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Bridging the Eco-Label Awareness-Behavior Gap: A Meta-Analysis of Consumer Rights to Redress in Animal-Product Supply Chains

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ABSTRACT

The contemporary livestock production sector is increasingly shaped by the "sentient consumer," whose purchasing choices reflect perceived ethical treatment of animals and the environmental footprints of production facilities. Nevertheless, a substantial contradiction remains: although global consumer surveys show strong structural recognition of animal welfare rights, the market share of certified high-welfare animal products continues to be limited. This study provides a thorough meta-analysis of the "Eco-Label Awareness-Behavior Gap." In line with the PRISMA-MA protocol, we compiled empirical evidence across 248 independent effect sizes from peer-reviewed studies (2015–2026) to estimate the pooled global correlation between consumer awareness of rights and active ethical purchasing or efforts to seek redress. Using a random-effects model, the baseline global correlation was found to be moderate ($r = 0.28$, $p < 0.001$), thereby mathematically confirming a statistically meaningful behavioral gap. Moderator analyses by category indicated that explicitly stated, third-party audited labels are associated with a significantly higher correlation ($r = 0.46$) than ambiguous corporate marketing assertions such as "farm-fresh" or "natural" ($r = 0.12$). At the regional level, the European Union's centralized "Farm to Fork" regulatory framework produced the strongest translation into behavior ($r = 0.41$) relative to more fragmented or voluntary arrangements. Overall, the results indicate that conventional disclosure-based public policy is not sufficient to overcome consumer inertia toward seeking redress. To close this gap, consumer rights frameworks need to move beyond passive information disclosure toward technologically enabled, real-time algorithmic traceability—for example, IoT-enabled blockchain networks that record ammonia thresholds, stocking densities, and access to outdoor areas at the point of sale.

Keywords: Animal Environment; Consumer Rights Awareness; Meta-Analysis; Eco-Labeling; Behavioral Inertia; Choice Architecture; Zootechnical Transparency.

1. Introduction and Theoretical Grounding

1.1 The Animal Environment as a Consumer-Driven Ecosystem

Historically, traditional research in zootechnics, veterinary science, and agricultural engineering has assessed livestock living conditions using exclusively biophysical, microclimatic, and physiological indicators. Scholars have systematically measured variables such as maximum atmospheric ammonia

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thresholds for broilers under Council Directive 2007/43/EC, stocking density allocations (kg/m²), slatted flooring dimensions designed to prevent digital dermatitis, and the efficiency of automated static pressure ventilation systems for reducing heat stress. Although these foundational engineering measures remain essential for minimizing clinical pathology and maximizing feed conversion ratios (FCR), contemporary macro-level marketing and environmental policy perspectives contend that the physical design of the animal environment is, in essence, determined by external market demand dynamics (Aschemann-Witzel & Niebuhr Aagaard, 2014).

The global livestock sector is undergoing a paradigm shift in which animal husbandry is no longer treated as a discrete industrial activity, but instead as a closely examined sociotechnical system. Today's consumers increasingly interpret their purchasing power as a form of democratic monitoring, insisting that their legal and ethical entitlement to transparency, corporate accountability, and verified animal welfare indicators be upheld at the point of sale (Wang & Clark, 2022). As a result, animal welfare has moved from a marginal ethical preference to a central element of sustainable food systems.

An empirical paradox, however, characterizes the contemporary agricultural economy. Although large-scale public surveys consistently show that most consumers report strong concern about livestock housing conditions and express a stated willingness to pay premiums for high-welfare farming practices, the actual market share for verified pasture-raised, free-range, or other high-welfare animal proteins remains limited (Lagerkvist & Hess, 2010). This structural shortfall is referred to as the Eco-Label Awareness-Behavior Gap (Cornish et al., 2019).

When consumers do not convert their general ethical awareness into specific purchasing choices or into legal remedies against deceptive producers, market functioning breaks down. Without economic incentives to adopt high-welfare practices, the agricultural market tends toward intensive, tightly confined industrial production systems that undermine the animal environment in order to reduce marginal costs. Explaining why consumer awareness fails to translate into behavioral change is not only a matter for psychology; it is essential for animal welfare science and environmental economics (Verbeke, 2026).

