



# Filling diesel's shoes

## Alternative fuels

**Diesel is an integral aspect of modern agriculture, but despite its enduring efficiency and affordability it will be phased out, but what will replace it? CPM explores the intricacies of alternative fuels and what could possibly be filling diesel's shoes.**

*By Melanie Jenkins*

**There'll come a time when UK agriculture no longer has access to red diesel but although this might seem like reason enough to explore alternative fuel options, the bigger picture includes looking at the long-term future of the industry and planet as the world strives to limit the impacts of climate change.**

The past few months have seen some controversial decisions by government, namely the authorisation of the Rosebank oilfield — with the potential to add 200m tonnes of CO<sub>2</sub> to the atmosphere — and the delaying of the ban on the production of new petrol vehicles. In addition, the attempts to slacken the environmental restrictions on

building regulations also raises questions surrounding the government's stance on climate change and reducing greenhouse gas (GHG) emissions.

Although none of the decisions could be said to directly affect agriculture or provide any certainty in government legislative direction, there's still tremendous pressure on the industry to cut emissions and operate in a more environmentally friendly way. And while it might seem like petrol and diesel vehicles will be around longer than expected, the net zero mandate remains in place.

*“You're a steward of your organisation, so it's about taking steps to safeguard it.”*

### Action needed now

According to Dr Nick McCarthy of Cenex, the time to start taking action is now. But, in agriculture this might seem like a bit of a non-starter for many. Diesel is still the most widely used and indeed, the most cost-efficient way to operate farm machinery. But the manufacturers haven't been sitting on their laurels just churning out new diesel machines. Instead, across the industry, a raft of innovations and developments are seeking to provide greener options for agricultural production.

“The direction of travel is certain,” says Nick. “Net zero is coming and although agriculture is still able to use red diesel,

there'll be a point where legislation on non-road mobile machinery (NRMM) will result in the red diesel duty rebate being phased out and diesel engines will stop being produced.”

However, this is something the NFU is advocating against until there's definite support from government for alternative solutions, says

Dr Jonathan Scurlock, the NFU's chief adviser on renewable energy and climate change. “It should be quid pro quo because there'd be a tremendous cost to businesses if there's no access to red diesel. The industry has to be presented with alternatives so that we can see the way out of using red diesel in the long term.”

As a whole, agriculture is responsible for approximately 18% of global GHG emissions, says Nick. “Around 2% is from farm machinery and the rest is from crop and livestock production. But it's easier to remove that 2% by using a fuel that isn't fossil based than it is to cut the remaining 16%.”

But he feels the transition has already been left very late. “There's been a real push from the scientific community since the start of the decade to cut emissions, but we're still waiting for this to come through in policies and law and it looks increasingly likely that we'll surpass limiting global warming to 1.5°C.” ▶



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*At the start of October, Claas announced that all its agricultural machinery that meets the latest emissions standards (Stage V) has been approved for operation with HVOs.*

► But he believes that waiting to be forced to take action is more detrimental than taking steps now. “In terms of the impact of climate change, as an individual it’ll cost you and your business more in the long-term if you do nothing now, instead of taking steps to mitigate the effects immediately. The faster we act, the more the negative consequences will be reduced.

“However, we can’t do everything without diesel just yet,” he admits. “Some agricultural processes have to use diesel, especially when larger machinery is involved. But there’s technology available now that offers a big reduction in GHG emissions for many farm operations and adopting these is better than waiting 25 years for a completely net zero technology to be available.”

There are a number of drop in or replacement fuels already available, one of which is hydrotreated vegetable oil (HVO). HVO is one of the most accessible alternative fuels to use in the short-term because it can usually be put into diesel internal combustion engines (ICEs) without alteration, says Nick.

This is generally made from used cooking oil and recovered fat feedstocks, says Jonathan. “There’s not a huge amount available on the market at the moment, but it’s basically identical to diesel.”

However, HVO is only a justifiable alternative if it comes from a sustainable source, explains Nick. “Its source will dictate

whether it reduces your carbon footprint or not.”

Certifying the origin of the feedstock which HVO comes from is a way to determine its sustainable credentials, but if it’s sourced from palm oil or land which has recently been deforested, it won’t meet these, explains Jonathan.

## Cost premium

Another issue with HVO is that it comes at a cost premium to diesel, adds Nick. “And although it’s a drop-in fuel that can be used in almost all new machinery, it’s worth double-checking with older equipment and with your insurance and warranties before putting it in the tank. However, storage equipment won’t require changing from diesel set ups,” he adds.

At the start of October, Claas announced that all its agricultural machinery that meets the latest emissions standards (Stage V) has been approved for operation with HVOs.

