WATER USE IN AGRICULTURE

Study builds knowledge around more sustainable beef production

In the first study of its kind in South Africa, a Water Research Commission (WRC) funded study investigated the water use of cattle feedlots in South Africa with the aim of making this industry increasing water wise. Article by Petro Kotzé.

At the start of 2022, a special group of young cattle, a combination of Ngunis, Bonsmaras and Simmentals, were delivered to the Animal Nutrition section of the Agricultural Research Council – Animal Production (ARC-AP) in Pretoria. Their home for the next five or so summer months were single feeding pens, a small simulation of a large and booming industry in South Africa – beef cattle feedlots. In South Africa, up to a 100 000 head of cattle can be kept in a feedlot, but the small group of 33 animals that spent the summer of '22 at the ARC helped examine a key question about this industry: how much water is used in the process?

The answer is of national importance. Eighty per cent of the cattle herds in South Africa are for beef production (the remaining 20% is for dairy), and our appetite for it is growing, fueled by a growing population and expanding urbanisation. It is the second-fastest growing industry after poultry in our agricultural sector. According to the national figures available, the industry saw a gross value increase of 135%, from R13 billion in 2006/07 to R30.6 billion in 2015/16, averaging R19 billion per annum.

However, we do not know what the related price tag in water is or how beef production could contribute to the country's water scarcity problem. Previous research has run simulation models to do the math but now, for the first time in South Africa, the data has been validated, says project leader Prof Bohani Mtileni from the Department of Animal Sciences at Tshwane University of Technology (TUT).

In a first-of-a-kind for the WRC, the organisation funded the project ***Sustainable application of livestock water footprints in***

different production systems and regions of South Africa. The final report (**WRC Report No. 2964/1/22**) was published in January and is the starting point of many questions that remain to be answered, says Prof Sylvester Mpandeli, Executive Manager for Water Utilisation in Agriculture at the WRC. However, the results already indicate the potentially vast amount of water that can be saved should beef production be approached from a water-wise angle.

How to measure the water in a kilogram of beef

The study aimed to evaluate the water footprints of cattle raised in South African feedlots, an intensive production system that grows and fattens the animals in high densities until they reach the right weight for slaughtering. Feedlots are usually large, fully mechanised and geared to optimum performance. Grazing is replaced with a feed mixture to obtain optimal growth until the animals are sent for slaughter and consumption as beef and hides.

The practice is well established in countries like the US and Canada and is rapidly growing in other regions like South America, Asia and Africa as demand for beef rises. An estimated 2% of the global cattle population is kept in feedlots to produce roughly 7% of the world's beef.

To measure the water footprint of beef cattle feedlots in South Africa, researchers from TUT, Botswana University of Agriculture & Natural Resources and the ARC-AP unit considered blue, green and grey water. This includes the water the animal drinks over its lifetime, the water contained in the food it ate and the water that is used when the meat is processed in the abattoir, explains Mtileni, a geneticist by training. The amount of irrigation water used to produce the feed is something that they would like to include in future but was not considered here.

The project team's objectives were to investigate the water footprints of different sizes of cattle; the degree to which the volume of water varied during their growth after weaning; the relationship between the volume of water used and carcass characteristics; and the amount of water consumed per kilogram of feed by the different breeds considered.

Of the herd of 33, eleven were Nguni cattle, the smallest breed; another eleven were Bonsmara cattle, a medium breed, and the last 11 were Simmental cattle, which has the largest frame size. During their time at the ARC the cattle were given free rein to water and food, a mix of hominy chop, grass hay (***Eragrostis***), soya oilcake, molasses, limestone, urea, salt and a premix of vitamins and minerals. The animals were weighed at the start and then every two weeks, and their feed and water intake were recorded daily.

Ultrasound transducers allowed researchers to investigate the boundaries between the animals' hide, fat and muscle layers to allow for the measurement of the various carcass traits and estimate retail yield and meat quality. Common traits include rib eye area (measured between the twelfth and thirteenth ribs, it gives an estimate of the amount of muscle and lean product in the animal), backfat (an estimate of the percentage external fat on the animal), rump fat and percentage intramuscular fat (an objective measurement of marbling, the main trait used to determine the meat's quality grades). When the cattle reached market weight, they were slaughtered for further analysis.