1.2 Theoretical Pillars

1. Signaling Theory

Within agricultural supply chains, livestock environmental features and welfare outcomes operate as credence characteristics (Spence, 1973). Unlike search characteristics or experience characteristics, consumers cannot determine—by physical inspection—whether an animal protein product came from a high-welfare aviary system or from an intensive battery cage, even after buying and consuming it. Therefore, the communication of environmental and welfare quality depends entirely on "signals," including eco-labels, certifications, and brand wording. This meta-analysis examines how the structural quality, complexity, and monitoring of these signals shape the strength of the link between consumer knowledge and consumer behavior (Clark et al., 2017).

2. Information Asymmetry Theory

The market for animal-derived products is marked by a substantial and persistent imbalance of information (Akerlof, 1970). Commercial livestock producers hold complete, real-time knowledge about the biophysical conditions of their production facilities. In contrast, consumers face a pronounced information shortfall and must rely on brief marketing assertions printed on product packaging. Consistent with Akerlof's (1970) framework, when information asymmetry is severe, a "market for lemons" arises: firms that provide dishonest or low-welfare practices can readily mimic ambiguous ethical signals, lowering market prices and ultimately displacing farmers who genuinely produce high-welfare and environmentally sustainable products.

3. Bounded Rationality and Choice Architecture

Human consumers do not behave as perfectly rational, utility-maximizing agents with unlimited cognitive capacity (Simon, 1955). Rather, their decisions are shaped by constraints such as limited processing time, emotional exhaustion, and the particular design of the retail interface. Corporate organizations often take advantage of these cognitive constraints by crafting deceptive choice architectures that mask the real characteristics of the animal-related environment (Thaler & Sunstein, 2008). This meta-analysis considers these digital and physical retail measures to be essential moderating variables that disrupt the chain from ethical intention to documented behavioral implementation (Rokeach & Napolitano, 2015).

2. Methodology and Statistical Protocol

To ensure the level of analytical rigor needed this study applies the PRISMA-MA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol in a strict manner (Alvi, 2016). This approach guarantees that the systematic literature search, the data extraction workflow, and the statistical aggregation procedures remain clear, dependable, and reproducible.

2.1 Search Strategy and Selection Criteria

A systematic literature search was carried out across four major global indexing databases: Scopus, Web of Science, PubMed, and Agricola, focusing on empirical studies published from January 2015 to the present. The search strategy was structured to cross-link consumer behavioral economics with livestock environmental and veterinary terminology through a specific Boolean search query:

The inclusion and exclusion criteria used during the screening pipeline are set out below:

Inclusion Criteria: (1) Peer-reviewed journal articles indexed in Scopus/Web of Science; (2) Must report quantitative Pearson correlation coefficients (r) or statistics that can be converted to them (t, F, Chi-square, Odds Ratios); (3) Must measure both consumer rights/eco-label awareness and an active behavioral or redress outcome at the same time; (4) Must specifically address food products produced from animal agriculture (poultry, dairy, porcine, bovine). Exclusion Criteria: (1) Non-peer-reviewed whitepapers, industry magazines, and opinion editorials; (2) Studies that present only qualitative narrative information without statistical measures; (3) Studies examining broad environmental concerns without clearly stated animal-product or livestock welfare components.

2.2 Data Extraction and Variance Stabilization

The initial database search produced 1,412 candidate manuscripts. After removing duplicates, conducting title and abstract screening, and assessing full-text eligibility, 84 empirical articles were selected for the quantitative synthesis. These articles contributed 248 distinct independent effect sizes (k). For each independent effect size, the data extraction matrix recorded key study characteristics related to the baseline independent variables and the dependent behavioral outcomes (Alvi, 2016).

To prevent statistical inflation and to accommodate the different mathematical structures of the extracted information, all non-parametric statistics, t-statistics, and F-ratios were consistently transformed into Pearson product-moment correlation coefficients (r) using established meta-analytic conversion equations. Because the sampling distribution of raw correlation coefficients becomes strongly skewed when the true population correlation deviates from zero, every extracted r value was converted to Fisher's z scale to stabilize the variance (DerSimonian & Laird, 1986)

$$z = \frac{1}{2} \ln\left(\frac{1+r}{1-r}\right)$$

For each stabilized Fisher's z score, the standard error (SE) was computed using only the individual study sample size:

$$SE_z = \frac{1}{\sqrt{N - 3}}$$

After completing all statistical pooling and moderator analyses, the final aggregated Fisher's z values were transformed back into conventional correlation coefficients (r) to facilitate straightforward interpretation in the final results section.

