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# Comparison of two water measurement systems for feedlot beef cattle

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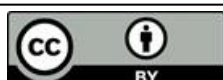
## ABSTRACT

The objective of this study was to compare cattle drinking water consumption collected electronically with that of direct human observation using water metres and to analyse whether an automated system compensates due to its greater precision. The study was conducted in the feedlot of Embrapa Pecuaria Sudeste. The reference unit had four pens: two with electronic drinkers and two with water metres. Experiment 1 utilised 52 Nelore steers and Experiment 2 utilised 44 Canchim steers. Nelore fed a conventional diet, the automated system median daily water intake (DWI) was higher than for animals drinking from the water metre, 17.9 L day$^{-1}$ and 15.6 L day$^{-1}$. The reverse was observed for animals fed the co-product diet, the automated system median DWI was 18.9 L day$^{-1}$ and in the water metre pen was 23.0 L day$^{-1}$. When the Canchim drank from water metres, the median DWI was lower than with the automated system group, 25.9 L day$^{-1}$ and 27.8 L day$^{-1}$, respectively. In Experiment 1, there was a statistical difference between the two sets of equipment for both diets. In Experiment 2, the animals were the same breed, had similar weights and were fed the same diet. There was no statistical difference between the equipment in these conditions. The results indicate that the water meter can have the same performance as high technology at a much lower cost. If a more simplified system for measuring water consumption has the same performance as an automated system, this will justify its use with environmental and economic advantages.

**Keywords:** electronic drinkers, precision livestock farming, water meter.

# Comparação de dois sistemas de medição de água em confinamento de bovinos

## RESUMO

O objetivo do estudo foi comparar o consumo de água de dessedentação de bovinos mensurado de forma eletrônica ou por observação direta com hidrômetro e analisar se o sistema

automatizado compensa devido à sua maior precisão. Esse estudo foi realizado na Embrapa Pecuária Sudeste. A unidade de referência possuía quatro baias: duas com sistemas de bebedouros eletrônicos e duas com hidrômetros. A base de dados usada para a avaliação dos equipamentos foi originada de dois experimentos. O experimento 1 utilizou 52 animais Nelore e o experimento 2 utilizou 44 animais Canchim. Nelores alimentados com dieta convencional e com acesso ao bebedouro eletrônico apresentaram a mediana da ingestão de água diária (IAD) maior do que os animais com acesso ao bebedouro com hidrômetro, 17,9 L dia$^{-1}$ e 15,6 L dia$^{-1}$. O inverso foi observado para animais alimentados com dieta de co-produto, a IAD mediana do bebedouro eletrônico foi 18,9 L dia$^{-1}$ e para baia com hidrômetro foi de 23,0 L dia$^{-1}$. Para o Canchim, a IAD mediana da baia com hidrômetro foi menor do que o grupo com bebedouro eletrônico, 25,9 L dia$^{-1}$ e 27,8 L dia$^{-1}$, respectivamente. No experimento 1 houve diferença estatística entre os dois conjuntos de equipamentos para ambas dietas. No experimento 2, os animais eram da mesma raça, tinham peso similar e foram alimentados com a mesma dieta. Não houve diferença estatística entre os equipamentos nestas condições. Os resultados indicam que o hidrômetro pode ter o mesmo desempenho do bebedouro eletrônico a um custo mais baixo. Se um sistema mais simplificado para mensuração do consumo de água tem o mesmo desempenho do sistema automatizado, isto justificará seu uso com vantagens ambientais e econômicas.

**Palavras-chave:** bebedouro eletrônico, hidrômetro, pecuária de precisão.

## 1. INTRODUCTION

Water is fundamental to animal agriculture and has three functions in a production system. It is a feed, which must be offered in quantity and quality. It is an input, which must be available for various uses such as cleaning, irrigation, etc. It is a natural resource that must be conserved in order to guarantee the farm's sustainability. For a long time water in animal agriculture has been understood as an infinite and inexpensive natural resource. This did not contribute to the internalization of water-use efficiency. This culture has changed in recent years, whether due to conflicts over water, the greater intensity and frequency of climatic events or the lesser availability of water of the quality required by the production system.

