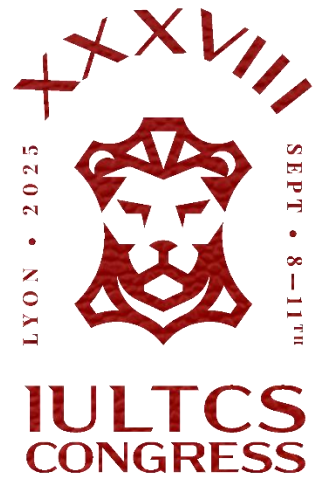


HIDE AND SEEK: ENHANCING SUSTAINABILITY IN LEATHER PRODUCTION WITH SPECTROSCOPIC TECHNOLOGIES



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PRESENTATION ROADMAP

- Sustainability Challenges in the Leather Industry
- Spectroscopic Technologies: Principles and Industrial Relevance
- Rapid Microbial Spoilage Detection with Hyperspectral Imaging
- Accurate Leather Product Traceability via Spectroscopy and Machine Learning
- Environmental and Industry Implications of Spectroscopic Approaches



SUSTAINABILITY CHALLENGES IN THE LEATHER INDUSTRY





INEFFICIENT DETECTION OF MICROBIAL SPOILAGE IN RAW HIDES

Slow Detection Methods

Traditional microbial spoilage detection in raw hides often takes a long time, delaying critical decisions.

Inaccuracy Risks

Inaccurate detection methods increase the risk of spoilage going unnoticed, leading to quality loss.

Quality Degradation Impact

Delayed and inaccurate detection results in higher waste and degradation of raw hide quality.

INADEQUACIES IN SUPPLY CHAIN TRACEABILITY FOR LEATHER PRODUCTS

Lack of Precision

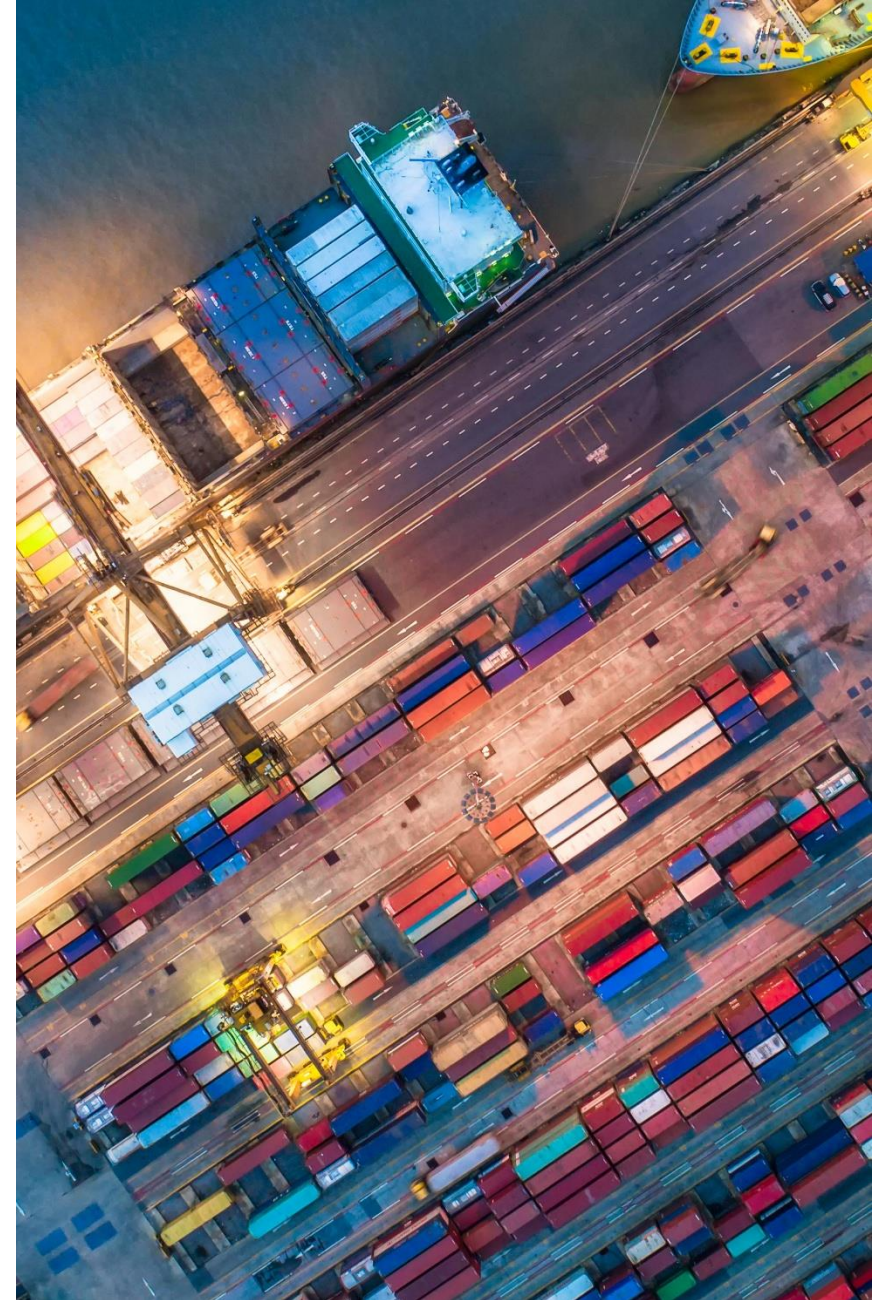
Existing traceability systems fail to accurately track leather product origins, causing gaps in supply chain data.