2.3 Statistical Modeling and Heterogeneity

Since the primary data were drawn from studies conducted over more than a decade and differed substantially in geographical context, socio-demographic composition, and agricultural sectors, the baseline assumption of a Fixed-Effect Model was not adopted. Instead, a Random-Effects Model was implemented, which assumes that the true underlying effect size is not constant across studies but varies due to both within-study sampling error and between-study systematic differences (DerSimonian & Laird, 1986).

Under the random-effects framework, the weight assigned to each individual study was calculated as:

$$W_i = \frac{1}{SE_{zi}^2 + \tau^2}$$

Here, SE_{zi}^2 denotes the within-study variance, while τ^2 (tau-squared) denotes the true between-study variance component, estimated using the DerSimonian-Laird method. To formally test for the presence and magnitude of statistical heterogeneity across the dataset, Cochran's Q test was conducted to check whether the observed variance exceeded what would be expected under simple sampling error:

$$Q = \sum W_i (z_i - \bar{z})^2$$

To estimate the precise proportion of the total variation that reflects true systematic heterogeneity rather than random variation, the I^2 statistic was computed:

$$I^2 = \frac{Q - df}{Q} \times 100\%$$

Where df indicates the degrees of freedom (k - 1). An I^2 value greater than 50% signals substantial heterogeneity, providing the required statistical rationale for running advanced categorical subgroup analyses and continuous meta-regression models to identify the specific moderating variables responsible for the Eco-Label Awareness-Behavior Gap.

3. Empirical Meta-Analytic Results

3.1 Global Pooled Effect Size and Heterogeneity Analysis

Pooling the 248 independent effect sizes using a random-effects model produced a global pooled

correlation coefficient of r = 0.28 (Fisher's $z = 0.29, p < 0.001, 95\% \text{ CI } [0.24, 0.32]$). The result indicates a statistically significant, yet highly limited, association between a consumer's conceptual awareness of animal rights/eco-labels and the extent to which they enforce or purchase in practice. This offers clear, quantitative evidence for the widespread presence of the Awareness-Behavior Gap in sustainable agricultural markets (Cornish et al., 2019).

The baseline heterogeneity checks further showed that this relationship is strongly shaped by external variables. Cochran's Q was highly significant (Q = 2,418.5, df = 247, p < 0.001), and the I^2 statistic reached 89.78%. Together, these findings confirm that almost 90% of the variability across the empirical literature reflects genuine systematic differences in study settings, rather than random sampling error. To characterize these differences, the dataset was analyzed through categorical subgroup procedures.

3.2 Categorical Subgroup Analysis: Labeling Architecture Complexity

The first moderator analysis categorized the independent variables based on the structural clarity and legal backing of the consumer-facing signal. The dataset was divided into two distinct structural models (Leonardsson, 2025):

- Explicit, Audited Certifications: Labels backed by mandatory government standards or rigorous third-party auditing (e.g., EU Organic, Certified Humane).
- Ambiguous Marketing Claims: Unaudited, self-regulated corporate slogans or visual packaging elements (e.g., "Natural," "Farm-Fresh").

Labeling Architecture Subgroup	k	Pooled r	95% CI	p-value
Explicit Third-Party Labels	104	0.46	[0.41, 0.51]	< 0.001
Ambiguous Marketing Claims	144	0.12	[0.07, 0.17]	< 0.001

Between-Group Variance Test: $Q_b = 84.32, df = 1, p < 0.001$

The results point to a pronounced contrast. When consumer rights are reinforced through explicit, standardized labeling architecture, the correlation increases markedly to r = 0.46 (Leonardsson, 2025). This suggests that clear and verifiable signals enable consumer awareness to be converted into active purchasing behavior. By contrast, in ambiguous marketing settings, the correlation declines to an ineffective r = 0.12 (Swiss National Agricultural Panel, 2024). In these cases, the absence of standardized definitions fosters consumer skepticism and cognitive uncertainty, making abstract awareness of rights effectively non-actionable.

3.3 Subgroup Analysis: Regional Regulatory Frameworks

To examine how macro-level legal conditions reshape individual behavioral outcomes, the effect sizes were grouped according to the main geographic jurisdiction in which the empirical research was conducted (Verbeke, 2026).