According to Dr Martin von Hoyningen-Huene, of BU Tractor, there are no real alternatives to the combustion engine for high-performance agricultural machines in the foreseeable future. “So we require solutions that reduce fossil fuel emissions associated with this type of drive, yet don’t have significant adverse effects on manufacturing costs, consumption, weight and durability. HVOs are an ideal choice because they already exist, and their

positive environmental impacts are immediately apparent.”

In March of this year, AGCO announced the launch of its Core75 engine which is capable of running on recycled and potentially green fuels. The engine is a feature of Fendt’s 700 Vario Gen 7 tractor and is compatible with HVOs.

In addition, the engine has been designed to be compatible with future fuels such as hydrogen, ethanol, methanol, biogas and could potentially operate as an electric hybrid with further development.

Fatty Acid Methyl Ester (FAME) biodiesel blends is an alternative fuel which has been available for some time, but if it’s being stored on site it requires a different set up to diesel, says Nick. “If you source this sustainably then it will reduce your CO<sub>2</sub> emissions, but you’ll have to factor in changing seals and filters more often and ensure that no moisture gets into stores or tanks. It’s important to think about the extra steps that might be required when switching to an alternative fuel.”

Deutz’s ICEs have been able to run from 100% canola oil since 2006 and in 2018, Valtra made the decision to fill all of its new tractors with biodiesel which, according to the firm, produces up to 90% less GHG emissions compared with fossil fuel diesel.

John Deere engines are able to run off different levels of biodiesels depending on the engine, but HVO can be readily used. And the firm also has aspirations to produce further working low and near zero carbon power solutions by 2026. As part of these aims it’ll have a concept 9-litre ethanol compatible engine on display at Agritechnica in November.

According to Jonathan, biomethane is a great alternative fuel that is being used more frequently in heavy goods fleet vehicles. “It’s a relatively mature technology and firms such as John Lewis have taken to using it.”

Using biomethane present significant CO<sub>2</sub> reductions, says Nick. “New Holland, which commercially launched its T6 100% methane powered tractor in 2022, claims that

biomethane is a like-for-like replacement for diesel. And if you can get fuel grade biomethane to your site, then it’s a viable option as it can reduce overall emissions by 80% when using farm supplied biomethane.”

One consideration with biomethane is having a regular supply able to meet the demands of the tractor, says Nick. “When you want more diesel, you call for a new delivery, but increasing biomethane output isn’t as simple yet because it requires a guaranteed input. If you’re producing your own, do you have a contingency plan if you ►



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*New Holland's T6 100% methane powered tractor was commercially launched in 2022.*

► lose enough cows to impact your supply? This could mean falling back on fossil methane which isn't environmentally friendly."

Another issue Nick flags with biomethane is that the system has to be leak free in order for it to be a sustainable solution. "If there's a leak and you accidentally emit CO<sub>2</sub> and methane in the production process, then you lose all of the environmental benefits of using this fuel."

Jonathan concurs that there won't be any GHG savings if there are fugitive emissions associated with the handling of the gas but is interested to see the results of New Holland's partnership with Bennamann, which involves capturing methane from slurry units and converting it to good quality, compressed biomethane on site.

Hydrogen is a fuel source that has a lot of conversation revolving around its potential, but utilising it in a fuel cell involves a different power train and research is still on-going to produce an effective system, says Nick.

However, JCB has managed to alter its ICE telehandlers and plant loaders to run off hydrogen without having to develop an entirely new fuel cell. "JCB's hydrogen combustion engine is a significant achievement despite being largely the same as its ICE counterpart," he explains. "The firm can use its existing production line because 75% of the engineering for a diesel-burning engine and a hydrogen-burning engine is the same. Although this is more targeted at construction customers at the moment, farmers could well use the telehandlers."

JCB's project, which cost £100m and involved a team of 100 engineers, went from conception to commercial reality in just two years. Although the idea of fuel cells was explored, the firm determined these to be too expensive, complex and not robust enough for construction or agricultural use yet, hence the hydrogen combustion engine was developed.

According to JCB's owner, Lord Bamford, the unique combustion properties of hydrogen enable the hydrogen engine to deliver the same power, the same torque, and the same efficiency that already powers JCB machines. "By leveraging diesel engine technology and components, they do not require rare earth elements and critically, combustion technology is already well proven on construction and agricultural equipment."

According to Jonathan, JCB has achieved something commendable, but he feels the safety case has to be made. "This technology really works and might become available in larger machinery, but because of hydrogen's combustibility, the safety element must be tackled."

## Hydrogen drawback

Although hydrogen could pose a solution to diesel in the long-run, one issue with it at present is that not all hydrogen is produced in an environmentally friendly way. "There are various types of hydrogen available, but the main three are grey, blue and green," explains Nick. "Grey is made from fossil fuels with the residual CO<sub>2</sub> released into the atmosphere — this isn't a green option. Most fertiliser we use has been produced using this method.