Reduced Reliability

Unreliable traceability erodes trust in verifying leather authenticity and product provenance.

Impact on Transparency

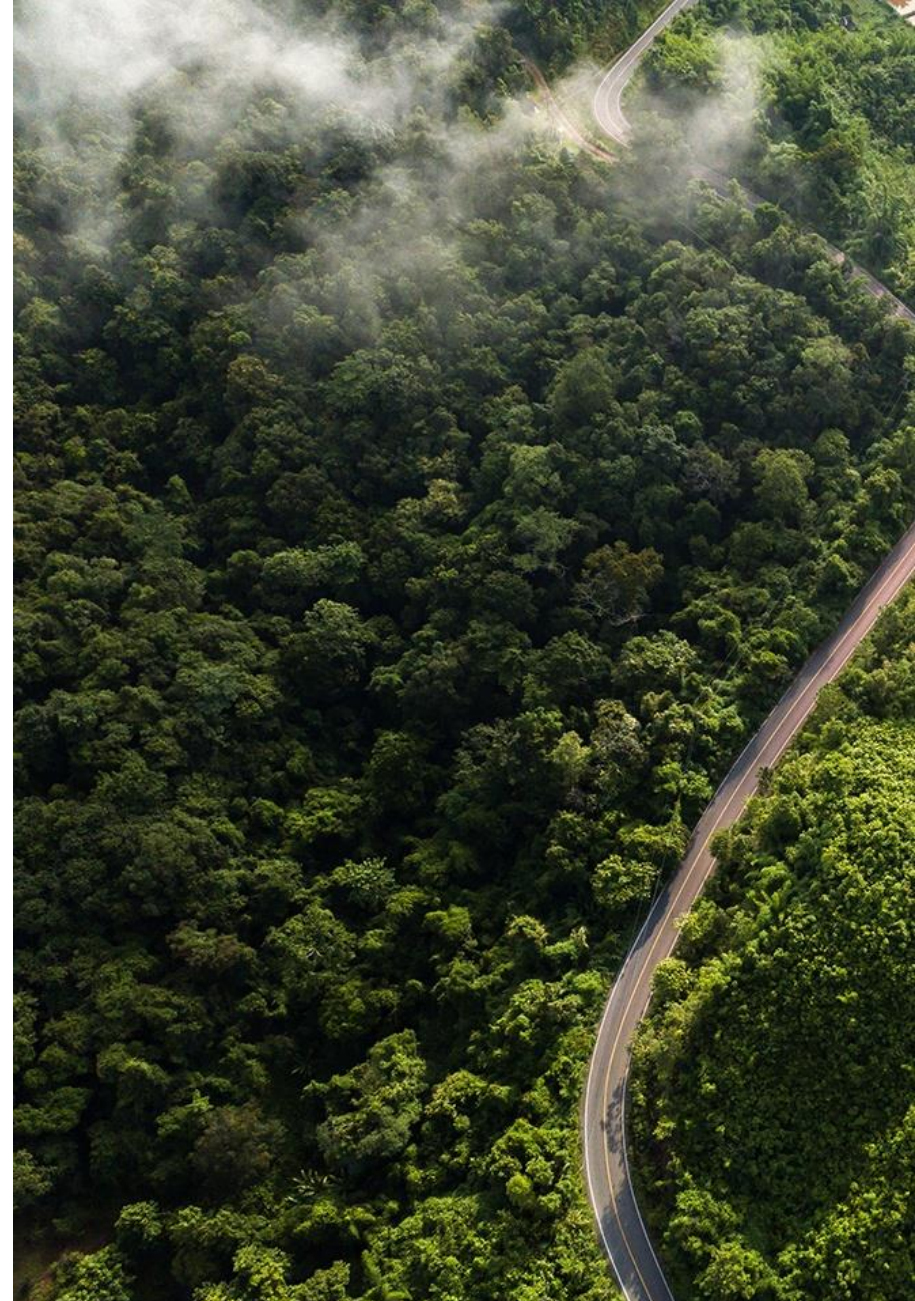
Insufficient traceability diminishes supply chain transparency, affecting consumer confidence negatively.





