



Original Research Paper

Ethical Animal Management Framework for Evaluating Welfare Practices in Modern Livestock Systems

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Key Words	Abstract
Animal welfare, Livestock Management, Ethical framework, Welfare indicators, Precision Livestock farming, Sustainability	The modern-day livestock industry faces increasing criticism concerning ethical treatment of animals due to intensification, technological advances and changing social expectations. However, contemporary methods for assessing welfare mostly concentrate either on physical health parameters or narrow regulatory compliance issues, neglecting more holistic approaches which would cover physical, behavioral, affective and governance aspects of animal welfare at once in a single evaluation system. In this paper an Ethical Animal Management Framework (EAMF) for evaluation of welfare practices in intensive, semi-intensive and extensive livestock production systems will be proposed. Welfare assessment will be made based on five interrelated dimensions, namely: physical health; behavioral activity; affective state; ethical-procedural governance; and impact of technology on welfare. Taking from the current welfare science and animal ethics literatures, the framework incorporates scientific welfare criteria with ethical criteria to facilitate the identification of welfare deficiencies and priorities for interventions by the producer, auditor, and policymaker. The present study also provides an illustration of the use of this framework by conducting a comparative analysis among three different types of livestock systems, emphasizing the areas where technological interventions such as precision livestock farming and virtual fencing have either helped improve or degraded welfare outcomes. The suggested ethical animal management framework provides a tool for welfare auditing that is replicable and ethical.

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Introduction

Animal agriculture is integral to food security, rural development, and national economies; however, in the last few decades, there have been fundamental changes in livestock production methods. Facility consolidation, housing intensification, and automation and data-driven technologies have made livestock production more efficient, but at the same time, have distanced consumers from the truth of animal husbandry (Lee et al., 2018). The increasing distance between consumer and livestock husbandry has led to increased consumer awareness about the treatment of livestock, which has created a need for methods of assessing welfare practices that are objective and based on scientific evidence.

Animal welfare science has made great strides, making it possible to assess physiological stress, injuries, and abnormal behavior (Fraser et al., 1997). Nonetheless, welfare is not only a biological state, but also an ethico-normative concept which is influenced by social norms about what constitutes appropriate treatment of sentient beings (Hurnik & Lehman, 1988). Therefore, assessment tools relying only on the biomedical and production-based parameters may fail to take into account the ethical aspects of husbandry decision-making, such as openness of procedures, informed consent in a research setting, and introduction of new technologies of management whose welfare implications remain unknown (Brink & Lewis, 2023; Broom, 2011). Meanwhile, discussions on sustainability have put the welfare of animals forward as an equally important dimension along with environmental

and economic ones (Buller et al., 2018; Boyle & Stevenson, 2025).

Against this backdrop, there is no single model that would incorporate the measurement of physical welfare, behavioral and affective states, ethical standards of governance, and assessment of technological influence. The present research attempts to address this problem.

Key Contributions

The present paper offers the following contributions:

- (i) It develops the Ethical Animal Management Framework (EAMF) – a five-dimensional framework that incorporates physical, behavioral, affective, ethical-procedural and technological welfare aspects into one evaluative construct.
- (ii) It defines operational measures of each aspect with a view to applying them for scoring through an auditing rubric.
- (iii) It shows how the developed framework can be applied by evaluating several types of animal husbandry – intensive, semi-intensive and extensive – showing how welfare issues emerge from production intensification and technologization of farming.
- (iv) It outlines the potential implications of the framework in practice.

Paper Organization

The rest of this paper is organized as follows. The next section provides an overview of relevant literature in animal welfare science, ethics, and technology-enabled animal welfare assessment. Section 3 outlines the Ethical

Animal Management Framework that I have developed, including the five dimensions and a scoring rubric used to evaluate systems against this framework. Section 4 shows a comparison of different livestock management systems using the new framework.

Related Work

Earlier ethical discussions of farm animal welfare revealed that there is no separation of scientific and ethical components in the analysis of the farming system; according to such theories, the practice of agriculture should be evaluated not only with regard to the animal but also in terms of the ethical responsibility of the producer (Hurnik & Lehman, 1988). Taking this point forward, Fraser et al. have defined a scientific understanding of welfare which integrates ethical issues about biological function, natural living, and affective state (Fraser et al., 1997). Moreover, Broom has integrated welfare concepts and welfare measures, noting that the evaluation of welfare needs several converging measures rather than one biological proxy (Broom, 2011).

