

Introductory notes for the Acta IMEKO thematic issue on Measurements and Applications in Veterinary and Animal Sciences

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Dear Readers,
this thematic issue collects research papers about measurement systems, methods, instruments, and sensors applied for the health care and diagnostics in veterinary medicine, as well as for the monitoring and capture of biological information related to animal's health, behaviour and growing in Precision Livestock Farming (PLF), which is expected to optimize animal production and welfare. Measurements and applications in veterinary medicine, animal sciences and PLF encompass a diverse array of techniques and tools that contribute to the comprehensive understanding, management, and care of animals. With special regard to veterinary medicine, measurement science plays a pivotal role in diagnostics and treatment. Accurate measurements provide essential data for diagnosing illnesses, monitoring responses to treatments, and ensuring the overall well-being of animals under veterinary care. In the field of animal science, PLF represents a new frontier to improve and guarantee environmental, social and economic sustainability of livestock systems.

Beyond clinical settings, measurements find extensive applications in animal sciences, aiding researchers in studying various facets of animal biology and behaviour.

In [1] the authors propose a measurement method based on impedance to detect *Escherichia coli* in Bivalve Molluscan Shellfish (BMS). Indeed, BMS have an important role in the transmission of some pathogens, including *Escherichia coli*, responsible for food-borne disease because they are filter-feeding animals capable of greatly concentrating certain pathogenic agents present in the water column. The reference method for *E. coli* testing in bivalves is the most probable number (MPN) method (EU Regulation 2019/627), but this method has some

disadvantages: labour-intensive, time-consuming (showing results only after three days), and has statistical limitations on precision. The method proposed by Authors is based on the principle that bacteria produce positively or negatively charged end products causing an impedance variation of the medium that can be used to measure their growth. The efficiency and the effectiveness of the direct impedance measuring technique was demonstrated through a series of laboratory tests performed on 6 kg of clams belonging to two different batches.

Rational heifer management in buffalo (*Bubalus bubalis*) rearing is of paramount importance. There are no studies in the literature dealing with automatic feeding in individual boxes for buffalo calves. The research presented in [2] aims to deepen knowledge in this area and to evaluate the ability of buffalo calves to adapt to a mobile automatic feeder through data provided by the system's monitoring software. The experimental results presented in the paper shows that the buffalo calves are able to adapt to this type of feeding, making use of its advantages.

Genetic evaluation in the Italian Mediterranean Buffalo (IMB) traditionally relied on the BLUP method (Best Linear Unbiased Predictor), a mixed model system incorporating both random and fixed effects simultaneously. However, recent advancements in genome sequencing technologies have opened up the opportunity to incorporate genomic information into genetic evaluations. The ssGBLUP (Single-Step Best Linear Unbiased Predictor) has become the method par excellence. It replaces the traditional relationship matrix with one that combines pedigree and genomic relationships, allowing for the estimation of genetic values for non-genotyped animals. The findings of the study presented in [3] highlight how genomic selection enhances the precision of breeding values, facilitates greater genetic

advancement and reduces the generation interval, ultimately enabling a rapid return on investment.

The eel (*Anguilla anguilla*) population in Europe has declined dramatically since the 1980s and shows no signs of recovery. There are several threats to this species: migratory barriers, loss of habitats, hydroelectric dams, overfishing, and illegal trade. As a result, the eel has become part of the ICUN endangered species and is protected by various institutions. Information data on the maturation stage is needed to monitor silver eel escapement and assess population trends. In the sampling activities spanning from 2012 to 2022 silver index was calculated on 1852 eels in the northern Adriatic Sea. With the help of machine learning technology, the Authors in [4] trained an algorithm in pupil recognition and the calculation of horizontal eye diameter in eels. This allows to identify a single parameter to discriminate the sexual maturity of the eel and thus to know the female with a migratory instinct and to use this parameter as a proxy to develop an easy and user-friendly app for all management operators.

