Comparing ways to tune an engine:

Walking a tightrope

Engine chip tuning manufacturers make plenty of bold claims about improving overall fuel economy and performance. But just how effective is this controversial technology? profi decided to find out by testing a chip box and a remap system at the DLG test station

hipping engines can lead to some very heated debate, but there is no denying that the practice is actively carried out across Europe. For some tractor operators it might be the carrot of reduced fuel use that leads them down the chipping road, while for others it's to gain extra power and performance. What few would deny, however, is that the relentless pursuit over the past decade of lower engine emissions has, in some cases, left Stage IIIA tractors struggling to match the fuel consumption performance of their 'dirtier' predecessors, and it is this, along with the escalating cost of diesel, that has probably done much to encourage farmers to experiment with chipping. Granted, the new and supposedly more economical Stage IIIB engines are now reckoned to be reversing the argument, yet the interest in chipping amongst the farming community remains.

So, how do these individual chipping systems 'trick' a tractor's electronic brain? And what effect do they really have on output and fuel consumption? To find the answers to these two common questions, profi has carried out some investigative work with the DLG test station in Germany. We looked at the two systems available – a chip tune box and a remap – on two different tractors. As usual, there are both pros and cons to each system: the chip tuning box can be easily removed; whereas remapping the ECU is said to give a slightly faster response, and it can be wiped off the tractor during a routine service software upgrade.

From the outset it's important to stress that all of the prices quoted in this article are for the German market and that there are several firms offering this service. Prices vary greatly, as do the standards of installation and the level of back-up. Speedhawk is just one firm that provides a plug and play auxiliary control box. Its XXL box cranks up the pressure in the engine's common rail by a maximum of 200 bar, so it can direct more fuel into the cylinder during the injection window. In effect, the control box increases the total amount of fuel injected relative to the load. Claims for this

box of tricks include a performance increase of at least 10% and a reduction in fuel consumption by as much as 20%. Eberl's approach is more intrusive and remaps the tractor's Electronic Control Unit (ECU) by altering multiple parameters. The programmers claim these changes can boost engine output by up to 20% and give diesel savings of 10-20%. The remap needs to be carried out by a technician, who plugs into the tractor's diagnostics socket to upload new software, and the cost typically ranges from , depending on tractor to subject size.

Our two test candidates were a Claas Axion 820 Cmatic, which relies on a DPS 6.8-litre engine to produce its 135kW/183hp, and a Deutz-Fahr Agrotron X720 with a 7.2-litre Deutz motor delivering 193kW/262hp. Both tractors had already completed some work before their time with us, so they weren't fresh off the production line.

To define our starting point we measured the two tractors in their original condition when they arrived at the DLG test station by sticking them on the pto test stand (see

> Under the spotlight: Two used tractors were plugged into a test bed at the DLG test station in Germany, so engineers were able to compare the effects of chip tuning on different engines. Photos: HW.



THE SYSTEMS IN COMPARISON

Speedhawk XXL

The Speedhawk XXL is an auxiliary control box that is plugged into the tractor just in front of the Engine Control Unit or ECU. It manipulates the electronic system by boosting the pressure inside the common-rail system as required by up to 200 bar, hence injecting a larger amount of diesel during a given time window. The manufacturer says this boosts the machine's performance by at least 10% and reduces consumption by as much as 20%. The Speedhawk box offers ten different setting options, although we didn't observe any difference between settings '5' and '9' in the default configu ration. The manufacturer says that it's easy enough to customise



the configuration to meet specific requirements. The Speedhawk XXL is plugged into the tractor electrics and comes with a remote control. The cost is excl VAT, which include updates every three years.



Remapping from Eberl

Remapping is a system that directly reprograms the vehicle's ECU by resetting a large number of parameters – from throttle pedal calibration and turbocharger boost pressure to the amount of exhaust gases that are recirculated by the engine.

