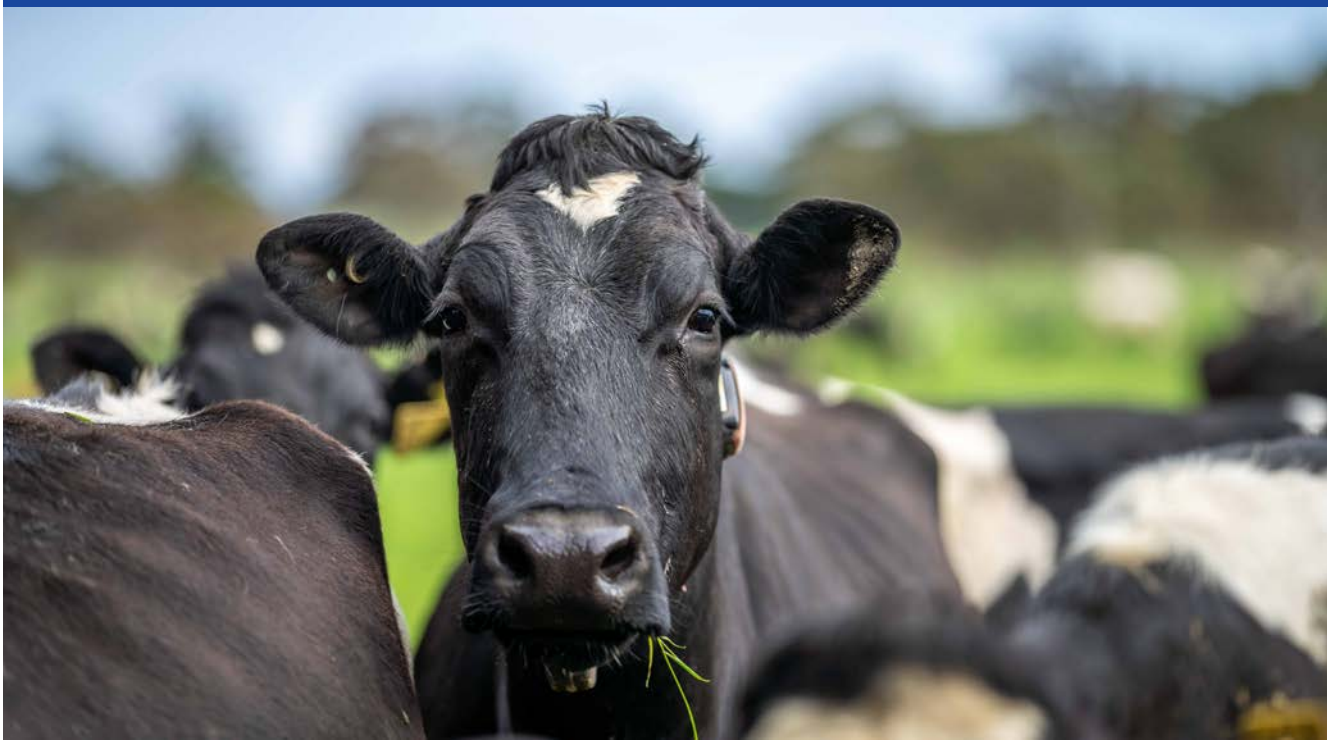
WATER AND AGRICULTURE

How much water does a milk cow need? Study looks to save water in dairy industry

A study of water use on dairy farms in the Eastern Cape found numerous ways to improve their water use efficiency, with astounding financial benefits to the farmers who participated. Article by Petro Kotzé.



Milk production is the fourth largest agricultural sector in South Africa. In 2019/20, about 3.427 million tons of milk were produced, mostly on farms distributed around our coastal areas where mild temperatures and good rainfall provide quality pastures.