"Blue hydrogen involves splitting methane into hydrogen and CO<sub>2</sub> with the latter being sequestered. However, this is very rare and difficult to get hold of. Green hydrogen is a renewable energy that is produced through electrolysis, whereby an electric current is used to separate hydrogen and oxygen in water."

One of the drawbacks with hydrogen is how expensive green hydrogen is. "This is at a premium and is likely to be expensive to run at present, but post 2030 it'll probably be more viable," he adds.

Fendt is one of the firms that has been researching hydrogen fuel cells, according

to the company's Ed Dennet. "The use of hydrogen is just one of many alternatives we are researching to help farmers reduce their carbon footprint. The H2Agrar project is exploring the potential of a hydrogen infrastructure in agriculture. The further development of H2 tractors also depends strongly on an infrastructure that has yet to be built, technical progress, and also the availability and price development of green hydrogen."

Deutz has also done work on a hydrogen engine, in partnership with AGCO. Due to be commercially launched in 2024, its six-cylinder TCG 7.8 H2 engine meets all of the eligibility criteria set by the EU for zero CO<sub>2</sub> emission engines.

Another fuel source being explored is ammonia, but like hydrogen it also requires a different power train to diesel, says Nick.

Ammonia, as a concentrated fuel, has an energy density three times that of compressed hydrogen and can be more viably stored as it doesn't have to be kept at low temperatures or high compression, explains Jonathan. "It's still a toxic gas, so caution has to be taken to avoid fugitive emissions and Defra already has concerns with ammonia related to fertiliser spreading."

But ammonia could be the solution to safely transporting green hydrogen, he says. "The ammonia industry already transports it around the world in bulk carriers, but this could be further employed as an energy storage medium to move it internationally in a safe capacity."

Battery electric vehicles (BEVs) are a good alternative, except for their power density and work rate, says Jonathan. "We're seeing a lot of smaller tractors and



*In March of this year, AGCO announced the launch of its Core75 engine which is capable of running on recycled and potentially green fuels.*

prototypes being produced, as well as telehandlers becoming available. If farms have solar arrays or renewable sources, BEVs can be charged using this on-site electricity."

Smaller tractors can probably be trickle charged on site but a large electric vehicle will require a sufficient charging point on site to charge the machine at night so that it can be used during the day, says Nick. "And power capacity will depend on how close you're located to the grid, and this can be very expensive."

In addition, intensive charging will require bigger cables and charging equipment, he adds. "Electrification means changing your habits to ensure that the electric vehicle is charged up ready for use."

However, there are limitations with the duty cycles of larger machines, says Jonathan. "No manufacturer has yet solved the issue whereby harder working machines can't store enough power without battery swapping."

"Currently, electric power seems more suited to smaller machinery. But interestingly, Ford has recently launched its F-150 Lightning pick-up truck which provides 10kW of power and has a 100kWh battery that electrical appliances can be plugged

into in the field without depleting the car battery – it's basically a workshop on wheels for farmers."

A further consideration with electric vehicles is that batteries do reduce in their output over time, says Nick. "But manufacturers predict this and are building batteries that will be able to meet their original output seven-10 years down the line. And even with ICE vehicles, we understand that these will perform very differently when they're 15-40-years old compared with when they're new."

"Just check when you're buying an electric vehicle that it'll have the range to do the duty cycle that you want it to — not just straight off the forecourt, but 15 years down the line," advises Nick.

## Disposal concern

Another concern related to batteries is the disposal of and waste created by them. "The disposal and recycling of batteries is an area that is undergoing research. And we can't continue to supply all the batteries that are likely to be required without recycling them because there just isn't enough of the base materials available."

Addressing the concerns surrounding the carbon emissions of battery manufacturing,



*JCB has altered its internal combustion engine telehandlers and plant loaders to run off hydrogen without having to develop an entirely new fuel cell.*

Nick points out that with an electric car, once it's been driven 35,000 miles, it'll have paid off its carbon debt.

Battery systems can also be very expensive and are unlikely to reduce in price much in the long run, he adds. "Small vehicles with small batteries may be cost-effective compared with diesel over the vehicle's life (if worked hard enough). ▶

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# Alternative fuels



Steyr announced the launch of its hybrid CVT tractor in September. The tractor's E-CVT function means that this tractor is powered purely by hybrid-electric at up to 75kW and 1100rpm.

▶ The larger the battery gets, the harder it becomes to justify the price over the vehicle's life."

At present, a number of manufacturers have already produced commercially available small electric tractors, including Fendt which is launching its e100 Vario at Agritechnica. Currently, the overall package of size and weight of the energy storage unit and the available power only fits a machine between 50kW and 100kW, says Ed. "Research and development on batteries is continuing. It's therefore conceivable that in the future batteries with less weight and size will achieve a higher power density and longer range."

