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Gea DairyRobot R9500 Monobox:

Welcome to Formula 1

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Gea's latest single-box milking robot, the Monobox DairyRobot R9500 Edition 2021, was put through the DLG test last September.

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With electricity an increasingly expensive cost, and much more attention being paid to the total amount of water used on farms, these two consumables are becoming more important than ever when comparing all of the different automatic milking systems. In the past, farmers had to rely on manufacturer information, but today they can get hold of independent data.

Back in 2014, the German Agricultural Society (DLG) debuted the world's only test carried out to a set standard for measuring all the various consumables under lab conditions, allowing the tests to be repeated on different makes of robot. In conjunction with the calculation model developed by the Bavarian State Research Centre for Agriculture (LfL) and profi, the test results allow farmers to compare various consumption figures for different scenarios.

Gea shows commitment

When profi asked Gea in 2018 to submit a milking robot for the consumption tests, it not only supplied the Monobox design that was launched in 2016, but also its two-box system introduced in 2017. Great news for us and you, too, as we were able to compare both set-ups.

Our conclusion at the time was that when it comes down to electricity consumption, the

KEEPING IT BRIEF

After 2018, Gea had its DairyRobot R9500 robot measured for a second time by the DLG.

Compared with the 2018 results, the Monobox consumed up to 37% less electricity per 100 litres of milk in the bulk tank.

Water consumption fell by around 12% for all four scenario farms.

To ensure that all of the sensors function properly, the DLG always conducts its tests with milk in the system. This was also the case with the Monobox.

The DLG tests are carried out to a set standard. This includes three different milk curves to simulate different milking speeds.

The Atlas Copco SF22 compressor has a nominal output of 2.2kW.

No brushes required here – the Gea system cleans the teats inside the cups.

Monobox scored good results. Indeed with a few minor tweaks and improvements, these would have been exceptional. The water consumption was not so good; in fact it was 30% higher than the reference value (see profi 5/2019 for the complete report on the Monobox unit and 10/2019 for the two-box system).

Gea listened, and two years ago the company launched a fully updated version of the DairyRobot R9500 – the Edition 2021. From the outside, it looks pretty much the same, but the new robot is claimed to have lots of technical changes that boost its efficiency. In optimal working conditions, the Edition 2021 version will attach all four cups in just 15 seconds.

The maker points out that valuable seconds can also be gained by having the processes overlap. This includes items such as starting mechanical stimulation earlier, while the teat cleaning is simultaneously happening inside the teat cup. This Formula 1 pit-stop-style tuning saves up to 26 seconds per milking. Assuming 60 cows are being milked by each robot with an average of 2.7 milkings per day with a flow rate of 2.0l/min, this adds up to an eyebrow-raising saving of 70mins per day.

Improved cleaning

Gea relies on circulating chemicals to clean the pipework. Compared to systems using boiling water, the cleaning periods are up to 15mins longer and the energy consumption is higher due to the additional return line that is required.

Here is the first result of the latest DLG test: energy consumption was significantly lower, which is mainly attributed to downsizing the water heater (it is now 120 litres compared with previously being 1,000 litres) and by lowering the water temperature from 80°C down to 60°C.

Our test measurements don't reflect the so-called selecting mode which was part of the Edition 2021 revamp. Fresh cows or those undergoing treatment can be selected at the touch of a button to form a group within a group. The animals are no longer randomly milked but in order. So, instead of carrying out an expensive main clean after each cow, a 5.5-minute localised clean of the teat cup and the receiver assembly, once the last animal in the group has been milked, is used. Hence, the new selecting mode saves time, water and electricity.

Our measurements

For every 100 litres of milk in the tank, the Edition 2021 with one milking box requires 2.1kWh of electricity as well as 37.6 litres of water on an average AMS farm (Scenario 3). Compared to 2018, this is a 22% reduction in electricity use and 12% less water. On this dairy farm with 150 milkings and three main cleanings, the daily consumption rates are 33.6kWh for electricity and 604 litres of water.

On the Scenario 1 farm, which is optimised for robot milking, the R9500 achieves even more savings, as it uses only 1.4kWh per 100 litres of milk in the tank. Compared to 2018, this represents a reduction of 37%. Water consumption is now 644 litres, a 12% drop from 737l in 2018. Up to now, only double-box systems have proved to be this frugal.

Why are the cost savings much greater on the optimised farm (Scenario 1) rather than the average farm (Scenario 3)? The answer can be found in the cleaning systems. The optimised operation uses 45°C water, which is sourced from the plate cooler. Compared to 12°C water from the mains, this saves 1.8kWh with each main cleaning.

