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30% electricity saving

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We know from the May issue how much water and electricity a single GEA Monobox milking robot uses. But what happens to the measurements when you add a second box? It's not necessarily as straightforward as simply 'doubling the consumption and costs'. Photos/graphs: Stefan Tovornik.

Back in the May issue we brought you the results of our DLG test on a single Monobox focusing on electricity, water and chemical usage. And, just so you are aware, at EuroTier last year GEA announced it was changing the name of its single-robot Monobox to the somewhat less catchy DairyRobot R9500 ... hence we switch to the new range name.

So back to the test. Originally we planned on publishing the single- and double-box tests closer together, but things suffered a bit of a delay when we looked at the measurements. Our test procedure had been developed for a single box and could not be applied to a two-box set-up. On a two-robot system some of the processes run in parallel while others are carried out individually. Then there are the 'silent' consumers such as the water heater that maintains the pre-set temperature regardless of the amount of water being used.

We could have made things easy by simply using the daily consumption figures, but then you couldn't drill down to the detailed findings. So, along with the milking equipment makers, the DLG and Dr Harms, from the Bavarian Institute of Agriculture, we developed four scenarios similar to those used in the tractor Powermix tests. Each scenario represents one type of farm. Now you can glance at the water and electricity consumption for your farming system to compare the figures.

Here is a rough outline of the DLG tests and results. The measurements were carried out using milk as the test liquid and a 25m long milk pipe as well as a 5.0m length going to each box. Under standardised conditions, the DLG test station simulated three different flow curves:

- First curve – fast-milking cows that achieve an average flow of 2.1l/min with a maximum of 4.0l/min
- Second curve – difficult-to-milk cows. The average flow was pitched at 0.9l/min and at most 2.0l/min
- Third curve – very-fast-milking cows with a maximum flow rate of 6.0l/min and individual yields of 12.5 litres.

Admittedly, milking is only one of several duties undertaken that consumes electricity, but the comparison shows the differences between the single- and dual-box systems are substantial. Electricity consumption for the GEA Monobox was 258Wh when milking difficult cows. In comparison the two-box set-up used just 181Wh per box, which is over 30% less. The results were similar when we simulated milking fast milkers (197Wh and 132Wh) and very fast cows (192Wh and 130Wh).
This reduced consumption trend with the second robot is thanks to several components being shared. One example is the cold air dryer for the compressor, which runs 24 hours per day irrespective of how often the compressor is starting.
This more efficient system usage also applies to the system wash. What you need to know here is that GEA actually used an oversized water heater (1,000 litres) for this test. The consumption of the water heater in standby mode alone was nearly 10kWh per day, which is necessary to maintain the 85°C temperature. If 1kWh costs €0.25, then standby mode costs €2.50 per day. If the system is a two-box set-up, then this cost is shared.

The details: Using cold water for the main cleaning on the Monobox consumes 2.87kWh, whereas two boxes consume just 1.94kWh per box. This means the second box saves around one third in electricity use. These savings accumulate to 2.79kWh over the three main cleanings.
If the water is heated to 45°C by the plate cooler, for example, two boxes will also save 30% in electricity during the main clean.
For the main clean GEA relies on circulation cleaning as well as chemicals. Cleaning all systems and the pipe to the bulk tank takes 21.5 mins. Each main clean starts with a rinse to remove protein and milk fat at almost 40°C. This initial rinse is followed by the main clean, which uses water heated to at least 65°C. Until the target temperature inside the cleaning tank reaches 85°C, hot water is constantly flowing in. The detergent is metered into the water proportionally. Finally the whole system is given a cold water rinse.
The best part here is that 20 litres of water are collected inside the cleaning tank of the supply unit at the end of the last rinse. This water is reused for a post-rinsing cycle and in the next main clean. This 20 litres may not seem a lot, but in a double-box system it takes just 67 litres for a main clean on each robot. Compare this with the main clean on the Monobox, which used 82 litres of water in the DLG test.

Teat cleaning and dipping operations take place inside the teat cups on the GEA DairyRobot.

water. A system rinse is carried out if the boxes are not in use for a length of time such as during the night. Again, the energy and water consumption for this cleaning is shared between two boxes, so you save again: the duel box uses 232kWh compared to 298kWh for one box and only 7.2 litres of water instead of 10.4 litres of water for one box.

