International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
VET 2024; 9(1): 423-426

www.veterinarypaper.com
Received: 16-11-2023
Accepted: 20-12-2023

Akhil Kumar Jha
Department of Livestock Production Management, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Hari Om Pandey
Department of Livestock Production Management, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Mukesh Singh
Department of Livestock Production Management, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Ayon Tarafdar
Department of Livestock Production Management, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Triveni Dutt
Department of Livestock Production Management, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Patel Dipak Kumar Ajitbhai
Department of Livestock Production Management, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Corresponding Author:
Hari Om Pandey
Department of Livestock Production Management, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Assessment of water footprint for growth of Murrah buffalo calves under field conditions

Akhil Kumar Jha, Hari Om Pandey, Mukesh Singh, Ayon Tarafdar, Triveni Dutt and Patel Dipak Kumar Ajitbhai

DOI: https://doi.org/10.22271/veterinary.2024.v9.i1f.908

Abstract
The purpose of this study was to calculate the water footprint of Murrah buffalo calves in order to quantify the amount of water used for their growth. The present study was carried out under field conditions using the volumetric approach. The direct water intake, water demand for washing of sheds and washing of animals were measured. Feed intake of individual animals was also recorded to calculate the indirect water footprint. Results revealed that the water requirements for drinking and operational purpose were 12.23±0.07 and 5.89±0.02 L/animal/day, respectively. The measured quantities of water consumed by growing calves were 18.12±0.08 L/animal/day for direct usage and 470.44±10.41 L/animal/day for indirect usage. The water footprint of growing Murrah calves was 488.56±10.42 L/animal/day under field conditions. There was a significant difference ($p<0.05$) between water footprint of growth across different seasons with the majority of water footprint being contributed by the indirect component.

Keywords: Water footprint, Murrah, growing calves, consumptive water usage

Introduction
Buffaloes (*Bubalus bubalis*) are an important although insufficiently studied livestock species [1]. Presently, the largest buffalo populations are found in India, Pakistan, China, Egypt, and Nepal. More than half of the world's buffalo population is in India, which is also the largest exporter of buffalo meat [2]. The overall buffalo population in India is 109.85 million contributing to around 20.5% of the total livestock population [3]. Buffaloes are resilient, adapted to different climatic conditions, capable of digesting poor quality fodder, whilst maintaining a satisfactory growth rate, making them a versatile livestock species. Indian buffalo are an important source of milk for the organised dairy industry due to their contribution to global milk production, high fat content, and total solid content [4-6]. However, the production of meat, which is mostly drawn from aged animals nearing the end of their productive or working life, and to a lesser extent from young animals, also considerably benefits from the contribution of buffaloes. Given that there are no religious prohibitions on consuming buffalo meat, it is increasingly becoming a significant supply of red meat. The prohibition on cattle slaughter in the majority of Indian states has increased demand for carabeef or buffalo meat in both domestic and international markets. India produces 43% of the world's buffalo meat, with Uttar Pradesh having the highest production rates [7]. Livestock rearing for milk and meat production significantly contributes to land degradation, deforestation, acidification, and eutrophication. Animal-based products are a matter of global concern due to their higher ecological footprints, mainly consisting of carbon, land, and water footprint [8]. Buffalo rearing activities heavily depend on diverse natural resources, with a specific focus on abundant water, while concurrently giving rise to substantial environmental concerns throughout the production process. The concept of "water footprint" is an innovative and insightful technique to monitoring water usage and contamination throughout the entire livestock production chain. It is a useful tool for assessing the sustainability of water use techniques (direct and indirect water use) and investigating options for optimizing water use [9].

The present study was conducted to assess the water footprint of growing Murrah buffalo calves under field conditions using the volumetric approach given by the water footprint network [10].

Methodology

This study was carried out on growing Murrah buffalo calves raised under field conditions in the area of Bareilly, Uttar Pradesh. The purposive sampling methodology was used to select the farmers in the area who raised these dairy animal breeds within their households. A total of 78 Murrah buffalo calves were covered within the study area. The data was collected during the winter, summer, and rainy seasons for better understanding of the effects of the seasons on the overall water consumption. Prior to data collection, a data sheet was prepared in compliance with the study's goals and the reviews of literature. The data pertaining to the animals' water consumption for drinking and operation (cleaning of animals, sheds, milking utensils, etc.) uses was gathered through measurement and observation. The amount of feed and fodder consumed was also measured to calculate the indirect consumptive water usage. The indirect water footprint was determined by calculating the amount of water consumed by the crops used as animal feed and fodder. The water footprint of feeds and fodder was computed using previously published data [11]. Green fodders such as jowar, oats, and berseem had water productivity of 267.0, 312.5, and 454.5 L/kg water on a dry matter basis. Since wheat bran and broken wheat were given as concentrate feeds during the study, the grain's water productivity (800 L/kg) was taken into consideration. The water footprint was estimated by the volumetric approach using the formula:

$$\text{Direct CWU} = \text{CWU}_{\text{(Service purposes)}} + \text{CWU}_{\text{(drinking water)}}$$

$$\text{Indirect CWU} = \text{CWU}_{\text{(Green fodder)}} + \text{CWU}_{\text{(Dry fodder)}} + \text{CWU}_{\text{(Concentrates)}}$$ [12]

The weight measurement of calves was done on monthly basis by Shaeffer's formula, and subsequently, the average daily gain was computed [13].

$$W = G^2 \times L / 300.$$

Where, "W" is the live body weight of animal in pounds, "G" is the heart Girth (in inches), and "L" is the length from the point of shoulder to the point of pin bone (in inches).

The average daily gain (ADG) was calculated for the winter, summer and rainy seasons and reported as the daily average (kg/day) during each season.

Average Daily Gain (kg/day) is calculated by the formula:

Weight at the end of the period−Weight at the beginning of the period/ Number of days in the period

The water footprint of growth was obtained upon dividing the total consumptive water use (CWU) by the average daily gain of the animal.

Water footprint for growth (L/kg) = CWU $_{\text{Direct + Indirect}}$ / Average Daily Gain

The overall water consumption parameters such as daily direct water utilisation, indirect water utilisation, water footprint and water footprint for growth were analysed and tabulated as mean with standard error. For the determination of significant differences in daily direct water utilisation, indirect water utilisation as well as the water footprint across different seasons, one-way ANOVA test was done using IBM SPSS statistics 26 software.

Results and Discussion

The study findings indicate that the average daily water intake for Murrah buffalo calves was 8.75±0.15 L/animal/day, 16.11±0.12 L/animal/day, and 11.83±0.07 L/animal/day in the winter, summer, and rainy seasons, respectively. The overall average daily water intake was 12.23±0.07 L/animal/day (Table 1). The findings are consistent with the results of Paul's (2001) study [14], which indicated that Murrah calves consumed an average of 7.1 to 19.8 litres of water/calf/day. The operational water requirements for growing calves were 4.28±0.02 L/animal/day, 7.65±0.03 L/animal/day and 5.73±0.04 L/animal/day during the winter, summer and rainy seasons, respectively. The overall average water demand was 5.89±0.02 L/animal/day (Table1). There was a significant seasonal difference ($p<0.05$) in water intake as well as the operational water demand among calves, with a significantly higher consumption during the summer season.

The direct consumptive water usage of calves was 13.03±0.16, 23.76±0.12, and 17.57±0.09 L/animal/day during the winter, summer and rainy seasons, respectively. The overall average was 18.12±0.08 L/animal/day (Table 2). The total direct consumptive water use of calves differed significantly ($p<0.05$) between seasons with a significantly higher consumption during the summer season. These findings are consistent with those of Bray *et al*. (2008) [15], which indicate that the heat stress in domestic livestock causes the water consumption to increase significantly by 120–200%. The indirect consumptive water usage of calves was 506.50±8.47, 428.02±9.22, and 474.12±24.97 L/animal/day during the winter, summer and rainy seasons, respectively. The overall average was found to be 470.44±10.41 L/animal/day (Table 2). The overall indirect consumptive water usage of calves differed significantly ($p<0.05$) between seasons with a significantly higher consumption during the winter season. During the study period, the growing animals were provided with concentrate feed (wheat bran) and green fodder (jowar in summer and berseem in winter). Genetic composition, crop length, and environmental factors during growth are the primary factors influencing variations in crop water requirements (Singh *et al*., 2014) [11]. Indirect consumptive water usage was more during the winter since jowar, which is normally fed throughout the summer and rainy seasons, has a lower water footprint (267 L/kg DM) than Berseem (454.5 L/kg DM) given during the winter season. In addition, the higher consumption of dry matter and the availability of more feed and fodder in the winter compared to the summer and rainy seasons may also be the cause for higher indirect water demand throughout the winter.