In the field of research ethics, similar approaches to the integration of ethical principles and practices have been used. For example, 12 Rs approach represents the extension of the Three Rs paradigm by integrating responsibility, risks, and respect into the ethical principles of humane treatment (Brink & Lewis, 2023). Though this concept was created in the research context, it shows how useful can be an approach using a principle-based evaluation tool.

Welfare assessment based on technology has developed into a separate issue in the light of increased adoption of technology-enabled precise livestock farming technologies such as virtual fencing, monitoring through sensors, and automatic husbandry (Lee et al., 2018). In their model, Lee et al. suggest a particular approach to assess the welfare effects of new technologies in terms of the challenges to the learning capacity and cognition of animals (Lee et al., 2018). Therefore, it becomes important to include the dimension of technology impact in any comprehensive welfare evaluation system.

Finally, sustainability-oriented studies have emphasized the importance of animal welfare as an integral part of sustainable livestock production along with the environment and economy and argued that technological innovations should not replace animal welfare as the key area of reform (Buller et al., 2018; Boyle & Stevenson, 2025). In this regard, ethical-procedural governance becomes a necessary component of the proposed framework because the outcomes of welfare are influenced not only by the way farms operate but also by institutional accountability issues. The above-mentioned body of literature is a conceptual basis of the multidimensional framework introduced in Section 3, yet no previous study has combined these different aspects into one practical auditing framework.

Proposed Ethical Animal Management Framework

The Ethical Animal Management Framework (EAMF) categorizes welfare assessment in five

related dimensions that consider the combination of the welfare science and animal ethics presented in Section 2: Physical Welfare, Behavioral Welfare, Affective / Mental State, Ethical-Procedural Governance, and Technological Impact. These dimensions are measured by a set of specific indicators, based on

both welfare science and ethical governance criteria (Fraser et al., 1997; Broom, 2011; Hurnik & Lehman, 1988; Brink & Lewis, 2023). The Table 1 describes all five dimensions and their main indicators together with a particular method of evaluation.

Table 1: Dimensions of the Ethical Animal Management Framework

Dimension	Core Indicators	Evaluation Method
Physical Welfare	Body condition, injury prevalence, disease incidence, mortality rate, growth parameters	Clinical inspection, health records review
Behavioral Welfare	Expression of species-typical behavior, abnormal/stereotypic behavior, space allowance	Direct/video behavioral observation
Affective/Mental State	Fear and distress responses, positive engagement indicators, human-animal interaction quality	Qualitative behavioral assessment, stress physiology
Ethical-Procedural Governance	Transparency of husbandry decisions, staff training, compliance auditing, grievance/redress mechanisms	Document review, stakeholder interview
Technological Impact	Cognitive/learning demands of new systems, monitoring intrusiveness, autonomy retained by animal	Technology impact checklist, pre/post adoption comparison

For the comparative audit to be possible, each indicator within a dimension is rated on a four-scale ordinal rating scale (Poor: 0; Marginal: 1; Acceptable: 2; Good: 3). Scores for each

dimension are determined by taking an average score of all indicators' scores. Table 2 provides the scoring scheme which is used across dimensions.

Table 2: EAMF Scoring Rubric

Score	Label	Description
0	Poor	Indicator absent or actively violated; welfare compromised with no mitigating practice in place
1	Marginal	Indicator partially addressed; inconsistent practice or minimal documentation
2	Acceptable	Indicator substantially met; practice documented and generally consistent
3	Good	Indicator fully met; practice is consistent, documented, and independently verifiable

The EAMF generates the composite score by averaging the five dimension-level scores to generate an overall welfare ethics score ranging from 0 to 3 for a particular farm, unit, or management system. The dimensions are recorded individually as well as in aggregate, and

hence, the framework retains its diagnostic capacity to help the auditor pinpoint which particular dimension accounts for the low composite score.

Comparative Application Across Livestock Systems

To show how useful this EAMF framework is for diagnostics, this section provides an indicative comparative assessment of three representative livestock production systems: intensive confinement systems, semi-intensive systems, and extensive pasture-based systems. This comparison is meant to show how the

framework reveals welfare trade-offs related to production intensity and technology adoption, in line with sustainability and technology impact issues highlighted in earlier literature (Lee et al., 2018; Buller et al., 2018; Boyle & Stevenson, 2025). Table 3 shows the indicative scores of each dimension under each system type based on the typical management conditions as reported in the reviewed literature.