Merlo and Faresin have both produced fully electric telehandlers that are already available for use on farm. Merlo's eWorker has the capacity to work for eight hours without recharging and can lift to 4.8m, with a maximum reach of 2.6m and has a total

load capacity of 2.5t. Faresin's Full Electric range was launched in 2018 and has four-wheel steering and all-wheel drive. It has a small and large range, with total load capacity ranging from 2.6-4.5t and lifting height from 5.9-16.4, while the small range has a 24kWh battery capacity and the large a 45kWh one.

## Hybrid steyr

Taking a different approach, Steyr announced the launch of its hybrid CVT tractor in September. The hydro mechanical CVT drive to the rear axle and the hybrid module on the front axle means that although this tractor is based on the 180hp 6175 Impuls CVT platform, it has the power output of the larger model, which produces 260hp. The E-CVT function means that this tractor is powered purely by hybrid-electric at up to 75kW and 1100rpm.

Last year, John Deere launched

eAutoPowr, its first continuously variable transmission with an electro-mechanical power split. The transmission allows for up to 100kW of electrical power for external consumption. Along with Joskin, the firm has developed a slurry tanker with two electric drive axles. The eight-wheel drive system allows for a more efficient transmission of tractive power.

Because no single alternative fuel is being touted as the 'answer' to diesel, one of the issues for farmers is how many times they change direction before a permanent one is fixed. Nick admits that this'll be part of the transition process and that tractors are often changed on a regular basis, however, fuel suppliers also have to change their infrastructure. "There's a wider societal issue at stake based on the direction alternative fuels take.

"In my opinion, I think we have to change from diesel to another fuel now — which will likely be HVO. This'll probably be the case



The unique combustion properties of hydrogen enable the hydrogen engine to deliver the same power, the same torque, and the same efficiency that already powers JCB machines.

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until 2035 and then we'll possibly end up having to change again to something with lower emissions, which could be hydrogen."

It might appear there's no set direction in which fuel to adopt but Nick is in favour of multiple fuels being researched. "Anything that will reduce air pollution and contribute less to global warming now is a favourable alternative to diesel."

But before investing in a new fuel source, he flags that it's vital to understand the energy vector that's put in place is actually from a green source. "We're fortunate in this country that a lot of energy put into the grid is from a renewable source, but you still have to check."

Further considerations when adopting an alternative fuel is to train staff in using and storing them correctly, creating appropriate risk assessments, having conversations with insurance companies and involving local health and safety executives, advises Nick.

A significant issue with a lot of alternative fuels is the ability to refuel and diesel, FAME and HVO are still the most energy dense options. "The regularity of refuelling or recharging a vehicle will depend on numerous factors including how energy intensive an operation is, soil and weather conditions and crop type.

"Running out of fuel or charge in the field is a big issue and battery swapping in remote locations isn't yet viable. Neither can you hook up to the grid in each field, so you either have to get it delivered to the site or have another vehicle to tow the one which has run out of fuel. This will be an issue that will require adaption to overcome."

Developing new technology is a slow and iterative process, says Nick. "There's a lot



Last year, John Deere launched eAutoPower, its first continuously variable transmission with an electro-mechanical power split.

involved between the inception of an idea and looping the production process until a product is ready for commercial development. This is the case with hydrogen fuel cells — there are prototypes out there, but they're a long way off becoming a commercial product."

But as with everything, more money and investment is required to progress this area faster, says Nick. "Money rules everything. The same way that if manufacturers of equipment and fuel could make more profit they'd invest more, if farmers could significantly reduce their operating costs, they'd make changes right away. Our current system is built around fossil fuels, and we can't adopt a technology that will bankrupt us, so it's about looking at cost-effective solutions."

One way to make adopting new technologies more affordable is to apply for funding, but this is limited and competitive. "If you want to go down this route, I'd recommend finding a technology partner and involving a company like Cenex, as well

as approaching RASE or the NFU for advice. If you can get a working prototype on your farm, this is a huge plus toward winning funding."

The NFU would like to see more support from the government so that this emerging technology can be demonstrated more, says Jonathan. "We really have to see these funded so that they can go beyond the research and prototype phase. Farmers must be able to see low carbon agricultural machinery in action, they have to be able to drive it and try it out before they're going to invest."

Alternative technologies are coming through, but they have to be cost-competitive compared with existing options, says Nick. "Although it'll still be some time before true net zero tractors with a consistent power supply are available it's more important to understand that just because you don't feel it affect you now, it will in future. You're a steward of your organisation, so it's about taking steps to safeguard it and steer it for whoever will be operating it in 20- or 50-years' time." ■

A New Holland advertisement featuring a combine harvester and a truck in a field at sunset. The combine harvester is yellow and blue, and the truck is blue. The background shows a sunset sky with trees.

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