The total consumptive water usage or the water footprint of growing Murrah buffalo calves was calculated to be 519.52±8.46, 451.78±9.25, and 491.69±24.99 L/animal/day during the winter, summer and rainy seasons, respectively. The average water consumption throughout all seasons was 488.56±10.42 L/animal/day (Table 3). The total consumptive water use of buffalo calves differed significantly ($p<0.05$) between seasons with a significantly higher consumption during the winter season. This can be attributed to the fact that about 99% of the water footprint of animal production is due to feed and fodder production, and that direct water usage at the farm level has only a minor impact [16]. The average daily gain (ADG) was calculated to be 0.50±0.006, 0.49±0.009, and 0.48±0.01 kg/day during the winter, summer and rainy seasons, respectively, with an overall average of 0.49±0.006 kg/day. This was further utilised for the calculation of water footprint of growth. The water footprint of growth in the growing Murrah buffalo calves was 1051.40±21.72, 957.08±33.98, and 1061.81±53.62 L/kg body weight during the winter, summer and rainy seasons, respectively, with an overall average of 1025.69±27.35 L/kg body weight (Table 3). The water footprint of growth in buffalo calves differed significantly (p<0.05) between seasons with a significantly higher total consumptive water use during the rainy season.

Table 1: Daily water requirement for drinking and operational purpose in Murrah buffalo calves

	Winter	Summer	Rainy	Overall
Water intake (L/animal/day)	8.75±0.15^{A}	16.11±0.12^{C}	11.83±0.07^{B}	12.23±0.07
Operational water demand (L/animal/day)	4.28±0.02^{A}	7.65±0.03^{C}	5.73±0.04^{B}	5.89±0.02

Values are expressed as Means±SE. ^{ABC} Means bearing different superscripts in a row differ significantly (p<0.05)

Table 2: Total direct and indirect consumptive water usage in Murrah buffalo calves

	Winter	Summer	Rainy	Overall
Direct consumptive water use (L/day)	13.03±0.16^{A}	23.76±0.12^{C}	17.57±0.09^{B}	18.12±0.08
Indirect consumptive water use (L/day)	506.50±8.47^{C}	428.02±9.22^{A}	474.12±24.97^{B}	470.44±10.41

Values are expressed as Means±SE. ^{ABC} Means bearing different superscripts in a row differ significantly (p<0.05)

Table 3: Water footprint for growth in Murrah buffalo calves under field conditions

	Winter	Summer	Rainy	Overall
Water Footprint (L/animal/day)	519.52±8.46^{C}	451.78±9.25^{A}	491.69±24.99^{B}	488.56±10.42
Average daily gain (kg/day)	0.50±0.006^{A}	0.49±0.009^{A}	0.48±0.01^{A}	0.49±0.006
Water footprint for growth (L/kg)	1051.40±21.72^{C}	957.08±33.98^{A}	1061.81±53.62^{B}	1025.69±27.35

Values are expressed as Means±SE. ^{ABC} Means bearing different superscripts in a row differ significantly (p<0.05)

Conclusion

The study found that the total amount of water used per animal per day was 488.56±10.42 L, whereas the water required for growth was 1025.69±27.35 L per kilogram of body weight. Evaluating the water footprint allows for the identification of strategies to optimise water utilisation and facilitates the adoption of improved livestock rearing methods. The productivity of water used in livestock production per unit of animal output is influenced by various factors, including feed conversion efficiency (the amount of feed needed to produce per kg of meat or milk), the composition of the diet (the proportion of roughage to concentrate), and the source of the feed. Hence, the evaluation of the water footprint and implementing appropriate managerial adjustments can enhance the sustainability of buffalo production systems.