European Union Deforestation Regulation (EUDR)

According to Article 10(1) of the EUDR, the information collected must be assessed as a whole to ensure traceability and compliance throughout the supply chain.



CONSEQUENCES: INCREASED CHEMICAL USE, WASTE, AND ERODED CONSUMER TRUST



Excessive Chemical Use

Overreliance on chemicals for spoilage control raises health and environmental concerns.



Elevated Waste Levels

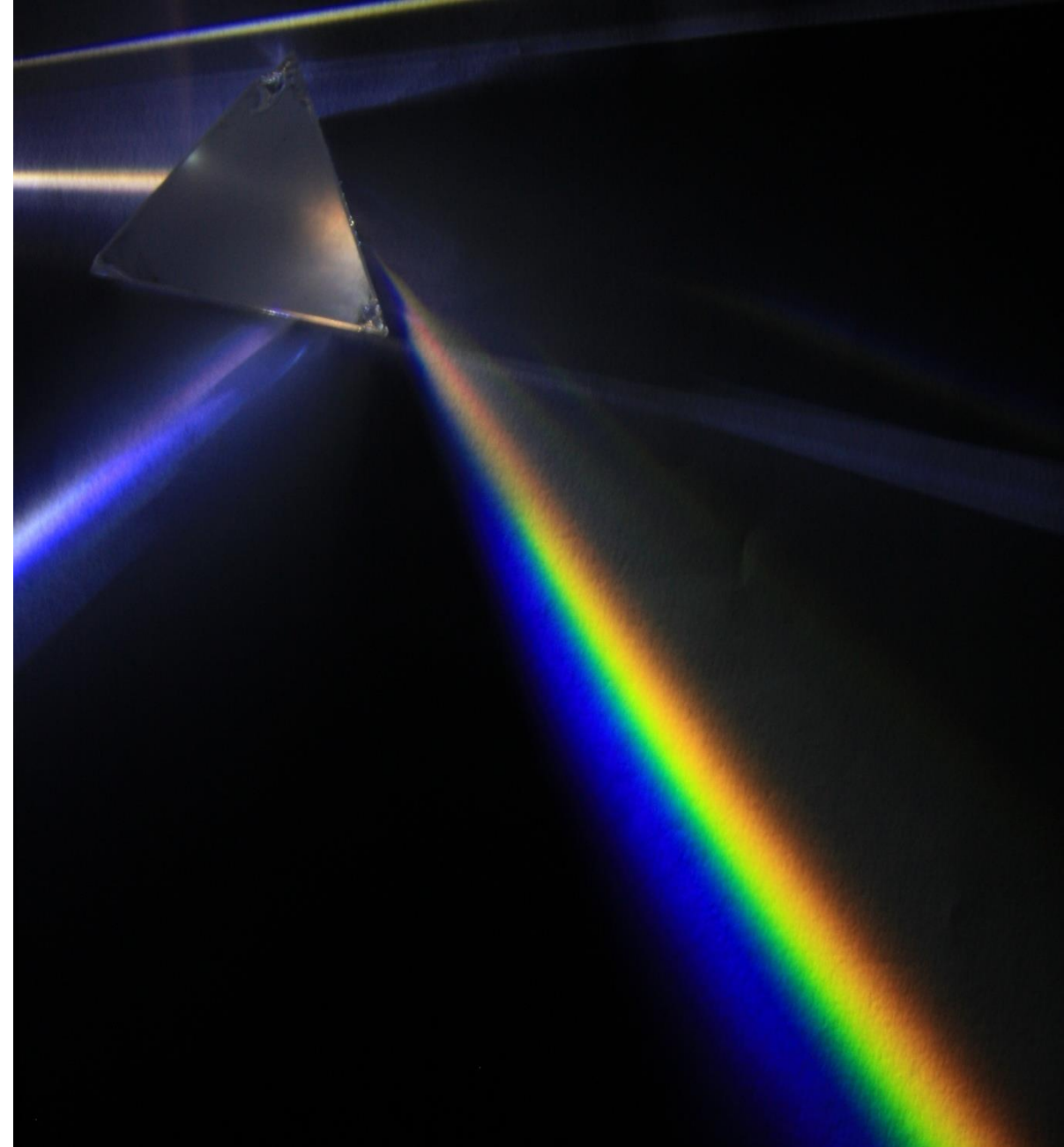
Increased waste results from unsustainable practices, harming the environment.



Consumer Trust Erosion

Consumers grow wary of products lacking sustainability and authenticity assurance.