A few words on water and consumables, with the two-box DairyRobot R9500 consuming 6.0g of teat dip and more than 14.0g of peracetic acid. All processes such as dipping are carried out on individual animals so there are no differences. The same applies to rinsing the TOF camera, which detects the teats; this takes 130ml of water after each milking. In all, the DLG measured 2.9 litres of water after each milking, which is split between cleaning the teats, diluted water for the peracetic acid for the intermediate cluster disinfection and removing the teat dip. It is also worth

By replicating various milk flow rates, the DLG measures electricity consumption relative to the milking performance of the cows. The difference between one- and two-box electricity use is surprising.

In parallel, detergent consumption drops from 260g to 180g per box when you switch from a single- to a double-box system.
GEA gives the option of carrying out a local clean in addition to the main clean. This is done after cows undergoing treatment have been through, so only the components in contact with the contaminated milk are cleaned with hot water and chemicals. This local clean takes exactly 9mins and consumes 1.3kWh, 42 litres of cold water to the heater and 146g of alkaline detergent.
The interval or system rinse cleans all elements up to the milk separator with 35°C hot

noting that following the in-liner principle GEA sprays teat dip onto the teat at the end of each milking. The water use mentioned does not include the 2.9 litres of water needed after every third milking to rinse the floor of the box and flush the dung trough.
If your head is starting to melt with all these figures, don't fret: you'll find typical farm scenarios on the next page. Each scenario is combined with the DLG measurements on model farms. To make it easier to compare we have a 'consumption per 100 litres' figure so you can see how much water and electricity is used with two DairyRobot R9500s.

Scenario 1

The optimised AMS farm

Scenario 1 is the farm geared up for robotic milking. Here slow-milking cows and those getting treatment are put through a parlour and not the robots. The two-box Automated Milking System in Scenario 1 completes 340 milkings per day – hence usage is excellent.

The main clean is carried out simultaneously on the two boxes. This is the case in all scenarios. As recommended by the robot manufacturer, the main clean is done three times per day. The water used for this main cleaning process is heated to 65°C, again as stated by the manufacturer. For this purpose, the water heater is supplied with 45°C water, as it would be from the plate cooler.

The main clean is supplemented by a local intermediate clean once per day. Although this job could be done with cold water, GEA uses warm water in order to remove milk fat.

The result: Doing 340 milkings per day with an average 10.7 litres per cow, the dual-box system in this scenario puts 3,638 litres in the bulk tank. For every 100 litres of milk the R9500 uses 38.4 litres of water and 1.51kWh of electricity. The farm's total consumption of electricity is 49.6kWh and 1,409 litres of water. Idle time for the two boxes is just 80mins per day.

Scenario 2

The non-optimised farm

This scenario is based on slow-milking and low-yielding cows, so the robots are not being used to their full capacity. All cows are milked via the robots regardless of whether they are undergoing treatment or not, so it's necessary to carry out four main cleans per day. Electricity use is higher because there is no plate cooler. This means the heater has to bring the cold water up to temperature.

In addition a cold system clean to the tank is needed after the system has been idle for a longer time. There are three local intermediate cleanings with warm water after milking defined animals, for example. This rinses all components that come into contact with milk from cows undergoing treatment.

The result: After 24 hours, Scenario 2 farm has milked 2,245 litres and used 63.3kWh of electricity and 1,321 litres of water.

For each 100 litres of milk, the farm used 56.6 litres of water and 2.71kWh of electricity. This is almost twice the electricity consumption of Scenario 4. Idle time was a theoretical 183 mins.

Scenario 3

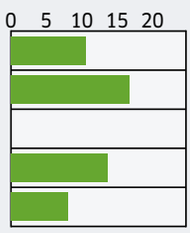
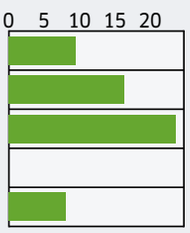
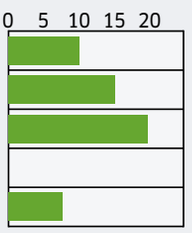
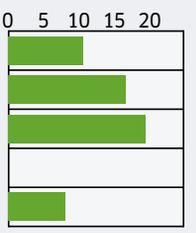
The average AMS farm

The herd is made up of easy- and fast-milking cows. All milking is done by the two robots due to lack of time and any other options. The animals with health issues are milked in an organised way. This type of management allows the farm to carry out just three main cleans, which are recommended by the manufacturer. However, the heater is supplied with cold water so each cleaning uses more electricity. Once a day each box receives a system clean and a local intermediate wash.