The programmers say that this process can boost the engine's output by up to 20% and reduce consumption by up to 10-20%. Eberl sells its products in Germany through a network of dealers, who use a data reader to read out the engine software via a diagnosis port that the user emails to the manufacturer. After the upgrade, the data is fed back into the machine. The cost for this service is between and depending on the tractor size. Should the remap be wiped during a software upgrade by a dealer when servicing the tractor, it can be reloaded for a fee.



Speedhawk XXL nudged the full-load output curve upwards, generating an almost 25hp increase, and the torque curve benefited from a similar lift. Onboard tuning from Eberl, in contrast, gave the Axion a completely new engine performance graph. Output was hiked by 30hp at rated speed and a staggering 50hp when the engine was revving in its maximum speed range; and, on top of that, this impressive boost was achieved at a modest 1,700rpm rather than up at 2,000rpm. As for torque, the rise stat rocketed from 41% to a staggering 54%, while maximum torque soared from 800Nm to 1,000Nm.

Claas Axion 820: Relative and absolute fuel consumption Relative (g/kWh) Absolute (I/hr) l/hr 40 350 30 Eberl Onboard tuning Speedhawk XXL Standard non-tuned tractor 20 300 g/kWh 250 10 01.000 200 1 500 2.000 2 500 Engine speed (rpm)

The absolute consumption (litres per hour) was, of course, higher on the tuned tractor, because it generated a higher output. This wasn't the case with the specific consumption (gram per kilowatt hour). Specific consumption was much less after tuning with the Eberl Onboard system than with the Speedhawk XXL; this applied in particular to the 1,500rpm to 1,900rpm engine speed range.

page 17 'How the measurements were taken'). We then installed the tuning systems. kicking off with the Speedhawk XXL. On the Axion this kit consistently boosted output by 12%, with another 22-24hp in the 1,500-2,200rpm speed range. Torque also jumped from 800Nm to 900Nm, while torgue rise increased from 41% to 44%. The main downside here was that the exhaust gas temperature shot up by 70°C when the engine was revving in the lower speed ranges. And, on top of that, both the engine and transmission temperature, as well as that of the coolant, all climbed by around 10°C in the wake of the hotter exhaust gases, Even so, these rises didn't trigger any alarms.

Turning to the all-green machine, the Speedhawk XXL box on the Deutz added 20kW/ 27hp or 13% to the tractor's output and sent maximum torque rocketing from 971Nm to a whopping 1,100Nm. There was no effect on what was an already excellent torque rise on the standard tractor, and this could go some way to explaining why the Deutz engine reassuringly refused to hike its temperatures: the exhaust temp only climbed by 20°C on the Agrotron, while its oil and coolant warmed by just a modest 5°C. For



The Speedhawk box failed to reduce fuel consumption at any of the half-load speeds when compared with the original Claas Axion settings. Moreover, fuel consumption was significantly higher at two grid points. By comparison, Eberl Onboard tuning reduced consumption at all half-load speeds – sometimes by more than 5%.

this reason, Speedhawk reckons it could be possible to achieve a substantially higher boost – if it was deemed necessary and provided the programming was appropriate. Not surprisingly we found fuel consumption to be the most intriguing stat to scrutinise. Don't be misled by the actual litres per hour, because these figures simply increase in line with the extra output. More revealing is any change in specific consumption in grams per kilowatt hour.

On the Claas Axion 820 Cmatic, fuel consumption dropped only when the engine was revving in its top speed range and then only by a maximum of 4%. Once below 1,300rpm, we found the Speedhawk tuning box actually increased consumption substantially. In contrast, the tuning box made little difference to the Agrotron's fuel consumption, with the two 'before' and 'after' curves almost identical. Only minor difference was in the engine's mid-speed range, between 1,300 and 1,600rpm, where the result was 2% less than the original factory settings. It's worth adding that the DPS motor in the Axion used 255g/kWh when running at 1,700rpm, while the Deutz in its original guise was content with 233g/kWh in the same speed range, a difference of nearly 10%.

In the real world we know machines are as likely to spend just as much time working at half load as they are at full chat. Therefore we included these speed ranges in our



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The test candidates

We purposely picked two tractors that had clocked up some hours and were powered by two different engines. These motors also put in an appearance in other tractors.