SPECTROSCOPIC TECHNOLOGIES: PRINCIPLES AND INDUSTRIAL RELEVANCE



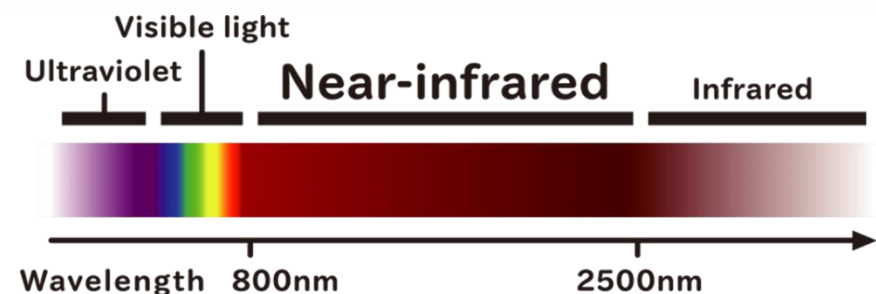
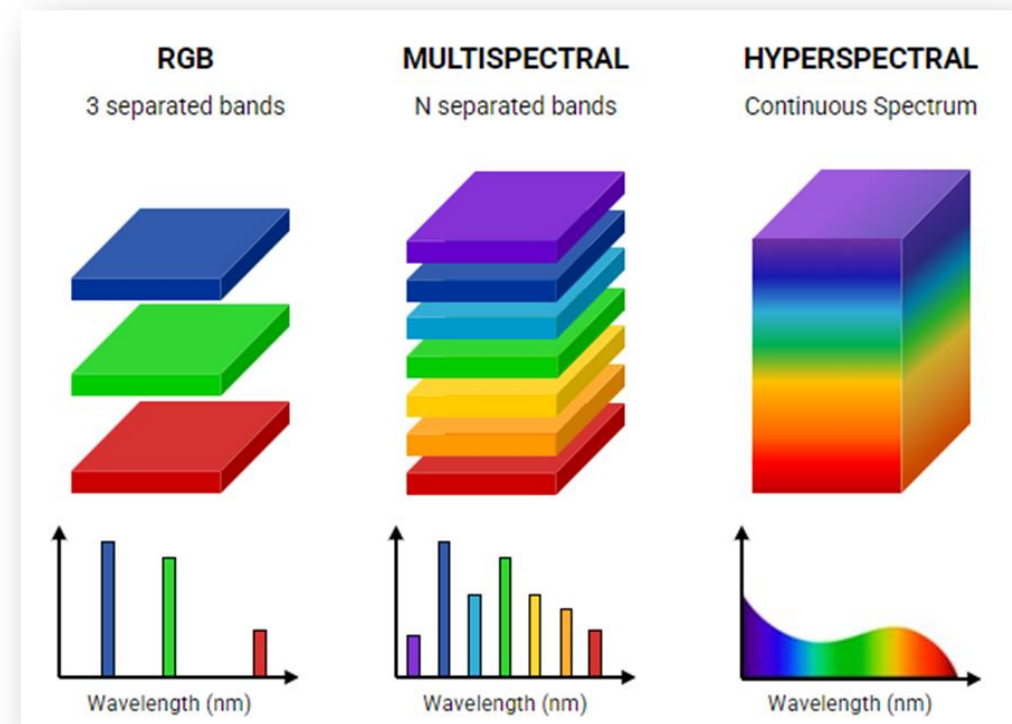
FUNDAMENTALS OF HYPERSENSPECTRAL AND VISIBLE- NEAR INFRARED SPECTROSCOPY

Hyperspectral Imaging

Hyperspectral imaging captures data across many wavelengths, allowing detailed chemical and physical analysis of materials.

Visible-Near Infrared Spectroscopy

Visible-near infrared spectroscopy detects overtone and combination vibrations of molecular bonds, providing information on chemical structures and functional groups.



The wavelength range of
near-infrared is 800–2500nm

ADVANTAGES OF NON-DESTRUCTIVE AND RAPID ANALYSIS

Non-invasive Quality Assessment

Non-destructive methods allow evaluation of materials without causing damage or alteration, preserving sample integrity.

Real-time Decision Support

Rapid analysis enables immediate data acquisition, facilitating timely and informed decision-making processes.

Seamless Workflow Integration

These techniques can be incorporated into existing processes with minimal disruption, supporting continuous monitoring and streamlined operations.





SUITABILITY FOR INDUSTRIAL ADOPTION IN LEATHER PROCESSING

Speed and Accuracy

Spectroscopic techniques provide fast and highly accurate analysis essential for leather processing quality control.

Automation Potential

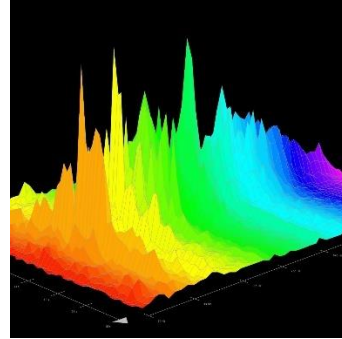
Automation of spectroscopic methods enables seamless integration into leather workflows, increasing productivity.

Enhanced Efficiency and Sustainability

Integrating spectroscopy improves process efficiency and supports sustainable leather production practices.

RAPID MICROBIAL SPOILAGE DETECTION WITH HYPERSPECTRAL IMAGING

IMPLEMENTATION OF LINESCAN HYPERSPPECTRAL IMAGING (550– 1700 NM)



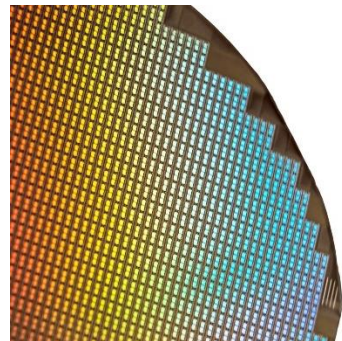
Wavelength Range Utilization

The imaging covers wavelengths between 550 and 1700 nm to capture detailed spectral signatures of hides.



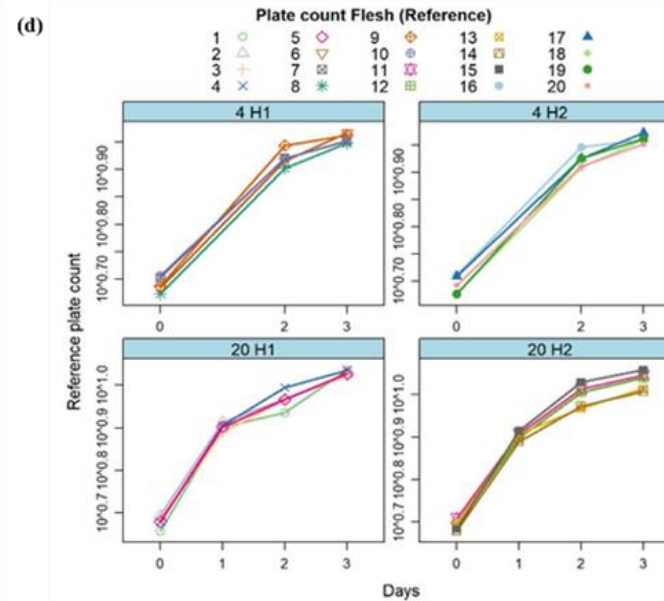
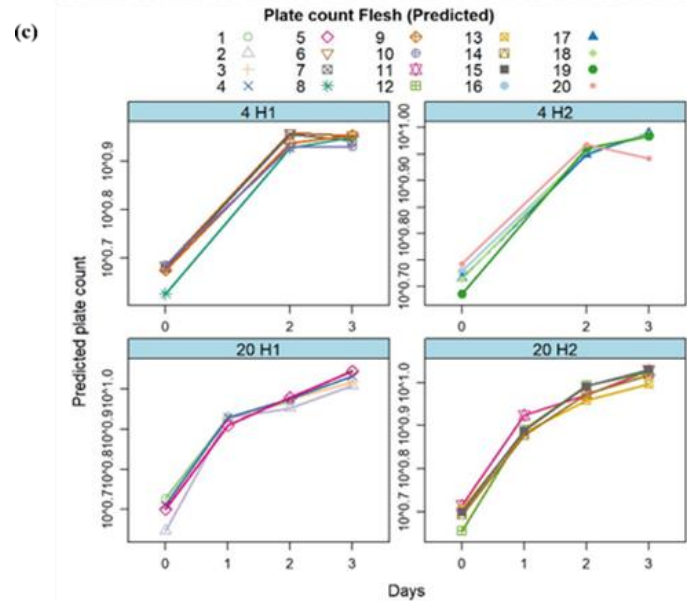
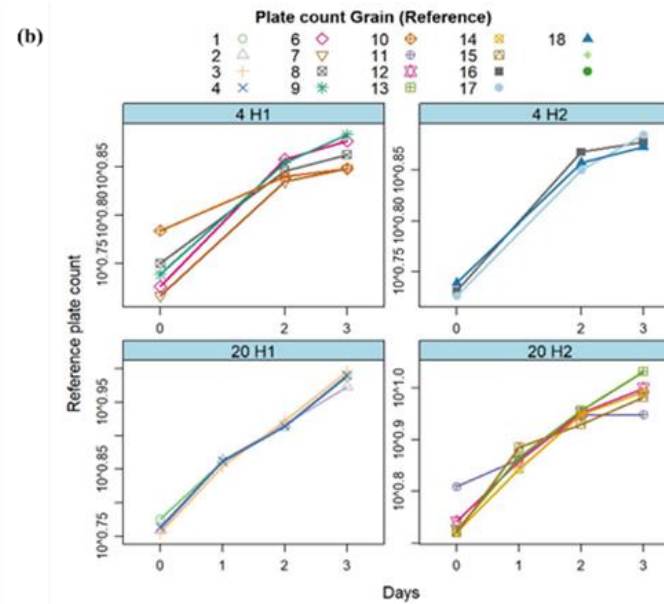
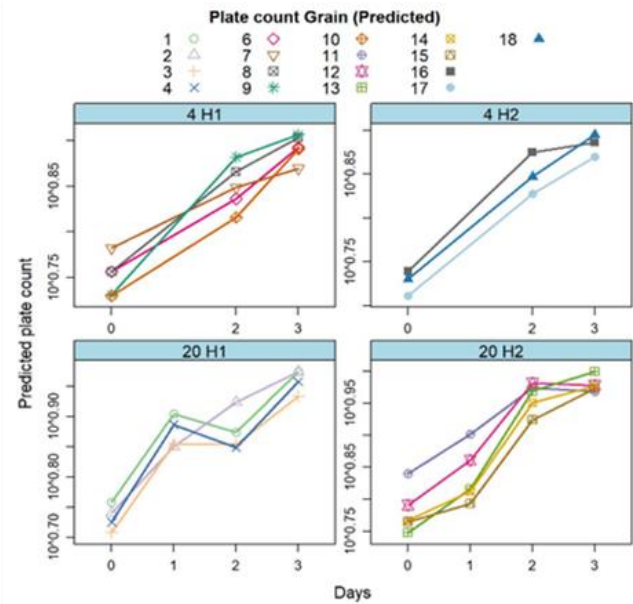
Efficient Hide Scanning

