EVALUATION OF THE RELIABILITY AND CONCORDANCE OF VISUAL WEIGHT ASSESSMENT IN WATER BUFFALO FEMALES †

[EVALUACIÓN DE LA FIABILIDAD Y LA CONCORDANCIA DE LA VALORACIÓN VISUAL DEL PESO EN HEMBRAS DE BÚFALO DE AGUA]

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SUMMARY

Background. For the development of reproductive, nutritional and health programmes, estimation of animal body weight (BW) is a fundamental tool in herd management. **Objective.** To evaluate of the reliability and concordance of visual weight assessment in water buffalo females. **Methodology.** Data on visually estimated body weight (VM) and actual body weight (BW) were recorded for 229 female water buffaloes. BW was recorded using a digital scale and visual estimation BW was taken as the average of three observations made by three observers. The measurements obtained by each of the different estimation methods were also compared with the observed weights by inspecting the paired Bland-Altman plots prior to logarithmic transformation. **Results.** Correlations between observed BW and mean predicted BW for visual methods showed a positive and significant relationship (P<0.001), with an r value of 0.95. According to the intraclass correlation coefficient (ICC), there was a high degree of reliability in the visual estimates of buffalo weight, due to the similarity in the mean and dispersion of each observer's estimates. Both the Bland-Altman plot and the ICC show that there is a high level of concordance between the buffalo weights obtained by the visual and real methods. **Implications.** The result of the present study showed that visual assessment highlights the ability of livestock handlers to have a very accurate estimation of BW in female water buffaloes. **Conclusion.** The results of this study show that visual assessment highlights the ability of livestock handlers to visually estimate BW in female water buffaloes with high reliability and concordance with the animal weighbridge method.
Key words: water buffalo; Live weight; Animal production; Accuracy.

RESUMEN

Antecedentes. Para el desarrollo de programas reproductivos, nutricionales y de salud, la estimación del peso corporal (PV) de los animales es una herramienta fundamental en el manejo del rebaño. **Objetivo**. Evaluar la confiabilidad y concordancia de la evaluación visual del peso en hembras de búfalo de agua. **Metodología**. Se registraron datos sobre el peso corporal (MV) estimado visualmente y el peso corporal real (PV) de 229 búfalas de agua. El BW se registró utilizando una balanza digital y la estimación visual del BW se tomó como el promedio de tres observaciones realizadas por tres observadores. Las medidas obtenidas por cada uno de los diferentes

† *Submitted September 28, 2023 – Accepted March 1, 2024. http://doi.org/10.56369/tsaes.5194*

ISSN: 1870-0462.
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métodos de estimación también se compararon con los pesos observados mediante la inspección de las gráficas pareadas de Bland-Altman antes de la transformación logarítmica. **Resultados**. Las correlaciones entre el BW observado y el BW medio previsto para los métodos visuales mostraron una relación positiva y significativa (P<0.001), con un valor de r de 0.95. Según el coeficiente de correlación intraclase (CCI), hubo un alto grado de confiabilidad en las estimaciones visuales del peso de los búfalos, debido a la similitud en la media y la dispersión de las estimaciones de cada observador. Tanto el gráfico de Bland-Altman como el CCI muestran que existe un alto nivel de concordancia entre los pesos de los búfalos obtenidos por los métodos visual y real. **Implicaciones.** El resultado del presente estudio mostró que la evaluación visual resalta la capacidad de los cuidadores de ganado para tener una estimación muy precisa del peso corporal en las hembras de búfalo de agua. **Conclusión.** Los resultados de este estudio muestran que la evaluación visual resalta la capacidad de los cuidadores de ganado para estimar visualmente el peso corporal en búfalas de agua con alta confiabilidad y concordancia con el método de báscula puente para animales.
Palabras clave: búfalo de agua; Peso vivo; Producción animal; Exactitud.

INTRODUCTION

In Mexico, water buffaloes (*Bubalus bubalis*) have been introduced in regions with a warm and humid climate, mainly in the states of Veracruz, Tabasco, Chiapas, and Campeche, due to the presence of extensive marshlands that are their natural environment (Peralta-Torres *et al*., 2000).

Body weight (BW) is an important parameter because it provides important information within production systems and is associated with several economic traits (Ruiz-Ramos *et al*., 2023; Ramos Zapata *et al*., 2023). However, in the major buffalo producing regions of the world, the systems are marked by low investment in infrastructure and regular weighing of animals is uncommon because of the lack of animal weighbridges (Ruiz-Ramos *et al*., 2023; Ramos-Zapata *et al*., 2023).

As an alternative to the use of animal scales, some studies have evaluated the reliability of visual assessment (Alejandro-Zarate *et al*., 2023). Málková *et al*. (2021) and Salazar-Cuytun *et al*. (2022) reported that in traditional production systems, it is common for animals to be sold based on visual assessment, leading to high errors in BW estimation, which affects the economic profits of producers. Furthermore, farmers and livestock traders often rely on visual judgement to determine the BW of livestock (Tebug *et al*., 2018). In this subjective method, the accuracy depends on the experience of the user. Recently, Alejandro-Zarate *et al*. (2023) concluded that visual assessment can be practical for animal management under certain conditions. To this end, it is necessary to assess the reliability of visual assessment of animal weight in different scenarios to validate a practical tool for producers. Therefore, the aim of this study was to evaluate the reliability and concordance of visual weight assessment in female water buffaloes reared in tropical environments.