Claas Axion 820: This has the same 6.8-litre engine from Deere Power Systems that can be found in John Deere's 6030 and 7030 series. In the Axion 820 Cmatic it has a rated output of 135kW/183hp (ECE R24) and a maximum boosted output of 152kW/ 207hp. When the test unit arrived at the DLG test centre it was showing 2,300 hours.

Deutz-Fahr Agrotron X720: This uses the 7.2-litre Deutz TCD 2013 LO6 4V motor that also powers Fendt's 900 series. The X720 model is rated at 193kW/262hp (to 2000/25EC), and the brochure claims a max output of 202kW/275hp. Our test unit had been operated by a contracting business to rack up 700 hours before it was delivered to us at the test centre.



Claas Axion 820 Cmatic



Deutz-Fahr Agrotron X720



The manufacturer emails the software update to the machine user, who saves it to a USB drive and imports it to the Speedhawk box.



A green LED signals the system has been switched on, and there's a remote control for powering the system on and off. Speedhawk has a choice of ten different settings, which users can reprogram to their particular needs.

tests as well, reverting to our five customary operating points at half load (see graphs 'Consumption at half load' on pages 12 and 16), as we do on our monthly tractor tests. These results show that the Speedhawk box failed to reduce consumption on the Claas Axion at any of the half-load speeds; in fact, it increased the consumption at two points. The Agrotron recorded an improvement of

Chip consequences:

The dark side of tuning

People generally accept that when they chip a tractor or other selfpropelled machine, they're saying goodbye to their manufacturerbacked warranty. Fair enough. After all, huge amounts of manufacturer time and money have gone into ensuring a particular transmission is capable of coping with, and making the most efficient use of, the power from its mated engine. Some owners will take a chance and swear blind that the machine has never been tinkered with to avoid loss of warranty status. Interestingly, though, one manufacturer has told us that Danish farmers are guite happy to announce that they intend to tune



The box is wired between the common-rail's pressure sensor and the existing electric line – potentially, quite a fiddle.

at least 3% at the lower engine speed and output ranges.

In response to the above test data, Speedhawk reckons the savings will be higher in the field where the engines are exposed to more frequent load changes. Also, the firm's new generation Speedhawk XXL box will feature multiple channel technology, allowing it to control the turbo as well.

Now for the Eberl system, which remaps the ECU software and, in doing so, alters a large number of the key engine parameters. The test measurements reflected this greater interaction, so that on both tractors the remap transformed the full load performance to dramatic effect. On the Axion, for example, it shifted the max engine output to a lower engine speed – from 2,000rpm down to 1,700rpm. To put some figures on this, there was an increase of 20kW/27hp

the tractor and are prepared to live with the consequences.

Meanwhile in Austria and Germany there have been reported cases of tractors being checked by government officials. If the tractor has been tuned, then it no longer meets the machine's original type approval, voiding insurance/tax and unleashing a whole can of potential nasties on the machine's owner. Some chip makers have been working with officials to overcome these various issues.

Understandably, mainstream tractor manufacturers are constantly trying to increase the protection against such systems.

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Deutz-Fahr Agrotron X720:



Speedhawk XXL is installed as an external unit and increased the Deutz-Fahr engine's power by nearly 30hp throughout all speed ranges. At the same time, it boosted maximum torque from 970Nm to 1,100Nm. The remap curves produced by the Eberl system looked very similar. Maximum torque was 1,140Nm, which was only slightly higher; also, the curve was less erratic.

at 2,200rpm and the max output stat soared by 36kW/49hp to a peak of 178kW/243hp at 1.700rpm, as previously mentioned. And it was a similar story with the torque figures. The 41% original rise figure rocketed to 54%, while max torgue leapt from 800Nm to 1,000Nm, and, importantly, these boosts only had a minor impact on exhaust temperature, which rose by 20°C. Of more concern, though, was the 15°C increase in oil and coolant temperatures, and the fact that the Cebis terminal started throwing up high injection pressure errors when working in the field – clear evidence of a tuning system undertaking its role with perhaps a little too much enthusiasm. In response, Eberl says this suggests an incorrect set-up.

