ASSESSING BEEF CATTLE WELFARE VIA SMART WEARABLE SENSORS IN INTENSIVE AND EXTENSIVE FARMING SYSTEMS

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Abstract

Beef cattle welfare is traditionally assessed through periodic visual inspection, a subjective and discontinuous method. This review examines smart wearable sensors, including accelerometers, GNSS collars, and physiological monitors, as continuous alternatives for welfare assessment, using the Five Domains Model as a framework, and compares performance in intensive versus extensive systems. Evidence on sensor validation, behavior classification, GPS/GNSS tracking, virtual fencing, and heat stress and lameness monitoring was synthesized across seven thematic areas. Results show behavior-classification technology has reached reasonable maturity, increasingly validated on beef-specific breeds, but formal validation and translation of sensor output into welfare outcomes remain markedly less developed for extensive systems and beef cattle relative to dairy cattle. Mapping this gap, the review offers an original, system-specific synthesis guiding future validation priorities.

Key words: *beef cattle welfare, wearable sensors, precision livestock farming, intensive and extensive systems*