MATERIALS AND METHODS

Animals and management

The animals included in this study were treated in accordance with the Ethical Guidelines and Animal Experimentation Regulations of the Agricultural Sciences Department of the University of Juarez Autonomous of Tabasco (authorisation code: UJAT-2012-IA-18). The experiment was conducted at the commercial farm "Polcay", located in the municipality of Sabancuy (18°99'N 91°14'W), north-east of the municipality of Carmen in the south-west of the state of Campeche, Mexico. The climate of the region is warm and sub-humid, with summer rains. The average annual temperature is 26.7 °C and rainfall is 1412 mm. The animals were fed on native grasses: *Cenchrus echinatus* (Mul), *Dactyloctenium aegiptyum* (Chimes su'uk), *Sporobolus virginicus* (Ch'ilibil su'uk), *Spartina spartinae* (K'oxolaak) and grasses such as *Brachiaraia brizantha* and *Panicum maximum*, as well as water *ad libitum*.

BW was recorded using a digital scale, while visual estimates of each animal's weight were recorded, first by an animal scientist and then by two producers with approximately 15 years of buffalo keeping and handling experience. Each estimate was blinded to the other participants, as described by Woods *et al*. (2015). Following Alejandro-Zarate *et al*. (2023), the mean of the three recordings was taken as the visual estimate.

Statistical analysis

Before the inferential analysis, an exploratory analysis (both numerical and graphical) was performed, including an assessment of the normality of all variables using the Shapiro-Wilk test. The degree of association between the observed weight and the mean weight estimated by visual methods was determined by the Pearson correlation coefficient. The reliability of observers' visual estimates was assessed using the intraclass correlation coefficient (ICC) (Shrout and Fleiss, 1979), where observers are considered as levels of a fixed factor. The closer the ICC is to 1, the higher the

interobserver reliability (agreement). The mean visual estimates were then compared graphically with the actual weights (both on a logarithmic scale, base 10) using the method of Bland and Altman (2010). In addition, the concordance correlation coefficient (CCC) of Lin (1989) was calculated to quantitatively assess the agreement between the values obtained by the two techniques (visual and real). All calculations and graphs were performed in the R programming environment (R Core Team, 2023), version 4.3.0, with an alpha level of 0.05.

RESULTS

Correlations between observed BW and mean predicted weight by visual methods showed a positive and significant relationship (P<<0.001), with an r value of 0.95. According to the ICC, there was a high degree of reliability in the visual estimates of buffalo weight (Figure 1), due to the similarity in the mean and dispersion of each observer's estimates. Both the Bland-Altman plot and the ICC show that there is a high level of concordance between the buffalo weights obtained by the visual and real methods (Figure 2). The plot also allows to detect the variability between individuals of different ages and the presence of some underestimations (values below the lower confidence limit) or overestimations (values above the upper confidence limit). The values are evenly and randomly distributed around the line, indicating that these methods neither underestimate nor overestimate BW (Figure 2). However, when comparing the methods, according to the Bland-Altman plot, the bias seems to be constant, with a slight widening of the limits of agreement, indicating a good correlation (r>0.90) between the methods (Figures 2).

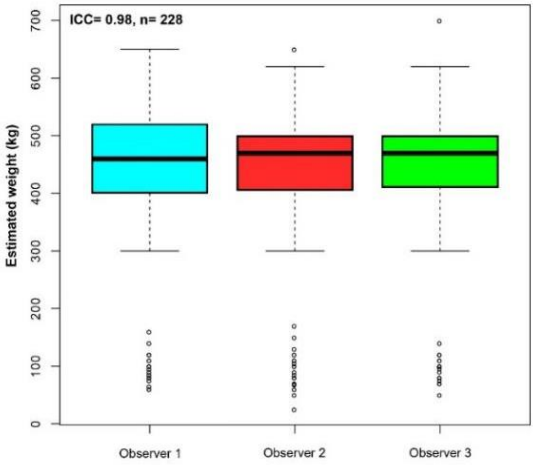

Figure 1. Comparison between the observers included in this study with respect to weight estimates made by the visual method. The intraclass correlation coefficient (ICC) and the number of animals scored (n) are included.