Linescan imaging enables rapid and efficient scanning of hides for quality assessment.



Microbial and Spoilage Detection

Spectral data captured helps identify microbial presence and spoilage levels on hides.



MODEL DEVELOPMENT FOR PREDICTING AEROBIC PLATE COUNTS ON RAW HIDES

Spectral Signature Correlation

Predictive models use spectral data to accurately correlate with aerobic plate counts on raw hides.

Microbial Load Quantification

Models enable precise quantification of microbial loads essential for grading and treatment decisions.

Figure 4 plate count vs day; Grain: (a) predicted plate count vs days and (b) reference plate count vs days. Flesh: (c) predicted plate count vs days and (d) reference plate count vs days.

INDUSTRIAL BENEFITS: REAL-TIME GRADING, REDUCED CHEMICAL USAGE, AND MINIMISED WASTE

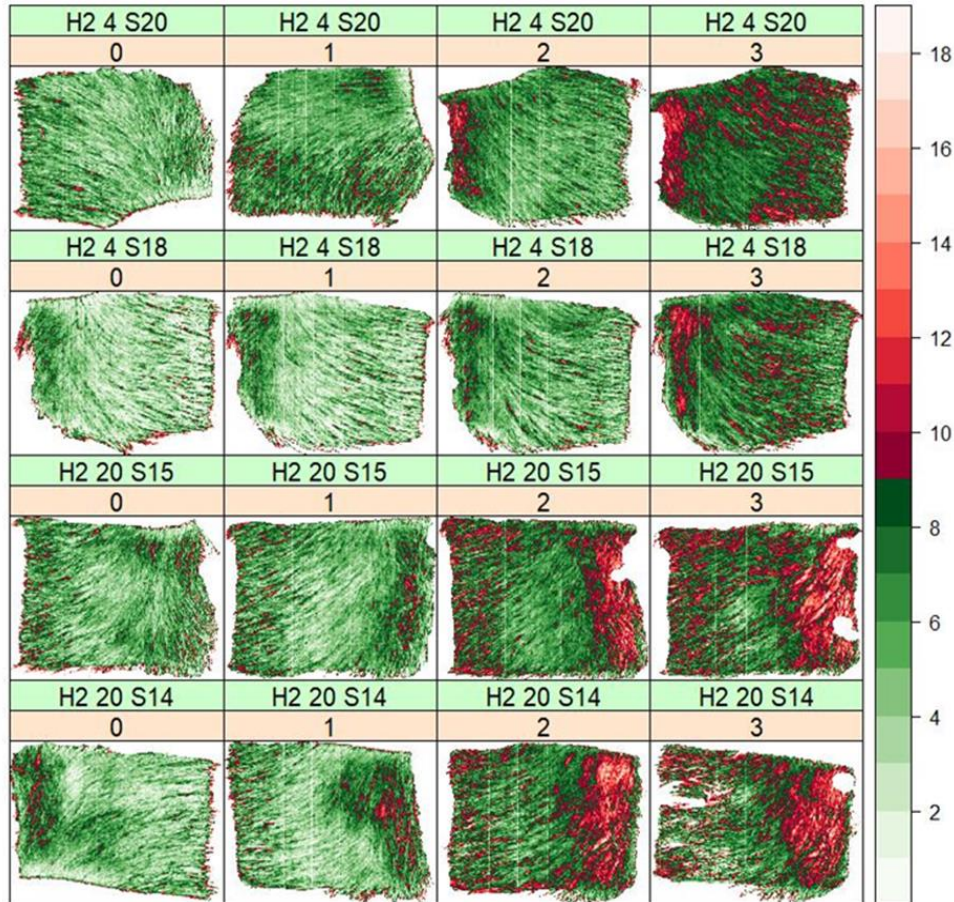


Figure 6 Prediction maps: spatial distribution of log 10 plate count for some of the hide 2 samples on grain side at both storage temperatures.