A typical South African feedlot.

Which frame-size animal performed the best?

The study provided numerous insights. The frame size of the animal significantly influenced many of the factors measured. These include the amount of water consumed in the feed, the water intake, water consumption, the water-to-feed ratio, the service water used and the water footprint. Researchers also considered the water intake efficiency (WIE), the ratio of water intake to the live weight gain of the animal and water consumption efficiency (WCE), the kilogram of weight gained per litres of water consumed.

Beyond the results

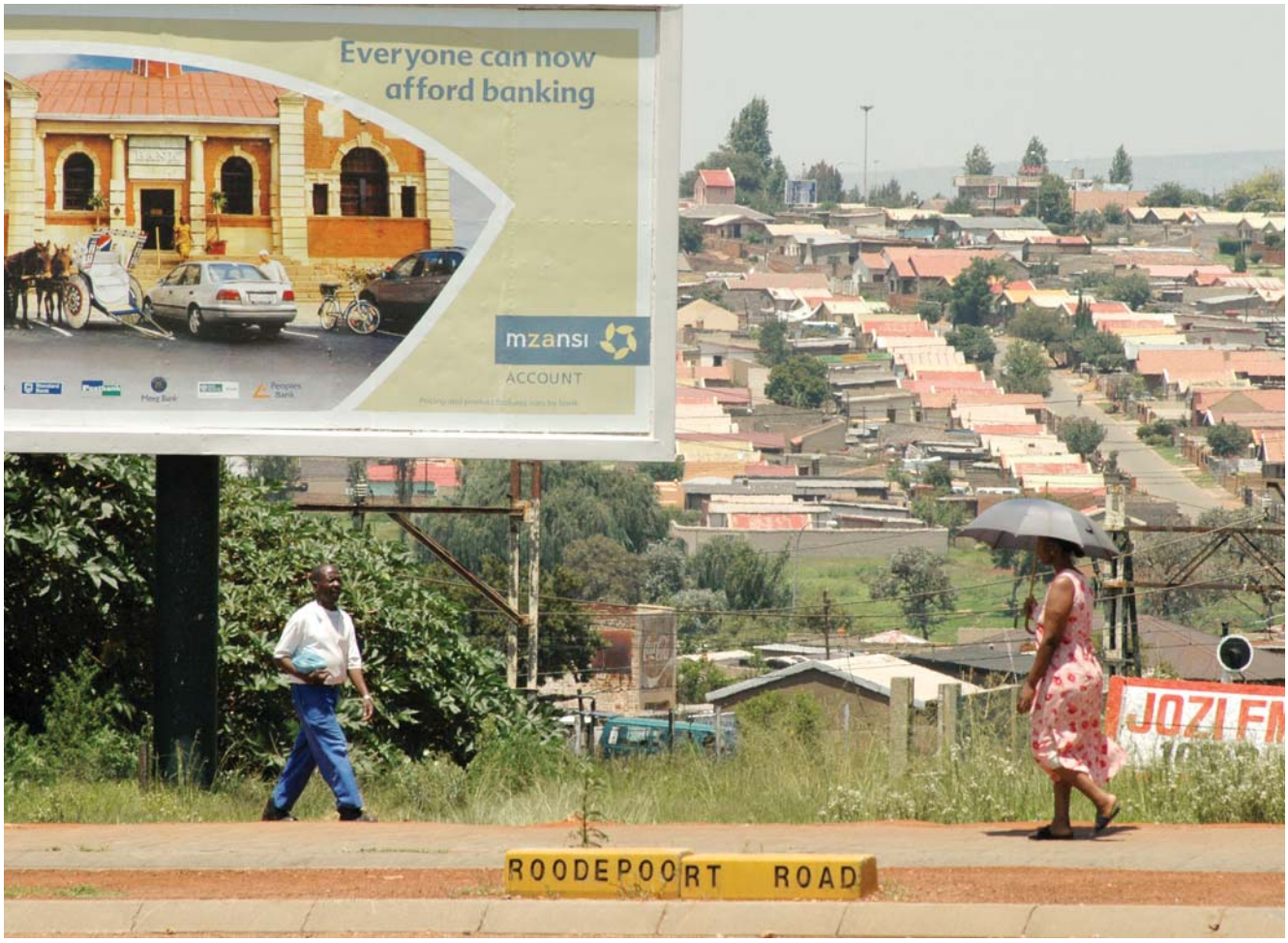
Over and above the reported findings, the project team also developed indicator traits of water footprints for intensive livestock production in South Africa, something that is currently lacking in livestock genetic improvement programmes here and in many countries of the world. As a result, we now have baseline information on WIE and WCE as potential indicator traits – an output that is of special importance to feedlots, breed associations, farmers, and policymakers.