As for the Eberl's effect on the Deutz, the Agrotron 720's pto output at rated speed climbed from 156kW/212hp up to 179kW/ 243hp, and max output headed in the same direction – from 182kW/248hp to 200kW/ 272hp at 1,900rpm. In terms of torque, the biggest change was observed in the lower engine speed range: max torque jumped from 970Nm at 1,600rpm to 1,140Nm at 1,500rpm; and, at the same time, start-off torque went from 108% to 119%.



Consumption of the Deutz engine in the lower speed and output ranges tended to be about 3% lower when tuned by Speedhawk. The effect is more visible after 'onboard-tuning' with the Eberl system. Here consumption at all half-load grid points was significantly lower than the consumption of the standard spec tractor.

On fuel use, the Eberl remap managed to peg back the Axion's specific consumption by 12% at full load. And the same applied to the Deutz, which, to be fair was already an economic engine; nonetheless the tuneup still cut thirst by 9%. Continuing the fuel reducing theme, consumption at half load was lower on both of the tested tractors. To put all of this into practical farming context, the Axion, for example, supped nearly 40 litres/hour on heavy draft work in the field before being tuned. After tweaking, it was burning only 35 litres/hour while doing exactly the same type of work, so giving a valuable saving of 5 litres/hour. This was largely down to the tuned tractor being able to operate at half load while the standard, non-tuned tractor was working further up its load curve.

Summary: Speedhawk charges for its XXL box of tricks, which is straightforward to install and remove. This external control box increases the pressure in the commonrail injection system so more fuel is blasted into the combustion chamber. It boosted our test tractor output by more than 12% both on the Claas Axion and the Deutz-Fahr. Not so impressive, however, the XXL system had almost no effect on fuel consumption, which was reduced by less than 5% at full and half load.

The remap from Eberl costs up to and needs to be installed by a service engineer, who will change a number of control variables. These have a dramatic impact on the





Speedhawk XXL left specific fuel consumption more or less at the same level as on the original non-tuned engine. The benefit of this system was that it delivered a higher output. The remap from Eberl, in contrast, achieved significant savings in the mid-speed range, where it trimmed fuel consumption on the already economical Deutz Agrotron engine by up to an impressive 12%.



Eberl uses a reader to send the engine software data through a diagnosis output, and then reads it back into the box after tuning.

torque curve, output and consumption. In the case of our two tractors, they delivered up to 25% more output while specific fuel consumption dropped by about 12%. All of these advantages are useful, if – and it's a big 'if' – you're prepared to effectively 'run the gauntlet'. As well as possible legal

How the measurements were taken

To simulate a real-life situation (see 'The test candidates') we specifically sought out two tractors that had already done some work. And to make the tests as independent as possible and guarantee repeatability we shipped the two units to the DLG test facility, where we carry out our regular tractor tests. Here, output and consumption were measured in compliance with the OECD standard. For this the induction air and fuel are kept at consistent temperatures, while the engine- and transmission oil temperatures, as well as those of the coolant and fuel, are also recorded. In

and warranty ramifications, owners must consider the higher oil and coolant temperatures, as well as the hotter exhaust gases during permanent operation or when radiators start to become clogged. Who's to say if and when these factors will make their presence felt – and at what cost? addition, the engineers note the exact speed of the radiator fan, because this item alone has an input requirement of up to 15kW at full speed. Both of our test candidates were given an initial test check-up to determine their original condition, and their full load curves and five grid positions in their half-load curves were also studied. We then tested both tractors with our featured tuning kits, starting with the Speedhawk and repeating the tests with the Eberl remap. To give an idea of the type of testing completed, we managed to burn more than 1,000 litres of fuel.

Although the latest Stage IIIB engines might offer improved performance and fuel consumption, as witnessed by our own tractor tests, engine chip manufacturers are already tempting tractor owners with the prospect of disabling SCR systems.

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