7M grant given to the Agricultural Research Service's National Center for Agricultural Utilization Research to optimise

Camelina: A brief history

Evidence that camelina was Lagriculturally farmed for its oil has been found in archaeological excavations in Scandinavia and Western Europe, dating as far back as the Bronze Age.

It is thought that cultivation of the seeds probably predates this to the Neolithic period. Cultivation has also been shown to occur in the Rhine River Valley area at as it was being cultivated in south-east Europe and south-west Asia. Known as 'gold of pleasure' to ancient Europeans, its popularity declined throughout the Middle Ages and it is thought the plant was eventually carried over to America as a weed, mixed in with flaxseed.

rapeseed/canola, mustard and camelina oilseed crops for oil quality and yield using recombinant inbred lines. Remote sensing and crop modelling will enhance production strategies to incorporate these crops into existing agricultural systems across four eco-regions in the west of the USA. The oils will be hydrotreated to produce diesel and jet fuel.

Finally, in December, Neste Oil announced it would produce 4,000 tonnes/year of renewable jet fuel using sustainable Spanish camelina oil and used cooking oil (UCO) under the EU-funded ITAKI project. The three-year project received US\$13.2M and will feed into the two million tonnes of renewable jet fuel initiative European Aviation Biofuels Flightpath.

While issues remain unresolved, the aerospace, biofuel and farming industries would benefit from the development of camelina oil into a renewable source of energy and, with the right investments and backing, it could become a contender on the biofuels scene.

Sally Roberts is a staff writer



CAMELINA SEEDS PRODUCE AN OIL WHICH HAS HIGH LEVELS OF OMEGA-3. AND LOW LEVELS OF SATURATED FATTY ACIDS

LEANNE PHILIPS, PHOTO: