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DIFFERENT METHODS FOR STUDYING WATER BUFFALO BEHAVIOR, ACCORDING TO DIFFERENT OBJECTIVES - A REVIEW

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Abstract

The paper highlights different methods of observing, recording and analysing the particularities of water buffalo behaviour, as to serve different research purposes. Proper understanding of buffalo behaviour is critical for improving welfare and productivity in buffalo dairy farming. Different methodologies have been employed to study these behaviours, mostly from communities were intensive farming is practiced and buffalo have to deal with and adapt to these technologies. from housing conditions to qualitative assessments of emotional states. Qualitive behaviour assessment (QBA) is of the most interesting applied. Most studies employed Scan sampling technique for direct observations in farms or on the field, since it better suited the aims of the studies in assesing group behaviour. Continuous observation is less used than in the past because new solutions like QBA or NEDAP tags prove adequate.

Key words*: behaviour, methods of recording, water buffalo.*

INTRODUCTION

Water buffalo (*Bubalus bubalis*) are extraordinary animals. They have a unique set of behavioural traits determined by the environment they evolved in. Among other domesticated animals, water buffalo are truly artists. They have even stimulated traditional art and culture thru their behaviour, as sometimes they forced people in the Romanian country-side to play music for them in order to be milked, as stories go. Understanding the particularities of their behaviour is critical for improving welfare and productivity in buffalo dairy farming. Different methodologies have been employed to study these behaviours, each tailored to specific objectives, from housing conditions to qualitative assessments of emotional states. This review synthesizes findings from different studies, each employing distinct methods to evaluate water buffalo behaviour. It also acts as a precursor to an on-going PhD-candidate study on Romanian water buffalo behaviour from Northern Transylvania (Figure 1). Similar research is revealed in the review, similar strategies are evaluated and possible novelty items are taken into account, as to bring value to our mentioned study and also a add to the over-all knowledge regarding domestic water buffalo. As well known, water-buffalo have been a part of the lives of people in this part of the world for over a millennium, arriving alongside migratory people (Onaciu, 2006), most likely hauling the carts full of supplies, families and maybe looted objects. Apart from labour, milk and meat, provided to people how adopted this foreign species (Vidu, 2013), buffalo intertwined in local rural traditions (Popa et al., 2020), because of their distinct behaviour. The fairy-tale called *Dan and the white buffalo* collected by D. Stăncescu (Cuibus & Mireșan, 2021) is one such example, where buffalo act as wise old supernatural guides and advisors. They also symbolise vitality (Vasluian, 2018), even saving the hero's life, probably due to the vital role they played in homestead livelihood. The role of these animals in cultural aspects of human life, filtered by their empirically observed behaviour, is a profound argument for insuring their welfare and quality of life thru out the animal husbandry specific to buffalo (Jurco, 2022). Even though water buffalo fit very well with extensive farming, respectively small homesteads with few animals similar to those of the past, and still present in rural areas, proper welfare is not always achieved in these systems (Vidu & Enea, 2024). Present day

issues, especially concerning global warming signalled by extreme weather, high temperature, drought and so on, are important aspects concerning cattle welfare, and they stand as part of the objectives of assessing water buffalo behaviour thru out the studies examined in the present review.

Figure 1. Romanian water buffalo from Cristorel village in Cluj County, during a severe drought (original)

Figure 2. Water buffalo in Germany (Paulsberg, 2024)

The particularities of water buffalo behaviour make it especially worthy for study, as is proven by the large number of such research undertakings of the last years, along side the diversity of ethological study methods. As well stated by Velea et al. (2019), the gentle nature of water buffalo and strong attachment to humans entitles them to the nickname offered by renowned buffalo scholar W. Ross Cockrill, as the dog of the bovine world. Also, the mentioned Romanian author and respected authority on buffalo, highlights the behavioural paradox that is the buffalo, extremely suspicious at times, with fear and aggressive response implied, and at the same time almost extremely friendly and attachable, if properly reared and handled. All these aspects constitute the specific bubaline behaviour, which, apart from being a motivation for ensuring buffalo welfare, is also an indicator of this matter. Indeed, other aspects, like physiological status, weigh gain, haematological indices, milk quality and others, can constitute indicators of welfare as well, often correlated with behavioural patterns (Mireşan et al., 2016). Some of the articles cited offer insight on such aspects as well.

Consumer interest in animal welfare and the selective purchase pressure induced might be reasons for the extensive studies regarding natural behaviour in buffalo related to welfare. Media scandals involving cruelty towards buffalo calves in intensive farms in Italy have played a similar role. Water buffalo have been imported by western countries in the last decade, like Germany (Figure 2), for instance, with significant Eastern European and Balkan genetics (Noce et al., 2021). In such societies, the interest for animal welfare and food security is high, as well known.

As far as studying animal behaviour goes, the diverse methods implied are well established in the specific fields of science. P. Martin and P. Bateson offer a clear and concise approach to these aspects in their book *Measuring Behaviour* (Martin & Bateson, 2007). Therefore, sampling rules, referring to subjects of the ethological study imply four strategies: *ad libidum* sampling, focal sampling, scan sampling and behaviour sampling. Furthermore, recording rules translate into three methods: continuous recording, instantaneous sampling and one-zero sampling. Qualitive behaviour assessment (QBA) and others were also applied. Different researchers use different methods mostly related to opportunity and practicality, also related to their research objectives. In the final part of the paper, a look is taken at similar research done on wild buffalo. Wild *Bubalus bubalis* from Bangladesh and African buffalo (*Syncerus caffer*) a different, but related, species with a significantlly similar behaviour to domestic bubaline. Over time, numerous studies have been done regarding these animals behaviour as they are the last lage size wild herds and the way they have evolved activity patterns, specific for their species in response to issues

posed by their habitat and ecology (Megaze et al., 2016), are illustrative for domestic species as well.

MATERIALS AND METHODS

This review was realised by consulting a number of bibliographical references, focused on water buffalo behavioural studies from recent years, and adherent to specialised and professional literature. Databases that were accessed include Google Academics, Frontiers, Science Direct, Springer, and Researchegate. As research methods used, analytical and critical approaches can be pointed out, as well as synthesizing the relevant information and organising facts in the body of the review and table. Identifying and highlighting the ethological recording methods related to the author's objectives along their research, was the main scope of this paper, with the general focus on water buffalo.

RESULTS AND DISCUSSIONS

As previously stated, this paper reviews different ways of studying water buffalo behaviour, and not the actual behaviour, as the subject has gained interest in the past decades, and a number of well documented reviews have been published, like that ode la Cruz Cruz et al. (2014) or Mota-Rojas et al. (2019), not to mention the elaborate book *El Búfalo de Agua en las Américas: Comportamiento y Productividad* , edited by prof. Mota-Rojas that has reached a 5th edition, and to which, one of the authors of the present paper, namely A. Cuibus has collaborated on three chapters.

Thus, Italian authors have conducted numerous studies on water buffalo behaviour since they use intensive rearing technology on this primitive species, which has resulted in some adaptation problems which interfere, of course with welfare. In 2009, Cavallina et al conducted an interesting study regarding the lactating water buffaloes response to mechanised milking. The study investigates the behavioural responses of buffaloes to machine milking, focusing on stress indicators, milk let-down efficiency, and overall adaptation to the process. It was performed with 10 observations per animal during the milking process. Thus, this scan sampling method was used to fit the objective of analysing strict the milking behaviour. In the end, the study emphasizes the importance of gentle handling, familiarization with milking procedures, and environmental modifications to improve buffalo welfare and milking efficiency.

Also, a relevant study was conducted by de Rosa et al. (2009) for instance, whom employ an Instantaneous scan sampling method along with milk production measurements on 88 multiparous lactating buffaloes in order to assess the effect of two housing systems, the wallowing opportunity being the difference. Observed behaviours included rumination, feeding, social interactions and others. The buffaloes were subjected to 8 sessions of instantaneous scan sampling at 10 days intervals. The study concluded that access to a pool and extended space improves welfare, social interactions and increases milk production. Interestingly, greater social interactions like sniffing nuzzling and social lickings increased in the group of water buffaloes that had access to wallowing than in group that did not (0.120 ± 0.010 vs. 0.067 ± 0.010, and 0.151 ± 0.018 vs. 0.090 ± 0.018, for instance)

Napolitano et al. (2012) was very prolific in this area, having numerous studies on buffalo ethology and pioneered buffalo welfare. The more recent studies, of interest here, one from 2012, implied the first use of Qualitative Behaviour Assessment (QBA) to water buffaloes, for assessing the reliability of this method. It implies observers with different cultural and experiential backgrounds that asses the recorded behaviour of the animals. Eight buffalo heifers (16-18 months old) were tested in two settings: a familiar indoor one, and a strange outdoor one. Each buffalo was filmed for 2.5 minutes in both settings. The videos were analysed by three groups of observers, revealing that animals in the outdoor paddock were more agitated and active, while indoors seemed calmer. The three groups showed high agreement in their qualitative assessments ($p < 0.001$), proving the reliability of the QBA method (Napolitano et al., 2012).

Another study led by the same scholar in 2015 explored the use of a continuous method for QBA for dairy buffaloes, integrating also

Temporal Dominant Behavioural Expression (TDBE). This is a recent methodology created for the field of sensory analysis with the opportunity to describe the evolution of the dominant perceptions happening while testing and relying on a fixed list of terms. The scope of the study was to analyse how buffalo behaviour changes dynamically in time and different environments. Eight heifers were recorded in similar conditions to the previous experiment, numerous behaviours being tracked. Conclusions revealed that QBA combined with TDBE efficiently tracks dynamic shifts for water buffalo behaviour (Napolitano, 2015).

An interesting study was performed by polish I. Antkowiak et al. using instantaneous scan sampling once per hour over a 10-h period, related to weather conditions, upon a group of 26 buffalo imported to Poland from Romania. The study took place on a large ecological pasture with three different wallowing opportunities. The results of this undertaking proved that constant access to a facility for wallowing allowed buffalo welfare not to be compromised during high recorded summer temperatures (Antkowiak, 2012; Vidu et al., 2013).

A research team in Pakistan led by Quddus evaluated the accuracy of NEDAP SmartTag technology in monitoring key behavioural activities of 30 water buffaloes (feeding, rumination, lying, and standing) by comparing it with manual visual observations and video recordings. The research may have a positive impact in improving precision livestock management. Researchers used manual visual observations and video recordings as reference methods to assess the accuracy of NEDAP's data. Data were collected over a specific period and analysed for correlation between the automated system and traditional methods. For comparison, visual observations were made for 2 hours 4 times per day, discontinuously. The feeding time monitored by NEDAP was 25.2 2.7 higher ($p < 0.05$) than visual observation and video recording. Rumination, lying, and standing time proved lower ($p < 0.05$) in buffaloes when monitored by the NEDAP technology than by visual observation and video recording. Conclusions showed that the system provides accurate and efficient behavioural tracking, making it a valuable tool for precision livestock farming (Quddus, 2022).

For an interesting comparison, a couple of papers regarding the behaviour of wild African buffalo have been taken into account. This was also undertaken to evoke the observational methods used. Therefore, in 2007 Melleti et al. undertook a study on the more elusive *Syncerus caffer nanus,* the forest buffalo. They analysed behaviours of the herd as well as social interactions among members of the herd. Individually they tracked the behaviour of an individual male, as well as that of females and juveniles. Direct observations were used with binoculars, as well as digital cameras This method suited best the purpose of the study. Formulated conclusions evoked that the buffalo gathered in smaller and more dispersed groups during the wet season. Also, higher aggregation behaviour was discovered near forest edges (Melleti, 2007).

Another paper, by A. Megaze et al, conducted in 2016, examines how African buffalo (*Syncerus caffer*) in an Etiopyan National Park, allocate their activity time across different periods of the day and seasons. The focal-animal sampling method was used to observe buffalo behaviour recordings been taken every 5 minutes for 12 h. The method fit the scope of the research as it saw major activities of selected individuals could be measured accurately by observing a group at a time. Results of this research confirmed that feeding and resting time of these wild buffalo was influenced by the time of day and the seasons (Megaze, 2016).

In 2023, Hossain et all carried out a research comparing the behavioural patterns of wild or semi-domesticated Asian *Bubalus bubalis* to that of a local competitor, on the island area taken into study, respectively *Axis axis*, Spotted deer. The study brings welcomed insight into wild buffalo behaviour. It was done using scan sampling methods and direct observations. Once every month, every 2 minutes for 12 hours, observations were done on 5 individuals. A wide spectrum of behaviours were recorded and analysed making them illustrative to reproduce here since they could stand as a pattern of possible natural behaviour for domestic buffalo.