Immediate Spoilage Detection

Real-time grading enables quick identification of spoilage, preventing defects and maintaining quality standards.

Optimised Hide Grading

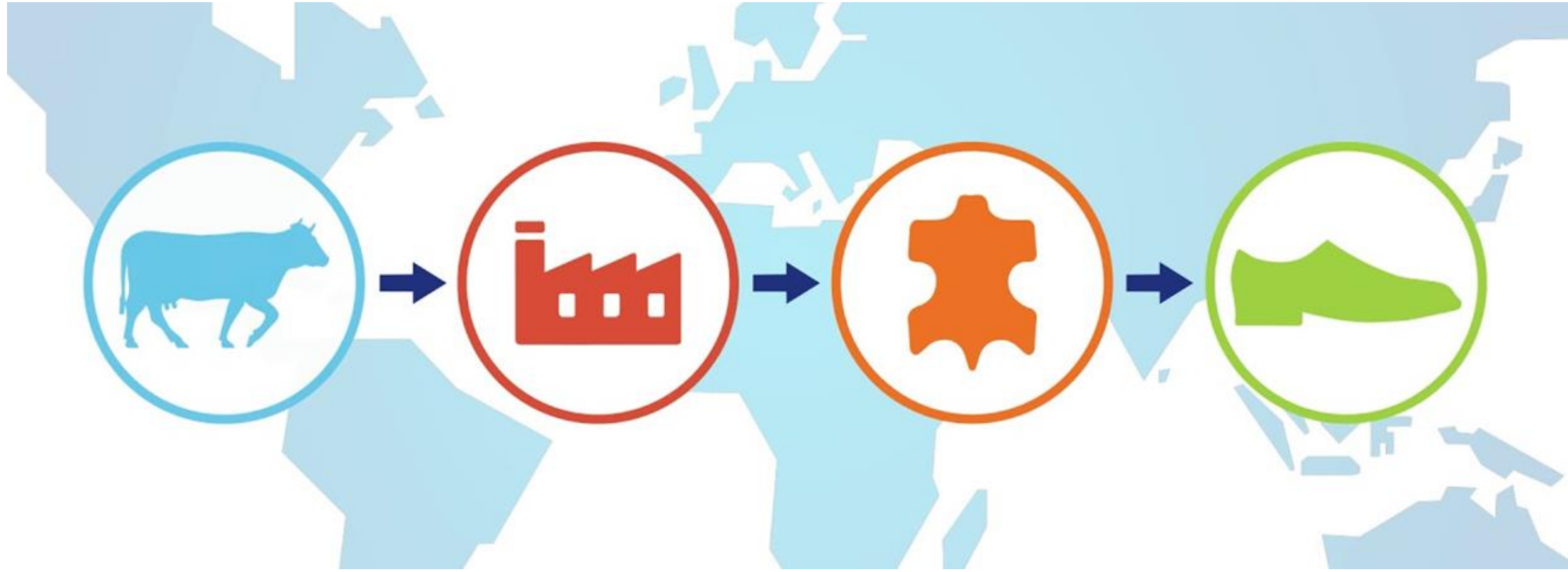
Accurate grading improves material sorting, enhancing product value and processing efficiency.

Reduced Chemical Usage

Minimising unnecessary chemical treatments lowers environmental impact and operational costs.