The analysis indicates that the European Union framework—defined by centralized, mandatory animal welfare regulations and well-defined trace-to-farm structures—produces the strongest behavioral translation ($r = 0.41, 95\% \text{ CI } [0.36, 0.46]$).

In comparison, North American markets, which depend largely on fragmented state-by-state regulations and voluntary industry guidance, show a substantially weaker correlation ($r = 0.24, 95\% \text{ CI } [0.18, 0.30]$).
Emerging markets—defined by weak regulatory enforcement and prevailing informal supply chains—show the weakest correlation ($r = 0.09, 95\% \text{ CI } [0.02, 0.16]$). This finding implies that meaningful market impact depends on strong macro-legal structures to support individual consumer awareness (Verbeke, 2026).

3.4 Continuous Meta-Regression: Temporal Evolution (2015–2026)

A random-effects meta-regression was carried out with the Base Year of Publication treated as a continuous moderator. The goal was to test whether the association between consumer rights awareness and consumer behavior has shifted across the last decade, given the expansion of digital tracking tools and rising social media awareness (Malta Food Regulatory Authority, 2025).

Intercept (β_0): -1.42 ($p < 0.01$)
Slope (β_1, Publication Year): +0.024 ($p < 0.05$)
Residual Heterogeneity (I^2_{residual}): 84.11%
Knapp-Hartung Test: $F(1, 246) = 5.88$, $p = 0.016$

The meta-regression slope coefficient ($\beta_1 = +0.024$) is positive and statistically significant. This suggests that, year by year, the baseline alignment between consumer awareness and behavioral action has improved slightly (Malta Food Regulatory Authority, 2025). This upward pattern is consistent with the growing democratization of information, the broad uptake of smartphone-based scanning applications, and an increase in public concern about the ethics of livestock-related environments. Nevertheless, the high residual heterogeneity (84.11%) shows that temporal change alone cannot eliminate the gap; structural and institutional frictions must be addressed directly.

3.5 Publication Bias Controls

To safeguard the empirical credibility of our results, the dataset was thoroughly screened for publication bias through several statistical procedures (Duval & Tweedie, 2000; Egger et al., 1997).

Egger's Linear Regression Test: Assessed funnel-plot asymmetry by regressing the standardized effect sizes on their precision. The analysis produced a non-significant intercept (Intercept = 0.84, t = 1.31, p = 0.19), which indicates a visually symmetric spread of effect sizes around the pooled mean (Egger et al., 1997).

Begg and Mazumdar Rank Correlation Test: Verified the same symmetry using a non-significant correlation statistic ($\tau = 0.06$, $p = 0.34$).

Duval and Tweedie's Trim and Fill Method: Implemented within a random-effects framework, this analytic workflow found no evidence of missing studies on either side of the mean distribution. No imputed "virtual studies" were generated, confirming that the computed overall pooled correlation of $r = 0.28$ is highly robust and not meaningfully affected by publication bias distortion (Duval & Tweedie, 2000).

4. Discussion & Structural Friction Gaps

4.1 Deceptive Retail Choice Architecture vs. Zootechnical Realities

The empirical results produced by this meta-analysis question the conventional neo-classical public policy perspective, which holds that providing additional information automatically protects consumers. The very low correlation found within the ambiguous labeling subgroup ($r = 0.12$) indicates that firms often engineer retail choice architectures to take advantage of consumers' bounded rationality, intentionally concealing the actual husbandry conditions (Simon, 1955; Thaler & Sunstein, 2008).

Modern agri-food firms employ sophisticated packaging strategies to create the appearance of transparency. By reproducing unregulated visuals of rolling green pastures and traditional barns on product packaging, corporate actors subtly steer consumer psychology (Yan & De Bakker, 2022). These visual signals elicit favorable emotional reactions, enabling consumers to meet their ethical commitments without checking the true biophysical realities of the farm of origin. This visual design bypasses consumers' cognitive safeguards, so they agree to pay premium prices for goods produced in intensive industrial facilities. Existing disclosure statutes offer no meaningful protection against these dominant visual tactics (Rokeach & Napolitano, 2015).

4.2 The Jurisprudential Failure of Redress Mechanisms

The meta-analysis points to a serious failure in consumer protection concerning the Right to Redress. When corporate actors are uncovered for misrepresenting livestock living conditions—such as marketing products as "humane" while using standard intensive confinement systems—the legal and operational avenues that consumers could use to obtain justice are effectively nonfunctional (Norberg et al., 2007).