With the heat recovery and going with three main cleanings, daily energy consumption is 5.5kWh lower. At a price of 40 cents/kWh, a plate cooler saves €803 per year. This just highlights how good management pays off, even when the tech is already economical.

Small things, big effects

If you study the results even closer, you'll see the manufacturer's statements about the updated Edition 2021 features are true.

- Compared with the 2018 robot, which used 260Wh per milking (slow milkers 9.3 litres in 10.5 minutes) the updated version uses just 190Wh.
- Although there was an undiscovered leak in the line in 2018, Gea was able to almost halve the consumption with 59 litres of compressed air per milking. The average AMS farm scenario saves 4kWh per day.
- As in 2018, Gea continues to supply its RPS400 vacuum pump. Further fettling has

This time the water heater was significantly smaller, holding a total of just 120 litres.

HOW THE MEASUREMENTS WERE TAKEN

Gea delivered a DairyRobot R9500 complete with one milking box to the DLG, in Groß-Umstadt, Germany, in September 2022. Over the course of the three-day test, a Gea service engineer was on hand to ensure the machine was performing as it should.

The standard Monobox had neck detection technology (CowScout) and a concentrate feeder for one liquid and three solid components. Compressed air was supplied by an Atlas Copco SF22 FF scroll compressor, which has a 2.2kW motor.

Consistent measurements

As with our previous milking robot tests, we used UHT milk (1.5% fat) and the same standards, following a strict timetable and procedure: each milking process starts with opening and closing the gate and simulating feeding a concentrate. The robot then cleans and stimulates the artificial udder.

After attaching the cups, the udder's solenoid valves regulate the milk so it is not instantly flowing from all four quarters – just like from a real cow. In addition, the technology differentiates between three milk flow curves so that the milking of slow, fast and very fast milkers can be simulated.

- For fast-milking cows, the measurement technology takes into account a peak milk flow of up to 3.5l/min and a total milking of 11 litres.
- For very slow milking cows, the milk flow is a maximum of 2.0l/min (milking capacity: 10 litres in 8mins).
- For super fast milkers (up to 6.0l/min milk flow), the technology simulates a volume of 12.5 litres per milking.

After removing the cups, the box opens and closes the gate; there is a one-minute pause so that processes such as pumping the milk are fully recorded by the DLG measuring instruments. Each of the measurements, which must be repeated at least five times, lasts up to 12 minutes.

The influence of the cleaning system

Automatic milking systems (AMS) use most of the energy and water to clean the milk-carrying components. A distinction must be made here between the main clean, system rinse including the line to the tank, local cleaning and a local intermediate rinsing.

The main cleaning is where all milk-carrying parts on the machine and the 25m long pipe going to the bulk tank are washed with hot water and a chemical. Since the temperature of the water being supplied and used for cleaning has a massive influence on consumption levels, measurements are taken with 12°C and 45°C water from the supply line.

The system rinse (called interval rinse by Gea) takes place between the main cleaning depending on the time and/or utilisation of the machine, including the line to the tank, which is rinsed with cold water. With the Gea system, however, the measurements were carried out with water that was at least 35°C, as experience shows that protein and fat dissolve better at this temperature.

The local or intermediate rinsing (Gea: box rinsing) includes rinsing the teat cups and the pipes up to the cabinet using 35°C warm water but no chemicals.

A local cleaning (Gea: box cleaning) is similar to local rinsing, but instead the wash is done with chemicals and warm water. Local cleaning is always necessary after milking a cow that is undergoing treatment with an oil-based product, for example.

In addition to water and electricity consumption, the DLG test also records consumption of peracetic acid, acidic and alkaline detergents and teat dips.

A service engineer was on the scene to ensure the system was working properly, fine-tuning the various settings to optimise performance.

allowed it to reduce consumption by up to 20Wh/milking – that's up to 2kWh per day.

- Consuming only 1.03Wh in maintenance mode, the hot water header, which now only holds 120 litres, makes a significant reduction in electricity consumption. In 2018, the 1,000-litre water heater had a standby consumption of 6.89Wh/min; in 2022, the 120-litre water heater used just 1.03Wh/min. This saving may not sound like much, but it adds up to a significant 8.6kWh/day.

Summary

Last autumn, Gea provided its DairyRobot R9500 milking robot for a second DLG test, the first having taken place in 2018. This latest version, the R9500 Edition 2021 unit, features several improvements to reduce electricity use; the downsized 120-litre water heater is among them.