References

1. FAO. Water buffalo: An asset undervalued. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. Ed; c2000. p. 1-6.
2. FAOSTAT. Food and Agriculture Organization of the United Nations; c2020. http://faostat.fao.org/site/567/default.aspx#ancor.
3. GOI. 20th Livestock Census-2019. Department of Animal Husbandry Dairying and Fisheries. New Delhi: Ministry of Agriculture.
4. Napolitano F, Pacelli C, Grasso F, Braghieri A, De Rosa G. The behaviour and welfare of buffaloes (*Bubalus bubalis*) in modern dairy enterprises. Animal. 2013;7:1704-13. https://doi.org/10.1017/s1751731113001109.
5. Mora-Medina P, Berdugo-Gutiérrez J, Mota-Rojas D, Ruiz-Buitrago J, Nava AJ, Guerrero-Legarreta I. Behaviour and welfare of dairy buffaloes: pasture or confinement? J Buffalo Sci. 2018a;7:43-48.
6. Guerrero-Legarreta I, Napolitano F, Mota-Rojas D, Cruz-Monterrosa R, Mora-Medina P, Berdugo-Gutiérrez J. The Water Buffalo: versatile, rustic and sustainable as a meat producer (In Spanish). Agro Meat. Buenos Aires, Argentina; c2019 Feb. p. 1-10.
7. Three Year Export Statement, APEDA. Retrieved from https://agriexchange.apeda. gov.in/indexp/ExportStatement.aspx.
8. De Vries M, de Boer IJM. Comparing environmental impacts for livestock products: A review of life cycle assessments. Livest Sci. 2010;28:1-11.
9. Mekonnen MM, Hoekstra AY. A global assessment of the water footprint of farm animal products. Ecosystems. 2012;15(3):401-415.
10. Hoekstra AY, Chapagain AK, Martinez-Aldaya M, Mekonnen MM. The water footprint assessment manual - setting the global standard. Accessed on 13th October 2021; c2011. http://www.waterfootprint. org/downloads/TheWaterFootprintAssessmentManual.pdf.
11. Singh OP, Singh PK, Singh R, Singh HP, Badal PS. Water intensity of milk production: a comparative analysis from water scarce and water-rich regions of India. Econ Aff. 2014;59(2):299.
12. Wankhade PR. Assessment of water footprint for the growth and milk production of dairy animals. Thesis, Ph.D. Deemed University, Indian Veterinary Research Institute, Izatnagar, India; c2021. p. 271.
13. Sastry NSR, Thomas CK, Sing RA. Shaeffer's formula for body weight of cattle described in farm animal management and poultry production. 5th edition. Vikas Publishing House, India; c1983.
14. Paul SS, Mahapatra S. Mineral Utilization and Water Metabolism in Buffalo Calves Fed on Roughage Based Diets. Indian J Anim Nutr. 2001;18:126-132.
15. Bray DR, Bucklin RA, Van Horn HH, Nordstedt RA, Bottcher AB, Gallaher RN, Chambliss CG, Kidder G. Water budgets for Florida dairy farms. EDIS. 2008;(4):1-6. DOI: 10.32473/edis-ds121-1993.
16. Noya I, Gonzalez-Garcia S, Berzosa J, Baucells F, Feijoo G, Moreira MT. Environmental and water sustainability of milk production in Northeast Spain. Sci Total Environ. 2018;616:1317-1329.

17. Hoekstra AY, Chapagain AK. Water footprints of nations: Water use by people as a function of their consumption pattern. Water Resour Manage. 2007;21:35-48.
18. Gerbens-Leenes PW, Mekonnen MM, Hoekstra AY. The water footprints of poultry, pork and beef: A comparative study in different countries and production systems. Water Resour Ind. 2013;1-2:25-36.