Tapping into on-farm energy

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Energy and food production can go hand in hand according to Victorian farmer Steven Hobbs, who is challenging Australian farmers to harness the potential of on-farm energy.

Farmers have an abundant source of under-utilised energy at their disposal according to Victorian farmer and Nuffield scholar Steven Hobbs.

"We've concentrated on the smallest part of the crop and that's the seed head or the grain, which is around 30% of what the plant produces," he said. "There's so much more in the plant that we can tap into. Some of that is in the biomass, which we can use to build the soil, but we can also use it for energy.

"Energy is one of the greatest demands in agriculture and I'd love to see farmers start growing energy as part of their cropping rotations. Farmers have a huge untapped potential in just one little oilseed crop."

The fourth-generation farmer from Kaniva in the West Wimmera region began experimenting with alternative fuel sources nearly 15 years ago, after becoming inspired when flicking through his grandfather's farming photographs which showed how he sourced energy: by growing oaten hay to feed the horses that powered the implements.

STEVE HOBBS SEES HUGE UNTAPPED POTENTIAL IN MUSTARD, FROM WHICH HE PRODUCES BIODIESEL FUEL FOR HIS FARM MACHINERY.

"Grandpa was growing and storing carbohydrate energy to run his organic tractors – his horses – and they would let the fertiliser go in the paddock," said Steven.

THIS OILSEED PRESS, IN A FARM SHED ON STEVEN HOBBS' KANIVA PROPERTY, IS THE FIRST STEP IN CONVERTING HIS MUSTARD SEED TO FUEL AND STOCK FEED.

"It was that concept that really struck me, and I thought 'we can apply it in a new way'."

In early 2000 he bought an oil expeller to produce vegetable oil and the results of these trials prompted him to build a small biodiesel plant and start producing biodiesel and pure vegetable oil from mustard seed grown on his property.

In 2004 his research went global, when a Nuffield scholarship allowed him to study decentralised energy production in Germany, Finland, Wales, England and the USA. "In Europe they're growing oil seeds to feed the iron horses," said Steven. "For Europeans, it's nothing different. It's happening over there because they've been forced to innovate. In Australia we've been too lazy and no one is innovating in this area."

He believes farmers can grow a biofuel crop without affecting food production. "From my own personal experience, I would argue that you can actually enhance and increase food production using a biofuel crop on your farm," he said.

Steven runs a mixed farm producing

cereal, legumes and oilseed crops, Merino wool and prime lambs. In his cropping operation, 80% of the land is used to produce food crops like wheat, barley, lentils and chick peas. The other 20% is sown to field peas, lupins, legumes or hay, which he describes as feed crops. "They're crops that have to go back through an animal to create protein, fibre or milk," he said. "Growing a dedicated fuel crop such as mustard seed can be easily integrated into the feed part of the rotation – into that 20% – without it affecting the other 80% of your production."

The secret to this equation is growing a fuel crop with high energy density, which means less is needed to create more power. The vegetable oil from the low glucosinolate mustard seed he grows produces 10.8 kilowatt hours a litre, nearly as much energy as diesel, which can generate 11.1 kilowatt hours/L.

"The high energy density of the mustard means I can grow less of it. I dedicate 5 to 8% of my land area to the fuel crop, which can easily fit into that 20% feed portion."

Steven has found many uses for his fuel crops. In addition to producing vegetable oil and biodiesel he uses the press cake left after the oil extraction as a feed supplement for his sheep and to produce briquettes to warm his home during winter.

When crushed, the oilseeds produce pure, ungummed vegetable oil which can be used to power diesel vehicles that have had their fuel delivery system modified. Or the oil can be converted to biodiesel by splitting the glycerol spine from the ester molecules in the oil. "Glycerol doesn't burn well at low temperatures so it's necessary to crack the bond," Steven said.

He likens biodiesel production to soap-making, which traditionally uses a fat (tallow), caustic soda and water. Biodiesel production uses a fat (vegetable oil), caustic soda and an alcohol, such as ethanol or methanol instead of water.

"What happens is that the free fatty acids in the oil turn into soaps during the process. You want to remove them from the fuel because they will lead to fouling and coking of your injectors and seizure of your rings. It's just a matter of washing your fuel until you get rid of the contaminants to bring the pH back to neutral, then drying the fuel."

It's an energy-intensive process, but far less intensive than producing petroleum fuel. "They say for every one unit of energy you put into petroleum fuel, you're only getting about 0.75 of a unit out. That's why our energy reserves are depleting, because we're using more energy to mine, extract, refine and distribute it than we are getting out of it.

STEVEN HOBBS WITH BREEDERS' LINES OF MUSTARD IN A GLASS HOUSE AT THE UNIVERSITY OF IDAHO, WHERE HE VISITED DURING HIS NUFFIELD SCHOLARSHIP STUDIES.