The bulk of water on dairy farms is used for irrigation, as pastures for livestock feed need supplementary water when there is not enough rain. Of the estimated 160 litres of water used to produce a litre of milk, around 135 litres are for irrigation (the rest are for the animals themselves and to wash facilities and equipment). Consideringn the total amount of milk produced, the sector uses a substantial amount of water each year – well over 3 billion litres (according to the mentioned total tons produced in 2019/20), roughly what 20 million people use daily. A study by Trace and Save and the WWF-SA analysed water use efficiency and irrigation efficiency on pasture-based dairy farms in South Africa. Though the results varied between farms, in general, they found that large amounts of water are potentially being wasted every year due to irrigation system inefficiencies. The study also proved the large financial benefits of improvements and that, with the necessary motivation and knowledge, some can already be implemented by farmers, as many that participated in the study have done upon seeing the results.

The project was led by soil scientist Lorraine Phadu, a sustainability researcher for Trace and Save. "We approached

this study from a holistic perspective," she says of their approach. This included aspects below and above ground, she adds, such as soil health, irrigation which are the pivots themselves and the climate that they function in.

An overview of the farms that participated

For ten months in 2021, from March to December, Phadu collected data on the water use and efficiency of 15 centre pivot irrigation systems on six dairy farms in Tsitsikamma and Outeniqua in the Southern Cape. The area is not only known for dairy farms but also for its ecological significance. The water management areas include dense clusters of freshwater ecosystem priority areas for rivers, wetlands and threatened and critically endangered fish sanctuaries and support areas.

The farms that participated in the study rely on a mix of irrigation and drylands for grazing, Phadu explains. This includes a variety of species such as lucerne, ryegrass, chicory, Kikuyu, white and red clover. The water for irrigation is mostly collected in dams and weirs, and then pumped to the pivots using electricity, but the availability of water, and the irrigation systems vary substantially across the farms. Some farms were found to have very effective irrigation systems in place, while others relied on rainfall and irregularly irrigate with varying amounts of water. The condition of irrigation systems also varied, with some of the irrigation systems found to be in good condition, used at capacity and fitted with mechanisms like ring feeds and variable speed drives to decrease electricity use, while others were found to be poorly designed, badly maintained, old and used more electricity than required.

The farmers' approach to irrigation varied widely too, based on a combination of technology, experience, knowledge and even, Phadu says, gut feeling. About half of the farmers use soil moisture probes and irrigate according to soil moisture content, either based on their own interpretation of the data or that of consultants. Other farmers irrigate according to the availability of water, depending on rainfall and dam levels, regardless of soil moisture. Some farmers have very little water available and schedule their irrigation so the water can last throughout the entire season. There are also farmers who irrigate according to their experience, anticipating certain pasture growth rates for a season. Lastly, there are farmers who irrigate conservatively, using as little water as possible, to lower their risk of running out in periods of low rainfall. "Some of these farmers were taught by their fathers or their grandfathers, and what they are applying is according to that generational knowledge," Phadu notes.

For the purpose of the study, pivots were fitted with water meters and data loggers to measure the amount of water entering the pivot. Every week, the farmers measured the pastures' growth rate and calculated tonnes of dry matter. The farmers also recorded the daily amount of milk produced by each cow.

How efficient was the irrigation?

The researchers found that, on average, more than 507 000 litres of water is potentially wasted per hectare every year due to irrigation system inefficiencies. The most efficient systems wasted only 84 210 ℓ/ha while less efficient systems wasted as much as 1 113 079 ℓ/ha. If every farm fixed all inefficiencies in its irrigation systems, as per the most efficient system (96,3%) in this case study, potentially 423 204,68 litres of water could be saved per hectare, every year, per farm.

Phadu explains that the systems' efficiency is driven largely by wind speed, the distance of the sprinkler head from the ground, and the droplet size. When the wind speed is high, and small droplets are irrigated from a sprinkler head far from the ground, a lot of water is lost. "Even if you have an efficient system but you have chosen a windy and hot day, you're losing a lot of water," Phadu says, mentioning that the team's data showed that as much as 40% of the water on a windy and hot day can be lost before it hits the pasture.