Results showed that the Nguni, the smallest frame-size, performed better than the medium Bonsmara and large Simmental in terms of water consumption efficiency for post-weaning growth performance under the intensive production system. A small frame-sized beef breed would be best in areas where water scarcity is common, they concluded.
However, the picture changes when the quality of the meat is taken into consideration and, results show, this was also significantly influenced by the size of the breed. Measured by fat and fat code, the small and medium breeds performed better, but the eye muscle area was higher for medium and large-framed breeds than for the small-framed breed.

In conclusion, the results suggest that the medium frame size breed (in this case, the Bonsmara) performed better in terms of water footprint whilst also providing comparable carcass characteristics to the large frame size in the intensive production system.

"So, we recommend that farmers in water scarce areas keep the smaller frame sizes because they use less water to produce a similar yield than the larger size," Mtileni says. "With large frame sizes, water is being wasted, while it doesn't result in better quality meat." However, farmers can best work with the medium frame size because it's a combination of all that is needed, he says.

Petro Katzé



Our growing appetite for beef is fuelled by an expanding population and urbanisation.

Nguni cattle is one of the species investigated as part of a study on water use of beef produced in feedlots.

Why do we need to know?

"It's critical to find the relationship between water intake, economic output, post-weaning growth and meat characteristics," Mtileni says. "If we don't know how much water is needed to produce a kilogram of meat we won't consider how much water is being wasted along the pipeline of producing a full-grown animal to market age. If we benchmark and document the information on how much water is needed to produce a kilogram of meat, we can put a projection together taking the amount of available water in the country in mind. We can compare the water being used vs the products yielded."

The potential water savings in question can be enormous. Mtileni says it amounts to a difference of around 500 litres and more between a small and large breed of cattle, per animal. According to figures by the South African Feedlot Association, South African cattle feedlots combined accommodate about 460 000 head of cattle. Seeing as the standing period for one cycle at a feedlot is about 100 to 120 days, three cycles can be completed each year, resulting in about 1.68 million cattle slaughtered annually.

However, Mpandeli points out that this was, for the moment, a scoping study and that results can be swayed by many factors, including the season, geographical location of the feedlot and weather conditions at the time. Hopefully, more detailed studies can look at different livestock in future. As a start, the WRC is planning an "exciting" project focusing on indigenous goats and water use efficiency for 2024.

Mtileni adds that other important study subjects would be on commercial and exotic breeds of cattle and small-holder farming operations instead of intensive production systems. However, the most important, he says, is to find out next if the indicator traits (see earlier text box) can be manipulated under genetic control.

"We need to look at factors that might affect our farming in future," Mtileni says. This project considered water scarcity and the health of our water resources, he says, but also the increasing demand for food that needs to be produced with the same, scarce resources. "We need to use water wisely, without sacrificing the end products of our produce." In the end, he says, we need to know how to strike that balance.

For more information, refer to WRC Report No. 2964/1/22, ***Sustainable application of livestock waterfootprints in different production systems and regions of South Africa***.