CHIMERTECH
PRIVATE LIMITED
Towards One Health Sustainability

Industrial Problem Statement

Rapid Antibiotic Decision Systems for Mastitis Management under One-Health and AMR Framework

Mastitis remains one of the most critical unresolved industrial challenges in the global dairy sector, directly affecting animal health, milk productivity, antibiotic consumption patterns, food safety, and environmental sustainability. Despite decades of veterinary advances, mastitis continues to impose severe economic and public health burdens because treatment decisions at farm level are largely empirical and not supported by rapid, field-ready diagnostic evidence.

Globally, mastitis prevalence varies across production systems but commonly ranges between 20–50% at herd level, with subclinical mastitis representing the largest hidden burden due to its asymptomatic nature. Subclinical infections often persist undetected for long durations, leading to gradual milk yield decline and deterioration of milk composition. Clinical mastitis, although more visible, contributes to acute productivity loss, pain, and increased animal welfare concerns. Milk production losses can range from 10–25% per lactation in subclinical infections and may exceed 50% in severe clinical cases. These losses directly reduce farm profitability and disrupt supply chain consistency.

From an industrial perspective, mastitis reduces both quantity and quality of milk produced. Infected milk typically exhibits elevated somatic cell counts (SCC), altered protein and fat composition, increased microbial load, and reduced processing suitability for value-added dairy products. Processors and quality assurance systems increasingly reject milk batches exceeding accepted quality thresholds, resulting in direct financial penalties to farmers and suppliers. Poor milk quality also affects shelf life and product stability, leading to downstream industrial inefficiencies.

Economic losses associated with mastitis extend beyond reduced milk production. Key financial pain points include:

- Milk discarded during treatment and withdrawal periods
- Repeated or prolonged veterinary interventions
- Overuse of broad-spectrum antibiotics
- Reduced reproductive efficiency and animal lifespan
- Increased culling rates and replacement costs
- Labor and management inefficiencies

In many dairy systems, the largest contributor to economic loss is not treatment cost itself but lost or downgraded milk and delayed recovery resulting from inappropriate antibiotic selection.

A major technological gap exists between laboratory diagnostic capability and real-world farm decision-making. Standard culture-based antimicrobial susceptibility testing requires 48–72 hours and relies on centralized laboratory infrastructure, skilled personnel, and controlled

conditions. This turnaround time is impractical for commercial dairy operations where treatment must often begin immediately after symptom detection. As a result, most antibiotic decisions are made empirically, based on historical practices or broad-spectrum protocols rather than pathogen-specific evidence.

This empirical treatment model has become a primary driver of antimicrobial resistance (AMR). Antibiotics are frequently administered without precise identification of causative pathogens or resistance profiles, leading to inappropriate dosing and selection pressure on microbial populations. The World Health Organization and multiple international regulatory bodies have identified livestock antibiotic misuse as a significant contributor to the global AMR crisis. The emergence of resistant mastitis pathogens complicates treatment outcomes, increases recurrence rates, and limits future therapeutic options.

Antibiotic abuse in dairy farming also has direct implications for human health and food safety. Failure to observe proper withdrawal periods—often due to lack of awareness, economic pressure, or inadequate monitoring—results in antibiotic residues entering the milk supply. Residue-contaminated milk poses multiple risks:

- Development of antimicrobial resistance in humans
- Allergic and toxic reactions in sensitive populations
- Disruption of human gut microbiota
- Regulatory non-compliance with maximum residue limits (MRLs)

Industrial dairy supply chains increasingly rely on strict residue testing protocols. Detection of antibiotic residues leads to rejection of milk consignments, financial penalties, and potential loss of market credibility. For export-oriented dairy industries, residue violations can result in export rejection, trade restrictions, or regulatory sanctions, creating large-scale economic implications beyond individual farms.

The environmental impact of uncontrolled antibiotic usage represents an emerging industrial and regulatory concern. Antibiotic residues and resistant bacteria enter soil and water systems through manure application, wastewater discharge, and runoff from dairy operations. Once introduced into environmental ecosystems, these residues can persist and influence microbial communities, promoting resistance gene development and dissemination. This environmental reservoir contributes to a broader One-Health AMR cycle linking animal production systems, ecological environments, and human populations.

The intersection of animal health, human health, and environmental safety positions mastitis management as a critical One-Health industrial challenge. Effective intervention requires shifting from empirical antibiotic usage toward evidence-based, precision treatment strategies that are practical for field deployment.

Current industrial gaps that require innovation include:

1. Lack of rapid, affordable, and field-compatible antibiotic selection tools.
2. Delayed pathogen identification and antimicrobial susceptibility assessment.
3. Limited farmer and field veterinarian awareness of withdrawal periods and residue risk.
4. Absence of real-time decision support systems that align treatment with antimicrobial stewardship.

5. High dependence on centralized laboratory infrastructure unsuitable for decentralized dairy systems.

Addressing these gaps represents a significant opportunity for translational research and industrial innovation. There is a clear need for technologies capable of enabling rapid detection of mastitis pathogens, early therapeutic decision-making, and reduction of unnecessary antibiotic exposure directly at the point of care.

The intended outcomes of such research initiatives should include:

- Reduction in inappropriate antibiotic use.
- Improved animal recovery rates and welfare outcomes.
- Lower milk losses through faster therapeutic accuracy.
- Improved milk quality and reduced processor rejection.
- Strengthened compliance with withdrawal periods.
- Reduced antibiotic residues in food products.
- Decreased environmental antibiotic contamination.
- Enhanced AMR mitigation across the dairy ecosystem.

In summary, mastitis represents a technically complex, economically significant, and socially relevant industrial problem that requires urgent innovation. The convergence of rising antimicrobial resistance, increasing food safety regulations, export quality requirements, and sustainability pressures demands next-generation solutions capable of bridging the diagnostic and decision-making gap at the farm level.

We are seeking technically sound, scalable, and scientifically robust research proposals focused on developing rapid, practical, and deployable solutions for antibiotic decision support in dairy mastitis management. Proposed innovations should align with One-Health principles, promote responsible antibiotic stewardship, and demonstrate clear pathways toward industrial adoption, regulatory compliance, and measurable impact across animal health, human health, and environmental safety domains.