Beef cattle production generates environmental, economic, and social positive and negative impacts that need to be accurately measured to support best practices, policies, and regulations that enhance water use efficiency and conserve water in quantity and quality (Palhares *et al.*, 2021)

The phrase is true: it is not possible to manage what we do not know. Thus, to promote water management in beef cattle systems, the first step is to know how the resource is used and in what volume. Baxter *et al.* (2017) indicate that water-use quantification in beef meat production is important because it is a commodity often criticized for inefficient input conversion. Quantifying water use in ruminant production is a crucial step for identifying strategies for water use (Ahlberg *et al.* 2019; West and Baxter, 2018; Legesse *et al.*, 2017).

The installation of equipment to measure the consumption of drinking water by animals is mandatory to identify reasons of misuse, propose corrective actions, monitor these actions and make the necessary adjustments. Weindl *et al.* (2017) cited that several authors state that interrelations between livestock and water have widely been disregarded by both water and livestock research communities. According to Williams *et al.* (2017), the consumption of water by cattle is not well understood by farmers and scientists. Williams *et al.* (2019) indicate that more information about cattle water needs and water usage in commercial livestock are important to subsidize decision making by farmers.

There are several types of equipment that can be installed on a farm to measure the

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consumption of water by the herd. The simplest are water meters. They are easy to monitor by the operator, can be bought in the local market and the costs of acquisition, installation and maintenance are low. The disadvantages are: it results in the average daily consumption of the animals; the lower limit of the equipment may be above the flow consumed; and they require labour for the monitoring. On the other hand, there is electronic equipment (electronic drinking). This is precision equipment, which measures the individual daily consumption of the animals, as well as producing behavior indicators such as the frequency of visits to the drinking trough and the time spent on each visit. All these results are available online, providing real-time operator intervention. But all this technology has a high cost of acquisition and maintenance, depends on the availability of energy on the farm and is offered by a few manufacturers.

The objective of this study was to compare cattle drinking water consumption collected electronically with that from direct human observation by water meters and analyze whether an automated system compensates due its greater precision.

## 2. MATERIAL AND METHODS

The study took place in the feedlot reference unity of Embrapa Pecuaria Sudeste. The reference unit had four pens: two with electronic drinker - Model WD-1000 Master, Intergado Ltd - (Chizzotti *et al.*, 2015) and tow with water meters – Model IM-T, Sensus Ltd. The water source for the reference unit was a deep well. Weather data were collected from Embrapa Pecuaria Sudeste automatic weather station located 200 m from the feedlot.

The daily water intake (DWI) for one animal measured with a water meter is the result of total water consumed by the groups of cattles divided by the number of animals in the pen as well as the DWI measured with an electronic drinker is the average intake of all animals in the pen.

The dataset used for the equipment evaluation was derived from 2 experiments. All experiments reported herein were conducted with the approval of the Institutional Animal Care and Use Committee at Embrapa Pecuaria Sudeste.

Experiment 1 utilized 52 male Nelore steers (*Bos taurus indicus*) born in 2014 and slaughtered in 2016 to determine the effects of different feeding regimens. Animals were divided into two subgroups of 26 animals by weight (light and heavy). Each subgroup was further divided into nutritional treatment groups of 13 animals each: Co-product Light Animals (COP_L) and Heavy (COP_H) and Conventional Light Animals (CON_L) and Heavy (CON_H). Light animals use the pens with electronic drinkers and heavy animals drink in the pens with water meters. Water intake was monitored over a 82-d period. The final dataset comprised 2,008 records for electronic drinkers and 152 for water meters. Electronic drinker failure (connection problems, power loss, and animal handling) occurred during 74 records (3.7% of the study period). For water meters, these failures represented 9 records (5.9% of the study period). These malfunctions were treated as missing to maintain data quality, so water intakes collected on these days were not considered.