After evaluating the results, Gea really didn't promise too much when it launched the Edition 2021 (see profi 9/2022). The unit achieves electricity savings of 21% to 37%, depending on the scenario. And in terms of water, the updated model uses around 12% less than the first generation R9500 we tested in 2018.

The consumption of peracetic acid, teat dips and detergents was also recorded as part of the test. Cleaning times can be longer.

Gea engineers would seem to have turned every stone, fine-tuning all elements of the milking system. This is highlighted by the consumption level in standby mode (without water heater), which dropped from 165Wh to 107Wh. It may not seem like much, but it translates into a saving of around 508kWh in a year. So, even the smallest adjustments will pay off. Welcome to Formula 1.

Martin Zah

DEAR READER,

Testing an automatic milking system (AMS) generates a huge amount of data. In order to translate this into something with more practical relevance, as we do with the *profi*-Powermix tractor tests, we developed four scenarios under the guidance of Dr Jan Harms from the Bavarian Institute of Agriculture along with input from various machine makers. These scenarios simulate consumption in four farming situations: Scenario 1 reveals the consumption levels that are most likely to be found on a livestock farm where the herd is geared up for robots. Scenario 2 reflects the figures of a non-optimised farm with poor herd management. Scenario 3 describes consumption on an average AMS farm. Scenario 4 shows how low consumption can be if both the management and the cows are of the highest quality.

Our four scenarios illustrate the consumption of the Gea R9500 in real-life conditions. There are savings when compared to the original version.

SCENARIO 1

Optimised AMS farm

Scenario 1 is the farm geared up for robotic milking so that only the fast-milking animals are milked in the Monobox. Slow milking cows

are milked separately in a parlour. This is how the optimised AMS achieves 170 milkings per day – and an excellent utilisation of the robot.

A main chemical cleaning with at least 45°C in the return flow takes place three times a day. In order to save energy, the optimised operation has connected its AMS to the plate cooler, so that the temperature of the supplied water is 45°C.

In addition to three main washes, Scenario 1 also requires a local intermediate rinse every day. Instead of cold water, Gea uses warm water of at least 35°C in the R9500 to remove fat and protein more effectively.

Result

With 170 milkings and 11 litres per milking, the optimised farm in Scenario 1 collects 1,836 litres of milk in the tank per day. Based on 100 litres of milk in the tank, the farmer only needs 35.1 litres of water and 1.4kWh of electricity.

One day's electricity use in optimised AMS operation with one milking robot amounts to 25.2kWh. At price of 40 cent/kWh, electricity consumption costs €10.08/day. Water use is 644 litres per day or 235m³ per year.

SCENARIO 2

Non-optimised farm

In the second scenario, there are only 120 milkings per day, as there aren't enough cows, so the robot is not utilised to the maximum. At the same time, the management doesn't optimise processes for improving consumption. These are mostly slow milking cows, which aren't milked to any specific plan. Animals undergoing treatment are not milked in a separate group but together with the herd, which requires four main cleans per day. As there's no plate cooler to pre-warm the water, the 120-litre water heater is supplied with cold water.

If the system is idle for a length of time during the night, the system must be flushed with clean water up to the tank. Scenario 2 also requires three local intermediate rinses to wash the milk-carrying parts up to the end unit after milking a defined group of animals.

Result

Over 24 hours, the Scenario 2 farm requires 34.6kWh of electricity. Although it only has 1,168 litres of milk in the tank in the evening, the water consumption of 629 litres is nearly the same as that of an optimised farm.

Converted to 100 litres of milk in the tank, the farm needs 53.8 litres of water and 3.0kWh of electricity. Comparing this consumption with the top notch Scenario 4 farm, we find the premium operation has a 44% lower use per 100 litres of milk in the tank.

SCENARIO 3

Average AMS farm

The third scenario shows the consumption on an average AMS farm. This farm mainly owns cows that can be milked well and quickly. Due to lack of time and other options, all animals in the herd are milked by the robot. The cows with health issues are milked separately and/or put into small groups by accessing the separation mode. This way, only three main cleanings are required per day.

As there is no heat recovery, the boiler first has to bring the 12°C cold water up to the cleaning temperature of 45°C in the return line. Once a day, the Monobox receives a local rinse and a system flush including the milk line to the tank.

Result

This farm puts 1,605 litres of milk into the tank every day. To do this it uses 33.6kWh of electricity and 604 litres of water. For every 100 litres of milk, the robot uses 37.6 litres of water and 2.1kWh of electricity.