The research team went a step further. Had all the water (including the 507 414 ℓ/ha water lost) that flowed through the water meters reached the pasture, an extra 1.6 tonnes of dry matter could be grown, instead of buying it in. The cost of bought in roughage to compensate for the shortage amounted to R4 598/ha, which is R1 149 500 per year on a 250 ha farm. This still excludes the additional financial, logistical and environmental input required to buy in roughage grown elsewhere.

Phadu explains that they really wanted to drive home the financial benefits of savvy water use.

The wasted water was still pumped to the pivot, and this amounted to 15 769,30 kg CO_2/ha and approximately R483,95/ha/year in Eskom electricity bills. All and all, if the values are extrapolated, the cost of an inefficient pivot covering an area of

Photo supplied

The soil that the pasture is grown in is an integral element of efficient water use in farming operations.

Photo supplied

A 'catch can test' in action, to test the irrigation efficiency of pivots. Water droplets are captured to calculate efficiency measures (calibration, system and scheduling).

30 ha will be approximately R57 419,10/year for pumping water that did not reach the pasture. According to the final report, "This is considerably more than the most efficient pivot in this study, for which the cost would be R14 515,50/year for pumping water that did not reach the pasture."

You have to look at the weather, the time of the day when you are irrigating and your system efficiency, Phadu reiterates. Another integral element is the soil health. "You have to know the capacity of your soil to hold water, because as you are irrigating you want that water to be held in the soil and be provided to the pastures as per need." In the study area, soils with more abundant fungi and carbon or overall healthy soils, retained water better, and resulted in better pasture water-use efficiency.

The findings indicated that, for efficient irrigation, farmers need accurate weather and environmental data, a good understanding of their systems and to work to build soil carbons that will improve soil structure and a good water holding capacity. In essence, the research found that the overall water used for irrigation would decrease if farmers applied higher quantities of water per irrigation event, but irrigate less often.

Why the change is not easy

There are serious challenges to implementing the study suggestions. First is the "major financial costs for the implementation and upkeep of infrastructure, both to improve irrigation system efficiency and monitor water use." According to

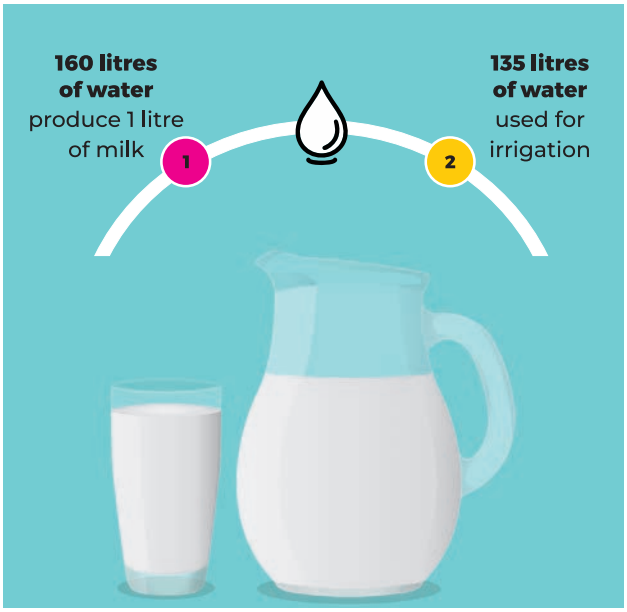
Photo supplied

The bulk of water on dairy farms is used for irrigation, as pastures for livestock feed need supplementary water when there is not enough rain.

the final report, the costs of the water meters ranged between R8 000 and R10 000 each and the installation, the data logger and any adjustments needed on the pipework were on average R25 000 to R40 000. Weather stations cost R8 598 each.

A second challenge is the lack of maintenance and follow-up support from irrigation equipment service providers. "It was heartbreaking to know that the farmers paid hundreds of thousands of Rands for a pivot, but then had to wait four or five months to get leaks fixed," Phadu says. Many became despondent to even try new suggestions, she says.