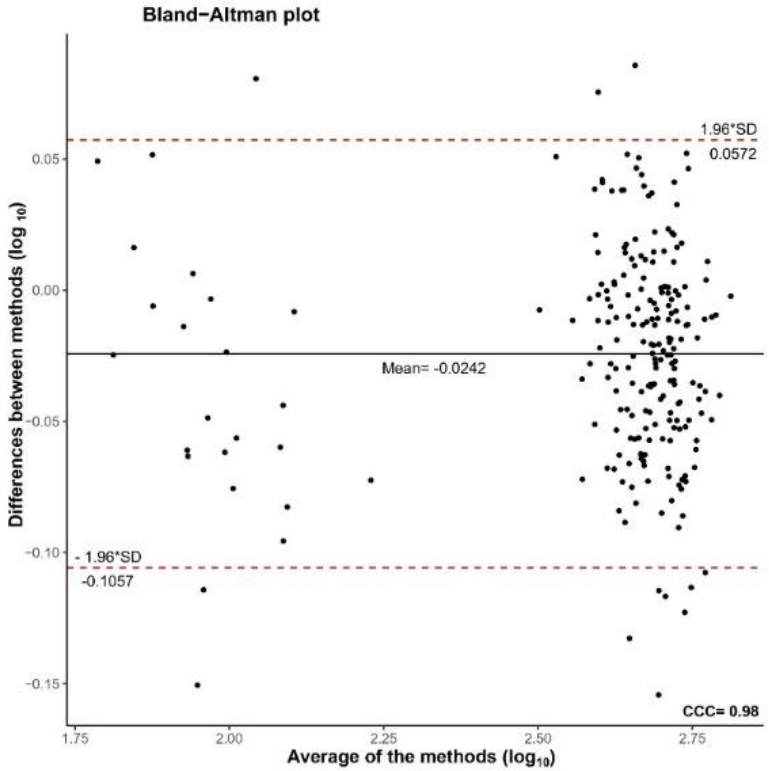

Figure 2. Bland-Altman plot comparing the means (x-axis) and differences (y-axis) of the visual and actual methods of obtaining buffalo weights. The value of the correlation coefficient of concordance (CCC) is included.

DISCUSSION

The "gold standard" method of weighing livestock is the digital scale, due to its high accuracy. However, its cost is a limiting factor for many farmers and its use may in some instances cause stress to the livestock, especially when they must travel long distances to reach the scales (Heinrichs *et al*., 1992; Salazar-Cuytun *et al*., 2022).

Visual weighing can be effective in animal management under certain conditions. Alejandro-Zarate *et al*. (2023) concluded that the result showed that the visual assessment highlighted the ability of the observers to visually estimate the BW of beef heifers. In this sense, Jimenez et al. (2019), when evaluating the agreement of weighing methods with a digital scale (gold standard) and indirect weighing by measuring the chest, by applying the Lin coefficient of agreement (CCC), the Bland-Altman graph in Nelore bulls. A higher average weight was observed in the readings obtained with the digital scale, while the range obtained with the chest tape was greater, with an average difference between weights of 13.8 kg. The weight data of the Nelore steers were found to be inconsistent between the digital scale and thoracic measurements. There are differences in the measurements that make it impossible for these methods to be interchangeable. Therefore, calculating the weight of Nelore cattle using the chest strap provides measurements that may lead to erroneous conclusions. Similarly, Alejandro-Zarate *et al*. (2023) compared actual BW and its estimation by visual method and measurement of heart girth (HG) or hip width (HW) to estimate BW in crossbred beef heifers reared under humid tropical conditions in Mexico. They found a correlation between observed BW and predicted BW for HG, HW and visual methods showed a positive and significant relationship ($P<0.001$) with r values of 0.95, 0.89 and 0.92 respectively. The HG method tended to overestimate the true BW, whereas the values for the visual and HW methods were evenly and randomly distributed around the line, indicating that these methods neither underestimated nor overestimated BW. Similarly, Tebug *et al*. (2018) reported that farmers and livestock traders often rely on visual judgement to determine the BW of livestock. In this subjective method, the accuracy depends on the experience of the user. This aspect is consistent with the results of the present study.

CONCLUSIONS

The results of this study show that visual assessment highlights the ability of livestock handlers to visually estimate BW in female water buffaloes with high reliability and concordance with the animal weighbridge method.

Acknowledgments
The authors are grateful for the assistance of Sr. Isaac Garcia Rodriguez, who provided access to the facilities of his buffalo farms. We also thank Ing. Gonzalo Ortega Garcia for his technical assistance.

Funding. This research did not receive any specific funding.

Compliance with ethical standards. Animals were handled according to the guidelines and regulations for animal experimentation of the Academic Division of Agricultural Sciences of the Universidad Juárez Autónoma de Tabasco (authorisation code: UJAT-2012-IA-18).

Conflict of interest. The authors declare that there is no conflict of interest.

Data availability. Data are available with the corresponding author of this publication upon reasonable request.

Authors contribution statement (CRediT).
J.I. Vázquez-Bolaina: Investigation; Methodology, and Writing – original draft. **R. Salazar-Cuytun:** Software, Supervision, Validation, Visualization, and Writing – original draft. **J.C. Escobar España:** Validation, Visualization, and Writing – original draft. **A.A. Cruz-Tamayo:** Supervision, Validation, Visualization, and Writing – original draft. **R.C. Barrientos-Medina:** Data curation, Formal Analysis, and Writing – original draft. **R.A. Garcia-Herrera:** Conceptualization, Data curation, Writing – original draft, and Writing – review & editing. **A.J. Chay-Canul:** Conceptualization, Data curation, Formal Analysis, Funding acquisition, Writing – original draft, and Writing – review & editing

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