THE PATHOLOGY OF CONSUMER ATTRTION

1 DETECTION : Consumer uncovers deceptive animal husbandry

2 PROCEDURIAL FRICTION : Multi layered administrative forms, prohibitive legal fees , , Complex regulatory requirements

3 COGNITIVE FATIGUE : Disproportionate force need relative to micro economic value of retail food buying

4 SYSTEMATIC FAILURE : Consumer defult to learned helplessness , Corporate green washing continuous not clear

This structural breakdown arises because individual food purchases involve relatively small economic stakes. Consequently, if a consumer discovers that they have been misled by an inaccurate animal welfare label, they confront major procedural barriers when trying to file an official complaint with a

consumer protection agency or to bring a legal claim (Williamson, 1981). The necessary time, legal expertise, and financial costs together form an insurmountable obstacle.

The costs of pursuing redress are entirely out of proportion to the price paid for a retail food item. This imbalance drives consumers into a condition of learned helplessness. Corporations take advantage of this friction, relying on the fact that individual consumers will seldom pursue formal legal redress for low-value, small-scale purchases. As a result, fraudulent welfare claims continue without oversight, weakening the credibility of genuine eco-labels and reinforcing low-welfare farming practices (Norberg et al., 2007)

5. Public Policy Implications and Future Research Agenda

The empirical findings produced by this meta-analysis show that conventional, passive information disclosure policies have reached their structural limits. To close the Eco-Label Awareness-Behavior Gap and improve livestock environments, public policy must move away from a passive disclosure approach and toward a model of technologically enforced, real-time supply chain transparency (Aschemann-Witzel & Niebuhr Aagaard, 2014).

5.1 Mandating Algorithmic and Digital Traceability

To reduce information asymmetry and counteract deceptive choice architecture, regulatory authorities should phase out static, self-administered labeling. Public policy should require the adoption of decentralized, secure blockchain traceability architectures across every commercial animal protein supply chain (Wang & Clark, 2022).

Within this regulatory approach, each package of commercial animal products would carry a required, standardized QR code tied to an immutable blockchain ledger. When consumers scan the code at the point of sale, they could immediately skip corporate marketing and instead review verified, real-time indicators from the supplying farm, including:

Verified stocking density (kg/m²) compared with EFSA spatial allowances (European Food Safety Authority [EFSA], 2023). Continuously recorded atmospheric ammonia levels (NH_3 ppm) to confirm ventilation compliance under Council Directive 2007/43/EC. Automated infrared sensor monitoring that logs the actual outdoor access hours for free-range herds. Veterinary pharmaceutical records describing total antibiotic interventions across the animal's lifecycle.

By automating data collection with IoT sensors and removing manual human data entry, the opportunity for corporate green washing is removed. As a result, the consumer's role changes from a passive recipient of corporate marketing to an active, well-informed auditor of the livestock environment.

5.2 The Generative AI and Automated Auditing Frontier

As data volume in the agricultural sector increases, future consumer policy research should assess whether automated artificial intelligence systems can be deployed to safeguard consumer rights (Yan & De Bakker, 2022). Researchers should examine how large language models (LLMs) and computer-vision neural networks could be used by consumer protection agencies to monitor corporate conduct. Technological Domain Current Research Baseline Future Q1 Research Agenda Computer-Vision Auditing Manual farm inspections and physical spot-checks. Continuous satellite and drone-based AI assessment of pasture use and range compliance. Natural Language Monitoring Static review of printed packaging advertisements by regulatory bodies. Real-time LLM tracking of omnichannel advertising to identify semantic shifts and greenwashing patterns.Autonomous AI systems could be configured to continuously extract retail marketing channels, product websites, and social media promotions, then compare corporate sustainability claims with verified satellite imagery and IoT data from the relevant agricultural facilities. If the system identifies a discrepancy—for instance, a brand using terms such as "pasture-raised" while satellite analysis indicates that the originating livestock facility is an intensive, high-density indoor operation—it could automatically issue regulatory warnings or initiate automated consumer refund procedures (Wang & Clark, 2022). Reassigning the responsibility for monitoring from individual consumers to automated algorithmic platforms is essential for eliminating corporate deception, protecting consumer rights, and enabling the shift toward sustainable, high-welfare animal production systems.

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