Comparing these results with the 2018 test figures, the Monobox uses 24% less electricity and nearly 13% less water in Scenario 3.

SCENARIO 4

Fast milking cows

Today, more dairy cows are high-performance milkers. This situation is reflected in Scenario 4 which is based on 170 milkings, 12.5 litres per milking and a milking rate of up to 6.0l/min.

Thanks to good management, only three main cleanings are needed per day. However, the robot's internal boiler is not supplied with warm but 12°C cold water. Once a day, the teat cups receive a local rinse including the milk line to the cabinet.

Result

The high-performance farm puts 2,125 litres of milk into the tank. Due to the improved utilisation of the robot and excellent milk yields and rates, consumption is very low – only 1.7kWh and 30.3 litres of water are required per 100 litres of milk in the tank. The daily consumption adds up to 35.8kWh of electricity and 644 litres of water.

Compared with the 2018 test results, water consumption is 12% lower and electricity savings add up to 21%.

Martin Zäh

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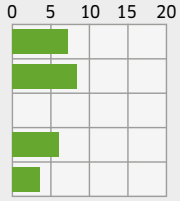
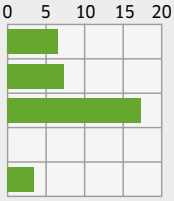
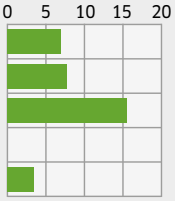
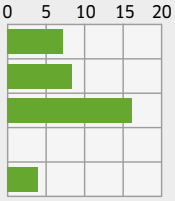
GEA DAIRYROBOT R9500: CONSUMPTION RATES BY THE GEA

	SCENARIO 1: OPTIMISED FARM	SCENARIO 2: NON-OPTIMSED FARM	SCENARIO 3: AVERAGE AMS FARM	SCENARIO 4: FAST MILKING COWS
ELECTRICAL ENERGY CONSUMPTION (KWH/DAY)				
Electrical energy consumption (kWh/day)				
Compressor				
Vacuum pump				
Water heater: Cold water supplied				
Water heater: Warm water supplied				
Remaining milking system				
Total power consumption/day	25.2kWh	34.6kWh	33.6kWh	35.8kWh
CONSUMABLES USED PER DAY				
Water	644 litres	629 litres	604 litres	644 litres
Peracetic acid	578g	408g	510g	578g
Acidic detergent	206g	275g	206g	206g
Alkaline detergent	429g	572g	429g	429g
Teat dip	2,057g	1,470g	1,817g	2,129g
CONSUMPTION PER 100 LITRES MILK (AMS WITHOUT TANK)				
Water	35.1 litres	53.8 litres	37.6 litres	30.3 litres
Electricity	1.4kWh	3.0kWh	2.1kWh	1.7kWh
The four scenarios applied for the calculations	170 milkings/day (AMS-optimised farm, all animals are fast milking) three main cleanings (45°C from the heat exchanger); one local, intermediate cleaning per day	120 milkings/day (35 fast and 85 slow milkers, poor management); four main cleanings, (without heat exchanger, cold water); one system cleaning, three local, intermediate cleanings; one local, intermediate cleaning; system idling time per day: 211 minutes	150 milkings/day (140 fast and 10 slow milkers, average management); three main cleanings (cold feed water, no heat exchanger); one system cleaning, one local, intermediate cleaning; system idling time per day: 150 minutes	170 milkings/day (excellent milkers: 12.5 l/milking, average 2.9l/min, good management); three main cleanings (cold feed water, no heat exchanger); no system rinse; system idling time per day: 72 minutes

DATA SHEET

Design	Single-box system, machine software 1.7, central utility cabinet for up to four milking boxes supplying electricity, compressed air, vacuum, water and cleaning, frequency-controlled milk pump
Power supply	2.5kW/16amps
Vacuum pump	RPS400, 1.1kW, 400V, frequency-controlled; 400l/min at 50kPA
Utility cabinet input power	6.0kW/32amps, 120-litre water heater
Teat cleaning	In liners (In-Liner-Everything)
Compressor	Atlas Copco SF2; with integral cold air dryer, 4.2l/sec at 8.0 bar; 2.2kW power supply
System wash	Circulation cleaning, min 45°C in return line. Cleaning types are system cleaning, box cleaning, box rinsing, interval rinsing, wetting and soaking the floor and end frame
Optional features	Cell count measuring, peracetic acid disinfection, feed dispenser
Price for the test specification model	Approx. €100,000 with 60 collars; excluding installation

Manufacturer information