Table 3: Indicative EAMF Dimension Scores by Livestock System Type

Dimension	Intensive System	Semi-Intensive System	Extensive System
Physical Welfare	2.0	2.3	2.1
Behavioral Welfare	1.2	2.0	2.7
Affective/Mental State	1.3	2.0	2.5
Ethical-Procedural Governance	1.8	2.0	1.6
Technological Impact	1.5	2.2	2.4
Composite EAMF Score	1.56	2.10	2.26

This comparison shows that one of the patterns that exist in welfare literature is that intensive systems have high ratings for physical well-being because of the high level of veterinary attention and control and low ratings for behavioral and emotional aspects owing to small amounts of space and inability to display species-specific behavior (Fraser et al., 1997; Broom, 2011). Extensive systems have just the opposite, as they have high ratings for behavioral and emotional well-being but lower ratings for ethics procedures because of lack of formal auditing and documentation in such operations. Hybrid systems, where animals spend time indoors and outdoors, have a balanced rating on all dimensions (Buller et al., 2018).

The technological impact factor provides an additional insight into the benefits of using the

framework: systems involving health monitoring technologies like automated sensors and virtual fencing receive higher ratings when technology contributes to reducing handling stress and facilitating early intervention; however, the framework highlights a number of issues associated with introducing new types of cognitive or learning experiences for animals in modern husbandry practices (Lee et al., 2018). It proves that the consideration of the technological impact factor in evaluating welfare cannot be overlooked.

Discussion

The main benefit of the EAMF is its structural design: by breaking down welfare into five distinct, but interrelated factors, the framework does not allow one to make the mistake of

considering welfare as an entity that can be reduced to physical or production indicators only (Fraser et al., 1997; Hurnik & Lehman, 1988). It is especially important for auditors who want to pinpoint the areas where targeted actions are necessary.

Moreover, the framework operationalizes ethical governance as a quantifiable dimension rather than treating it as an underlying assumption which was noted to be a limitation of previous research in research ethics where a principled construct has been found useful in transforming normative concerns into auditable practice (Brink & Lewis, 2023). The inclusion of a technological impact dimension is another way of addressing the increased popularity of precision livestock farming technologies and concerns raised in literature about technology being used to replace necessary welfare reform (Boyle & Stevenson, 2025).

There are some limitations which are worth mentioning. First of all, the example scores used in Section 4 are exemplary in nature, not a result of a larger empirical audit and there is still room left for the validation of the framework through its practical implementation on different farms and species. Secondly, the use of a four-point scoring system facilitates consistency but at the cost of oversimplification; additional qualitative score reporting is recommended.

Third, any cross-species adoption of specific indicators, especially in the behavioral and affective dimensions, is bound to require species-specific calibration due to known differences in behavior repertoire among cattle, poultry, swine, and small ruminants. Nonetheless, even with

such limitations, the EAMF presents an auditable and extendable starting point for combining science-based welfare metrics and ethics-based governance evaluation within one structure.

Conclusion

In this paper, the Ethical Animal Management Framework (EAMF) was presented as a five-dimensional tool for assessing welfare-related practices in contemporary livestock operations. It combines physical wellbeing, behavioral expression, affective state, ethics-procedural governance, and technology impact into one auditable framework. The motivation behind such a framework is increasing social concerns about livestock welfare in face of production intensification and increasing adoption of precision livestock farming technologies. It addresses the lack in the existing assessment methods that separate biological indicators from more wide-ranging ethical and governance considerations influencing welfare outcomes. The example of comparative application of this framework provided in this paper highlighted the characteristic welfare trade-offs generated by the framework, such as the inclination of intensive operations to prioritize physical welfare over behavioral and affective welfare, along with the associated lack of governance that is seen in extensive operations that are not well-formalized. By incorporating a technological impacts aspect, the framework makes sure that the new management tools do not automatically become part of the positive side of welfare but are considered on the basis of their overall welfare impact. Although the proposed framework still needs to be empirically tested and calibrated for

various livestock species, it provides a scientifically valid, replicable, and ethical means of welfare gap identification and prioritization to producers, auditors, and policy-makers. Future research must focus on validating the EAMF framework in the field setting for various species of livestock and on fine-tuning the weights of the indicators based on stakeholder input.

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