Each GEA robot has a reservoir for the milk destined for the bulk tank and a reservoir for separated milk. This reduces the number of necessary cleanings when cows are undergoing treatment.

In practice, as in our scenarios, electricity and water consumption is not only down to the system itself but also the management of the herd.

CONSUMPTION RATES BY THE GEA MONOBOX (SINGLE-BOX) MILKER

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Electrical energy consumption (kWh/day)				
Compressor				
Vacuum pump				
Water heater: Cold feed water				
Water heater: Warm feed water				
Remaining milking system				
Consumables used per day				
Water	1,409litres	1,321litres	1,308litres	1,409litres
Peracetic acid	4,930g	3,480g	4,350g	4,930g
Acidic detergent	547g	729g	546g	546g
Alkaline detergent	528g	704g	528g	528g
Teat dip	1,913g	1,346g	1,687g	1,904g
Consumption per 100 litres of milk (AMS without tank)				
Water	**38.4litres**	**56.5litres**	**40.8litres**	**33.2litres**
Electricity	**1.51kWh**	**2.71kWh**	**1.82kWh**	**1.43kWh**
The four scenarios used for the calculations	340 milkings/day (AMS-optimised farm, all animals are fast milkers); three main cleanings (45°C in the feedline or water from the heat exchanger), one local, intermediate cleaning. System idling time per day: 80mins	240 milkings/day (70 fast and 170 slow milkers, poor management); four main cleanings (cold feed water); one system cleaning, three local, intermediate cleanings. System idling time per day: 183mins	300 milkings per day (280 fast and 20 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: 199mins	340 milkings/day (very fast milkers, 12.5l/milking, 2.9l/min, good management); three main cleanings (cold feed water, no heat exchanger); no system cleaning; one local, intermediate cleaning. System idling time per day: 80mins

DATA SHEET

Single-box system	**Machine software 50.2018**	Milk pump	**0.55kW; frequency controlled**
Power supply	**2.5kW, 20amps**	System wash	**Chemically from 65°C**
Teat cleaning	**In liners**	Utility cabinet	**0.37kW, 16amps**
Cluster disinfection	**Peracetic acid**	Water heater	**1,000 litres, Reflex 5E 377-EFHR; 16kW; 400V**
Milk separation	**MS1 (milk from multiple farms)**		
Concentrate feed	**Coarse meal, pellets**	Compressor	**Atlas Copco SF2; with integral cold air dryer, 2.2kW, 400V; 7.8 bar, 240 litres/min**
Vacuum pump (RPS 1200)	**3kW; frequency-controlled**		

The result: The farm in this scenario finishes the day with 3,172 litres of milk in the tank at the expense of 53.3kWh of electricity and 1,308 litres of water.

For every 100 litres of milk, the robot uses 40.8 litres of water and 1.8kWh of electric. Comparing these figures with the earlier Monobox results shows electricity consumption was reduced by 32% and water consumption by just 5% (2.4 litres). Idle time is 199mins per day.

Scenario 4

Fast-milking cows

This is the dairy farm where the focus is on high-performance milkers. There are 340 milkings, with each one averaging 12.5 litres. The cows produce 6.0l/min. Thanks to good management the farm only needs to do three main cleans per day as recommended by the maker. The water supplied to the heater is already warmed to 12°C. Idle time is just 80 mins per day, providing enough time for one local intermediate wash.

The result: This farm with very-fast-milking cows puts 4,182 litres in the tank. The high usage of the robots, along with high animal performance, reduces consumption rates to 1.43kWh of electricity and 33 litres of water for every 100 litres of milk. Daily consumption amounts to 55.1kWh of electricity and 1,409 litres of water.

Summary: Our previous milking robot tests have focused on single-box set-ups with the GEA Monobox in the May issue. Now we have test figures for a two-box DairyRobot R9500 which, at first glance, can be confusing. The good news is the excellent consumption rates of the Monobox are even better with the two-box set-up – 30% lower results. Indeed the figures could have been even better if GEA had used a smaller water heater in the tests. The saving, however, was not repeated in the total water consumption measurements, which can be explained by what GEA calls the in-liner principle. This means the teat cleaning and dipping, as well as other milking processes, are carried out in the teat cup.

Martin Zah/Mervyn Bailey