An important point that was raised was that current water allocation regulations do not account for costs incurred by farmers if less water is used for irrigation. Consequently, there is little incentive for farmers to use less water than what is allocated to them. "If they don't use the water, they still have to pay the full amount," Phadu says. "Like any other business, profitability and production is the main thing. As such, once a farmer gets water [and has to pay for it], they want to turn it into pasture, to turn into milk, especially because pasture is the cheapest source of food for the cows."



More challenges included the time and effort necessary to change and/or adopt new methods and a lack of information to motivate the need for change or upgrades. According to the report, "Most farmers were not aware that their systems were not as efficient as they had been told, or farmers often stick to traditional methods of irrigation scheduling and are satisfied with their results."

Most of the farmers didn't know that it is possible for them to improve their own systems and management, Phadu says. Since they participated in the study, a number have addressed some of the highlighted issues and implemented better practices. For example, one farm has installed 12 water meters and serviced all his pivots, another fixed and replaced pumps. A number installed low-energy precision irrigation (LEPA) systems and fixed leaks in their pivot systems.

What can be done, and what should be done

The main thing for efficient water use, Phadu says is that you need to start measuring your water use accurately. Like a farmer said to me, she remembers, "You can't manage what you don't measure."

Water meters are integral, she adds. "You need to know how much water exactly is getting through to your pastures." Then, you need to know how much moisture is in your soil, and how much water your pasture needs. "Finally, you need a weather station to tell you the evapotranspiration, which is the crop water requirement. You need to maintain and service your systems as much as possible."

Phadu points out that the effort and initial financial costs are more than worth it. "If you're improving your irrigation efficiency, you're also improving your pasture water use efficiency. At the end of the day, this results in less water to produce first, more pastures and then, milk, at a lower cost."

Over and above that, the benefits extend to the ecosystem that the farmers rely on, improving the natural environment's capacity to support them, their broader community, and the future generations of farmers that will one day replace them.

References

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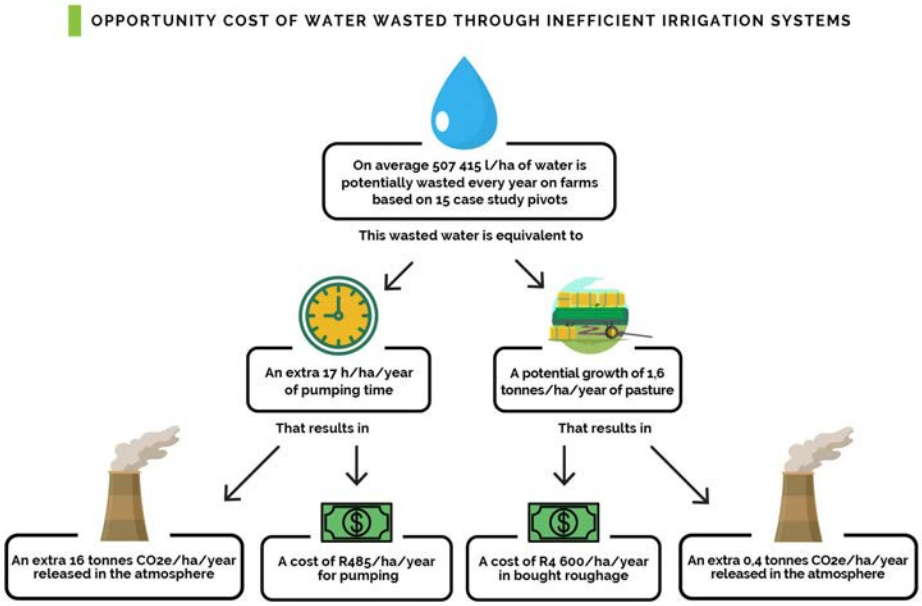

This flow diagram taken from the final report, describes the potential opportunity costs extrapolated from the average amount of water wasted due to inefficient application of irrigation in this study. System efficiencies measured during one irrigation event were used to estimate the amount of water wasted over the period of measured water use.