"With biofuels, the rough rule of thumb is for every one unit of energy you put in, you get three back."

The glycerol extracted during the transesterification splitting process is not wasted, with Steven looking to use it as an alternative to molasses. "Glycerol is a sugar precursor and I hope that it will increase the hunger of my sheep to digest stubble."

The co-product from crushing the oil seeds is the fibre or left over solids, known as press cake. It is high in protein, nutrients and energy and Steven uses it as part of his stock feed ration. Four years ago he conducted a simple trial with 180 lambs that weren't quite right for market. Using an old cow feeder, he mixed a feed ration consisting of 8% cold press mustard meal, 50% wheat straw, 1% each of salt, lime and bentonite and 39% frosted barley. "It was an inexpensive ration because it's all off the farm and we achieved up to 428 grams per day live weight gain," he said.

It's not only the sheep that benefit from the press cake. Steven has recently experimented with making high-density press cake briquettes to fuel a combustion heater used to heat his home and hot water system. The water is heated via a flue heat exchanger that captures heat that is normally lost through the flue. "You capture about three kilowatts of heat that would otherwise be lost to the atmosphere," said Steven, adding that the briquettes produce twice as much energy and burn up to three times longer that the equivalent weight in wood.

Steven believes agriculture is facing its biggest challenge in history; to produce as much food in the next 50 years as has been produced in all of history, while faced with a noticeable 20-year trend to less rainfall and more late frosts.

Based on his farm's rainfall records for the

MUSTARD AND CANOLA TRIALS ARE INTEGRAL TO STEVEN HOBBS' ON-GOING SEARCH FOR MUSTARD AND CANOLA VARIETIES THAT WILL PRODUCE HIGH OIL YIELDS IN HIS FARMING SYSTEM.

past 100 years, rainfall has declined about 32% in the past two decades. "From 1980 we've had seven droughts in 34 years, but the worst part is that there hasn't been any above-average rainfall to recharge the subsoil," he said. "The reason we're not pulling the roofs off our sheds to feed the horses, which is what farmers did in the Federation drought, is because we've got really good at using moisture."

Further investigation of rainfall patterns revealed a drying trend in spring. "We come unstuck in October," said Steven. "Consecutive dry years mean we don't have the subsoil moisture and we can't bank on having a spring finish."

This led him to explore the potential of biochar and polyacrylamides – water-absorbing granules – to store water in the soil. In conjunction with the Hindmarsh Landcare network he trialled biochar and polyacrylamides on several paddocks, including 4 ha of his most frost-prone land.

"In one polyacrylamide trial wheat yielded 2 t/ha where we used the granules, compared to 1.65 t/ha over the rest of the paddock. That gave me a yield difference of 25%. With wheat at $235/t, I picked up another $101t/ha."

Steven was equally impressed with the relative cost of the polyacrylamides – $24t/ha – which have a lifespan of three to five years. "Averaged over three years, applying polyacrylamides cost me $8/ha with a return of $100/ha."

In the low-lying, highly frost-prone paddock, the area treated with polyacrylamides yielded 54% more than the surrounding untreated area.

"There was a yield of 3.58t/ha where we had the polyacrylamides, whereas the rest of the paddock produced 2.32t/ha. It really blew me away," said Steven. "I think it was due to lack of frost damage. With the polyacrylamides the crop had extra moisture to help carry it over. I certainly noticed it on the header. When I got onto the area without the polyacrylamides there was all this pinched grain coming out the back.

"I intend to do more with it this year. I think we can use it to start getting some cover, to conserve some moisture, to kick start the whole system and get our biology happening."

In the biochar trial there was an 11% yield increase where the biochar was applied at 1t/ha and an 18% yield increase at 5t/ha. Biochar remains in the soil for more than 100 years, creating an environment conducive to storing water, reducing nutrient loss through leaching and improved soil biology.

Steven's passion is to harness the natural resources that all farmers have available to them – the soil, plants and the sun – and he challenges other farmers to recognise their own on-farm energy resources. "We don't realise what we've got. As someone once said, if you know better you do better. There's an opportunity for all of us to start tapping into the energy reserves on our farms," he said.

"Whether you believe in climate change or not, the point is that agriculture needs to dramatically reduce its dependence on fossil energy because we're only producing cheap food because we've got cheap energy.

"If we've got declining rainfall, how can we continue to grow more with less? Agriculture has a huge challenge to produce enough food to feed the world's growing population.

"We need to respond to changing climatic conditions by using our water, nutrients and resources better."

STEVEN HOBBS WITH AN ARRAY OF BOTTLES CONTAINING ENERGY-RICH PRODUCTS DERIVED FROM MUSTARD GROWN ON HIS WIMMERA PROPERTY.