



Review article

Genetic analysis and evaluation of behavioural traits in cattle



Krzysztof Adamczyk^{a,*}, Joanna Pokorska^a, Joanna Makulska^a,
Bernadette Earley^b, Mickael Mazurek^b

^a University of Agriculture in Krakow, Department of Cattle Breeding, 30-059 Kraków, Al. Mickiewicza 24/28, Poland

^b Animal and Bioscience Research Department, Animal & Grassland Research and Innovation Centre, Teagasc, Grange, Dunsany, Co. Meath, Ireland

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ABSTRACT

The behavioural traits of cattle in terms of docility and manageability have traditionally been the main factors that allowed the domestication of, and use of cattle by humans. Behavioural traits have a profound effect on cattle longevity and are very useful in the assessment of animal welfare and determination of ethical limits to animal handling by humans. In this review, we (1) discussed issues relating to the genetics of the behavioural traits of cattle, (2) characterise current status of cattle breeding in terms of behavioural traits, at the level of population and molecular genetics, giving special consideration to high individual variation in behavioural traits and their relatively high correlations with milk and meat performance traits, (3) discuss the present state of knowledge concerning the identification of quantitative trait loci (QTL) for behavioural traits of cattle, (4) characterise major problems that impede breeding progress in cattle behaviour, including great diversity of methods used for the assessment of behavioural traits and the considerable degree of its subjectivity. In summary, we show the need for systematically improving the effectiveness of cattle breeding with a focus on behaviour, including the consistent and uniform definition of behavioural traits and objective measures of their assessment.

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* Corresponding author. Tel./fax: +48 12 6624162.

E-mail address: rzadamcz@cyfronet.pl (K. Adamczyk).

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1. Introduction

The first cattle that were domesticated were *Bos primigenius*. People kept cattle for easy access to food, including milk, blood, and meat, and for use as load-bearers and as work animals (e.g. ploughing). *Bos taurus* cattle were domesticated approximately 8000 years ago (Hirst, 2009). Cattle use their senses to communicate, thus their behaviour will largely depend on their perception. Most forms of communication are related to the important sensory perceptions, for example, vision, sound, smell and touch. The means of communication will have an important impact on the group structure and cohesion (Albright and Arave, 1997; Phillips, 2002). Cattle behaviour is a means of communication between animals and their environment, enabling them to satisfy the needs necessary for survival of the species under different environmental conditions (Phillips, 2002; Fraser and Broom, 1997; Broom and Fraser, 2007). The way an animal will react will most of the time directly depends on its senses, sensory-related behaviour or its sensory environment. Cattle possess the same senses as other mammals: vision, olfaction, hearing, touch and taste. The most important behavioural traits without which animal domestication and breeding would be impossible include: the capacity for a gradual reduction of fearfulness towards humans; the ability to become gradually subordinate to humans as a dominant individual, the ability to learn desired responses and behaviours, the capacity to breed and to rear offspring under human-created conditions; and the capacity to accept feed provided by humans (Keeling and Gonyou, 2001; Jezierski, 2004). Since the behavioural traits of cattle affect their longevity, breeders regard them as workability traits (Boettcher, 2005; Fogh et al., 2009).

Thus the process of cattle domestication and their genetic improvement depend on the flexibility of behavioural traits of animals, which have to adapt to the conditions created by humans (Mignon-Grasteau et al., 2005). These traits play an important role in human–animal–environment relationships, which is particularly noticeable in intensified milk and beef production, when behavioural disorders (e.g. lameness, bar-biting, tongue-rolling, excessive licking and grooming or the buller steer syndrome) in cattle are especially frequent (Grandin and Deesing, 1998; Phillips, 2002; Brouček et al., 2008). Selection towards single purpose breeds induced behavioural changes more especially in the *B. taurus* species (Burrow, 1997; Von Keyserlingk and Weary, 2007; Hoppe et al., 2008; Cozzi et al., 2009; Prendiville et al., 2010; Titto et al., 2011).

Flexibility of behaviour enables animals to cope with their human-created environment and enables breeders, while respecting the behavioural needs of animals, to obtain higher quantity and/or better quality products from them (Price, 2003; Gruber et al., 2010; Sheahan et al., 2011).

Behavioural traits are therefore helpful in assessing cattle welfare and thus in determining the ethical limits to animal handling by humans (Praks et al., 2007; D'Eath et al., 2009; Nicol, 2011).

The considerable role of cattle behaviour from the perspective of milk and beef production resulted in behavioural traits being increasingly used in breeding programs for individual breeds in many countries (Miglior, 2004), although these traits appear to be much more difficult to assess than production traits. This is strictly dependent on the progress of knowledge on cattle behaviour and its genetic and environmental determinants (Mormède, 2005).

Therefore, the aim of this paper was to review the key problems in efficient breeding for behavioural traits of cattle, including their phenotypic evaluation, utilisation of population and of molecular genetics in the estimation of genetic parameters and breeding values. Additionally, examples of cattle selection for behavioural traits across countries were reviewed and presented.

2. The main problems in the evaluation of cattle behaviour

2.1. Definition of behavioural traits

Cattle behaviour is a function of the whole brain/body and the molecular pathways involved in genetic variability (Herskin et al., 2004; Van Reenen et al., 2004; Mormède, 2005). The plasticity of cattle behaviour and the learning capacities are well developed and are comparable with that of other mammals such as rodents, cats and horses (Kilgour, 1981). Cattle learn by memorising information received by their sensory organs. The information is analysed in the cerebral cortex and learning is made by association, generalisation or discrimination of the stimuli (Albright and Arave, 1997).

Robust evaluation of behavioural traits is difficult due to the problems with their definition and subjectivity of measurement. This even applies to such a seemingly well studied trait as cattle temperament. For example, Hurnik et al. (1995) hold that temperament is an animal's general trait that includes behaviours such as level of physical activity, persistent habits, emotionality, alertness and curiosity. According to the same authors, animal temperament depends on the interaction between excitatory and inhibitory reactions. Meanwhile, Burrow (1997) regarded temperament only as an animal's behavioural response to handling by humans. Likewise, Phillips (2002) defined this term as an animal's main personality or mood trait in relation to humans. Sewalem et al. (2011) state that milking temperament is broadly defined as milking behaviour, ease of handling or aggressiveness at feeding.

Depending on the definition of cattle temperament different methods of its assessment are used in research and breeding work. Burrow (1997) classified several

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