The negative impact associated with the presence of wild boars (*Sus scrofa*) throughout the Italian territory, as well as throughout Europe, is mainly linked to the damage caused to agriculture and the road accidents that this species is capable of causing during the year. In [5] Authors have measured the passage times of a wild boar family group along a known track and in two years they evaluated the frequency of the time slots in which pubescent and adult females meets the adult males to mate. Results show that family group of wild boars stably structured, has frequented the specific point in constant time slots and this fact helps researchers to estimate a dynamic behaviour of local population. These measurements and results are promising for the management of the wild population.

In [6], a proposal for an Internet-of-Things (IoT) based measurement system dealing with the enteric methane (CH₄) emission monitoring from ruminants is presented. Herein, a brief overview of the recent advances in sensors technologies and their IoT integration for realizing measurement systems able to monitor the CH₄ emissions in ruminants is also presented. Nowadays, it is confirmed that CH₄ emissions, which are mainly produced during normal fermentation of feeds (and fiber in particular) by the rumen microorganisms, are part of the Green-House Gas (GHG) emissions. Therefore, a classification of the existing measurement methods, sensing technologies and their impact on the animal's welfare is presented so as the measurement system together with the sensing elements and the developed data acquisition system. A preliminary disposal and field trials of the developed system in a farm facility is given showing the effectiveness of the proposed solution.

The paper in [7] discusses the challenges facing the dairy industry due to increased farm sizes and reduced staff-to-animal ratios, which are impacting animal welfare. The development of PLF technologies has gained momentum to address these challenges. PLF technologies can assess animal welfare and health status by monitoring animal behaviour and biological changes, and alerting farmers of any issues. However, the applicability of PLF tools in other productive phases of the dairy cattle is still limited. The article focuses on the challenges of managing unweaned dairy calves, particularly the variability in relation to when calves start consuming solid feed, and how PLF technologies can be used to monitor individual calf intake and manage weaning at the individual level. The attention is mainly focused on the advantages of using automated feeders for unweaned dairy calves, including labour savings, greater precision in measurement and control of individual intake of

liquid and solid feed, and higher preweaning growth rates. In particular, a method is proposed, involving a 3D depth camera and a proper algorithm to measure the volume and weight of eaten feed. The method is preliminarily assessed in tests conducted in laboratory, which highlight a remarkable concurrence (differences as low as 2 %) with respect to nominal values.

In 2022, there was a 25.77 % increase in work-related accidents reported in Italy, including 1090 with a fatal outcome. Legislative Decree 81/100 regulates worker safety and requires employers to assess risks and implement necessary interventions. When risks cannot be eliminated, employers must provide appropriate Personal Protective Equipment (PPE). However, safety management requires large investments and supervision to ensure proper use of PPE. The current regulatory system, which focuses on punishing noncompliance with safety requirements, has been insufficient in deterring workplace accidents. To address this, the National Institute for Insurance against Accidents at Work (INAIL), is introducing incentives and substantial discounts on insurance costs for companies that carry out preventive actions. In [8], the authors propose an innovative tool that leverages IoT and Blockchain technologies to record safety related events in an immutable and transparent way, quantifying the level of achieved safety. They suggest setting up a system consisting of PPE with RFID technology and an automated surveillance agent to record operations and issue consents. The number of events recorded in Blockchain can quantify the degree of achieved safety.

Precision Livestock Farming, as a specific sub-sector of Public Health Informatics, focuses on the application of process engineering principles and techniques to achieve an automatic monitoring, modelling, and management of animal productions. In [9] a timely "protocol" is proposed for unobtrusive direct/indirect monitoring of biometric parameters for the estimation of body conditions on Mediterranean Buffalo populations, using low-cost automated systems already present on the market i.e., smart cameras endowed with depth perception capabilities.

The adoption of Automatic Milking Systems (AMS) in Europe and Italy has been increasing gradually in recent years, driven by the advantages they offer over traditional milking methods. AMS reduces the need for manual labour, increases milk production, standardizes teat cleaning and disinfection, and promotes animal welfare. The adoption of milking robots also allows for continuous monitoring of milk parameters, animal health status, and production performance. In [10], the authors analysed the improvements achieved by a buffalo farm in Southern Italy that switched from an older model (Classic) to a newer generation model (VMS 300) of milking robot, showing an increase in production quantity and quality.

We hope you will enjoy your reading.

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Section Editors

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