Experiment 2 utilized 44 male Canchim steers (breed derived from the Charolais and Zebu group) born in 2016 and slaughtered in 2018. Animals were randomly divided into four subgroups of 11 animals to compose the four pens, two with water meters and two with electronic drinkers. Water intake was monitored over a 86-d period. The dataset comprised 1,892 records for electronic drinkers and 170 for water meters. Electronic drinker failure occurred during 217 records (11.5% of the study period). For water meters, these failures represented 25 records (14.5% of the study period). Water meter failures correspond to leaks that occurred so the reading could not be taken and/or days when the operator was not available to take the reading.

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The first step of the statistical analysis was to test the hypothesis of normality by the Shapiro-Wilk test. Both experiments reject the null hypothesis at the 0.05 significance level. Dependent-samples Sign-Test is a non-parametric test which makes very few assumptions about the nature of the distributions under test, this means that it has very general applicability (Dixon and Mood, 1946). The statistical method tests differences between pairs of observations, designated as X and Y. It can be used to test the hypothesis that the difference between the measurement X and the measurement Y has zero median, assuming continuous distribution of the two random variables X and Y. Statistical significance was set at $P < 0.05$.

## 3. RESULTS AND DISCUSSION

Data from Experiment 1 has non-normally distributed variables. Descriptive data are presented in Table 1. In animals fed conventional diets, the Intergado median DWI was higher than the animals' consumption per the water meter, 17.9 L day$^{-1}$ and 15.6 L day$^{-1}$. The reverse was observed for animals fed the co-product diet, the Intergado median DWI was 18.9 L day$^{-1}$ and the water meter pen 23.0 L day$^{-1}$. Based on the P-value of the Sign-Test, $H_0$ was rejected for both groups. There was a statistical difference at 5% significance.

**Table 1.** Summary of descriptive daily water intake (L day$^{-1}$) for Experiments 1 and 2.

| Experiment 1 | Mean | Median | SD | Minimum | Maximum |
|---|---|---|---|---|---|
| CON_H | 16.0 | 15.6 | ± 6.4 | 4.1 | 40.2 |
| CON_L | 18.6 | 17.9 | ± 8.2 | 8.5 | 64.6 |
| COP_H | 23.4 | 23.0 | ± 6.9 | 8.9 | 50.4 |
| COP_L | 19.7 | 18.9 | ± 7.8 | 0.9 | 62.8 |
| Experiment 2 | Mean | Median | SD | Minimum | Maximum |
| Water Meter | 29.9 | 25.9 | ± 13.5 | 6.9 | 70.0 |
| Intergado | 26.6 | 27.8 | ± 8.3 | 3.6 | 55.8 |

CON_H = Conventional heavy animal; CON_L = Conventional light animal; COP_H = Coproduct heavy animal; COP_L = Coproduct light animal.

Despite the wide variation between the maximum and minimum DWI values for all groups, 75% of the daily consumption was classified from 4.2 to 20.2 L day$^{-1}$ to CON_H. This range was from 8.5 to 14.8 L day$^{-1}$ to CON_L. Co-product diets present an interval from 8.9 to 27.4 L day$^{-1}$ to COP_H and from 0.9 to 21.5 L day$^{-1}$ to COP_L.

Data from Experiment 2 has non-normally distributed variables. Table 1 shows the descriptive data. To animals that drank in pens with water meters, the median DWI was lower than Intergado, 25.9 L day$^{-1}$ and 27.8 L day$^{-1}$, respectively. Since the P-value was 0.6792 at the 0.05 significance level, we do not reject the null hypothesis, which means that there was no difference between the two groups.

In the case of Intergado, 65% of the daily consumption was classified from 26.8 to 38.4 L day$^{-1}$, and this range was from 23.3 to 34.3 L day$^{-1}$ per water meter equipment.

The drinking water consumption of animals is very variable. It is influenced by several productive aspects, mainly those related to the type of feed and the weather conditions. The more information available for this type of consumption, the more reliable will be the decisions we make on how to promote the water efficiency of production systems. Higher water efficiency will result in economic benefits, lower water costs, and more water availability for other uses.

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These results are novel and the equipment comparisons are of immediate value for farmers and professionals and are relevant to support decisions about which equipment is more suitable to be used considering the economic and productive aspects and water availability of the production system. Palhares *et al.* (2018) accurate measurement is necessary to water management. By monitoring animal daily water intake, farmers can implement best water practices to improve water efficiency.