Table 1. Comparative Analysis of Water Buffalo behaviour assesment

Species	Habitat	Group Size	Observed Behaviors	Method of Behavioral Recordings	Findings	Source
Domestic buffalo (*Bubalus bubalis*)	Commercial intensive farm	14 individuals	Kicking, stepping, defecating, urinating, vocalizing, pulling the teat cup off	Instantaneous scan sampling during milking	The relationship between kicking, stepping and urinating occurrence and stress the need to administer oxytocin	Cavallina et al, 2008
	Farms with or without access to a pool	45-90 individuals	Rumination, feeding, social interactions	Instantaneous scan sampling, milk production measurements	Access to a pool and extended space improves welfare, social interactions, increases milk production	De Rosa et al., 2009
	Intensive farm, indoor and exterior paddock	8 heifers	Latency, run, vocalization, flight attempts, sniffing	Qualitive behavior assessment 2,5min recordings	Outdoor- more agitated and active, while indoor pen- more calm and relaxed. QBA reliable	Napolitano et al., 2012
	Intensive farm, indoor and exterior paddock	8 heifers	Inactive, run, vocalization, flight attempts, vigilance, exploration, urinating, defecating	QBA; Temporal Dominance of Sensations (TDS)	QBA combined with TDBE effectively tracks dynamic shifts in buffalo behavior	Napolitano et al., 2015
	Certified ecological and agro-tourism farm	26 individuals	Grazing, ruminating, standing, lying or wallowing	Instantaneous scan sampling once per hour over a 10-h period	Constant access to a facility for wallowing - welfare was not compromised during high summer temperatures	Antkowiak et al., 2012
	Conventional didactic farm	30 individuals	Feeding, rumination, lying, and standing behaviors	NEDAP tags, visually observed behavior 2hx4 Video recorded	Behavior monitored by NEDAP tags- precise and acceptable, compared with visual observation and video recording	Quddus et al., 2022
Wild Asian buffalo (*Bubalus bubalis*)	Tropical forested area, grazing land, and human habitations	5 individuals	Resting (standing and laying) ruminating foraging social behavior: and fighting, sniffing and wallowing alarm	Scan sampling technique from direct field Observations,, every 2 min/12 h/once a month	Wild buffaloes spent more time in foraging than that of the other activities	Hossain et al. 2023
Forest buffalo (*Syncerus caffer nanus*)	Tropical forests, natural clearings	16-24 individuals	Resting, rumination, grazing, movement, social interactions	Direct observations using binoculars and digital cameras	Smaller and more dispersed groups during the wet season; higher aggregation behavior near forest edges	Melletti et al., 2007
African buffalo (*Syncerus caffer*)	Mountain forests and grassland	7 individuals	Feeding, resting, lying down, standing, others	Focal-animal sampling method	Feeding and resting time was influenced by the time of day and the seasons.	Megaze et al., 2016

Thus, wild Asian buffaloes, spent 60.88% of their diurnal time moving, foraging, AND engaging in social behaviour. 35.41% of time was spent resting, sometimes with ruminating and 3.7% of time represented alarm behaviour. Among the major activities, they spent maximum time in foraging 36.41% with grazing for 28.19% and browsing for about 8.22%. Then, resting took 22.49% with standing for 16.06% and laying for 6.43%, while moving took 14.53% of time, with walking amounting to 14.51% and running to 0.02%, also ruminating took 12.92% of time, with standing while ruminating seen as 6.02% and laying doing so for 6.90% of time. Also, 9.94% was spent in social behaviour, with wallowing amounting to 8.56%, and fighting to 0.30%, with sniffing/smelling for 1.08% and 3.7% of time spent in alarm and precaution towards possible predators. Conclusions of this impressive study involved highlighting that most time is spent foraging for food, and ethological information is useful for wildlife management and protection.
Selected aspects have been synthesized in Table 1 for an easier comparison.

CONCLUSIONS

The particularities of water buffalo behaviour has made it an attractive theme for researchers worldwide. This is proven by the large number of studies of the last years, alongside the diversity of ethological study methods applied. The studies highlight the behavioural paradox of buffalo, fearful and aggressive sometimes and at the same time almost friendly, curious and adaptable. As seen, most studies employed Scan sampling technique for direct observations in farms or on the field, since it better suited the aims of the studies to assess group behaviour. Some also used the QBA method of assessing with adequate results. Continuous observation is less used than in the past because new solutions like QBA or NEDAP tags prove adequate, and according to objectives of study, most related to adaptation to intensive rearing technologies. All such research can contribute to proper management of welfare provided to these animals that properly reared and handled can sustainably produce superior milk and products.

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