The average daily consumption observed in Experiment 1 is similar to that observed by Zanetti *et al.* (2019) that evaluated Nellore cattle consumption using the same electronic drinker model of this study in tropical climate conditions. Authors measured an average DWI of 16.7 L day$^{-1}$ and estimated the water intake from equations developed from databases with predominantly *Bos taurus* cattle. The average daily consumption was 33.3 L day$^{-1}$ with a minimum of 4.1 L day$^{-1}$ and a maximum of 79 L day$^{-1}$.

The consumption estimated by equations is much higher than that verified with field measurements. This demonstrates the need to have water equipment installed in the production system. Legesse *et al.* (2017) observed that there is a high variability of animal performance even among farms in the same region; because of this it is important to have data that express the real productive condition.

In Experiment 1 there was a statistical difference between the two measuring devices for both diets. Daily water intake can vary greatly, because it is affected by a range of conditions such as animal type, diet type and percentage of roughage and concentrate. Shane *et al.* (2016) observed that drinking is a social behavior, resulting in groups of animals being at the water at the same time. Since both types of drinkers provided different access to animals, individual and collective, it may be a factor that influenced the daily water intake per animal.

Considering the diet with co-products, the difference between the median DWI was 4.1 L day$^{-1}$. For conventional diet, this difference was 2.3 L day$^{-1}$. From an environmental point of view, these differences are significant when analyzed on a commercial scale. For example, in a feedlot with 10,000 head, the total daily consumption would represent differences of 41 m$^3$ and 23 m$^3$ for co-products and conventional diets, respectively. These values will influence the decision-making of the farmer and introduce risks in it, especially if the farm is located in a region with water scarcity. But there is the economic aspect. While Intergado costs 6,000 dollars, the water meter costs 40 dollars.

Canchim is a crossbred between Bos taurus x Bos indicus. The mean DWI in Experiment 2 varied from 26.6 and 29.9 L day$^{-1}$. Brew *et al.* (2011) evaluated the daily water intake with electronic drinkers in a feedlot system. The breed composition Charolais X Angus consumed 42.8 L day$^{-1}$, Charolais X Brangus 29.7 L day$^{-1}$, and Charolais X Romosinuano 20.7 L day$^{-1}$. Sexson *et al.* (2012), utilizing water meters and using high-concentrate finishing diets with corn silage as the main roughage source, verified an average water consumption of 37 L day$^{-1}$ to yearling feedlot steers.

The difference between Experiments 1 and 2 is that in the second there was no variable other than the type of equipment. In Experiment 2, the animals had the same breed, similar weights and were fed with the same diet. There was no statistical difference between the two measuring devices in these conditions. The electronic system provided measures of water intake that were similar to those recorded by direct observation. Since the experimental condition is more homogeneous, it can be inferred that water-measuring equipment has similar performance, so both support decision-making in the same way. Therefore, the use of the water meter is more advantageous due to the lower cost and energy consumption, as well as the need for unskilled labor.

The use of electronic equipment is part of the process of livestock sustainable intensification where the technology is useful to measure various productive parameters in real time. Future research should encourage the evaluation of these types of equipment in

comparison with simpler technologies in order to learn about their accuracy and precision, as well as the economic, productive and environmental advantages and disadvantages of each one.

## 4. CONCLUSION

For a long time, water in animal agriculture has been understood as an infinite and inexpensive natural resource. This did not contribute to the internalisation of water-use efficiency. We compared cattle drinking water consumption collected electronically with that from direct human observation using water metres. The results indicated that the water meters can have the same performance as high technology at a much lower cost, with less demand for energy and training of workers. The use of individual systems for measuring zootechnical parameters is a mandatory aspect of precision livestock farming. These precision technologies have several advantages, such as the huge amount of information for decision making and the low intensity of labor. One of the main disadvantages is the high cost of technology that prevents its acquisition by small and medium farmers, but they should also appreciate efficient water use, either by legal obligation or societal demand. If a more simplified system for measuring water consumption has the same performance as an automated system, this will justify its use with environmental and economic advantages.

## 5. ACKNOWLEDGEMENTS

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