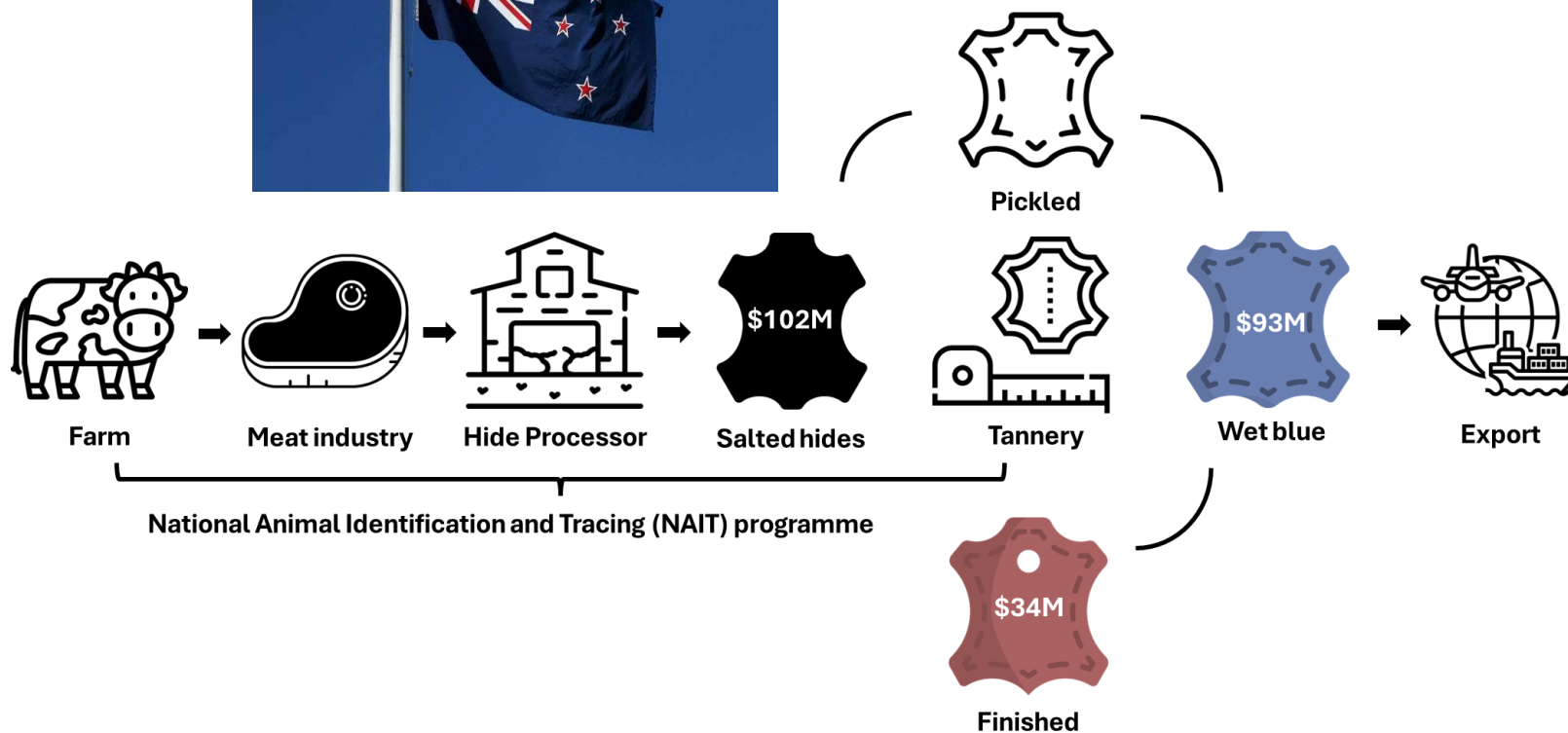
Minimised Waste Generation

Decreasing waste from rejected materials boosts sustainability and resource efficiency.



ACCURATE LEATHER PRODUCT TRACEABILITY VIA SPECTROSCOPY AND MACHINE LEARNING

IMPACT ON SUPPLY CHAIN TRANSPARENCY AND CONSUMER CONFIDENCE

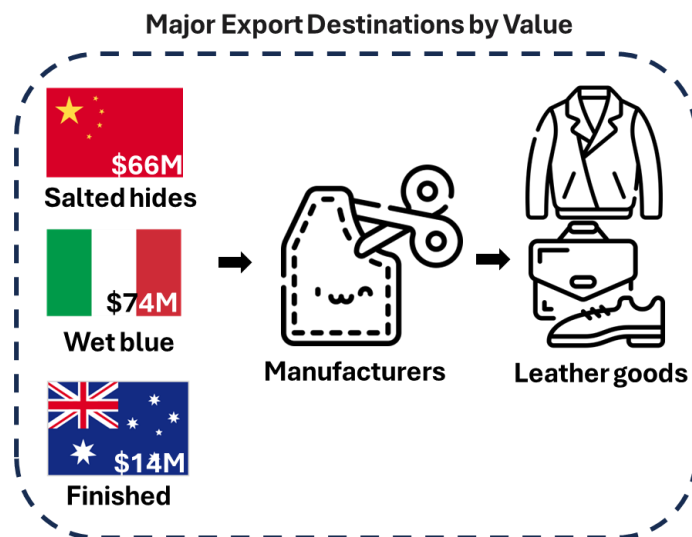


Enhanced Supply Chain Traceability

Improved traceability allows detailed tracking of products through the supply chain, ensuring accountability and transparency.

Building Consumer Trust

Transparency in sourcing and production builds consumer confidence in product quality and ethical standards.



Data source: Statistics New Zealand



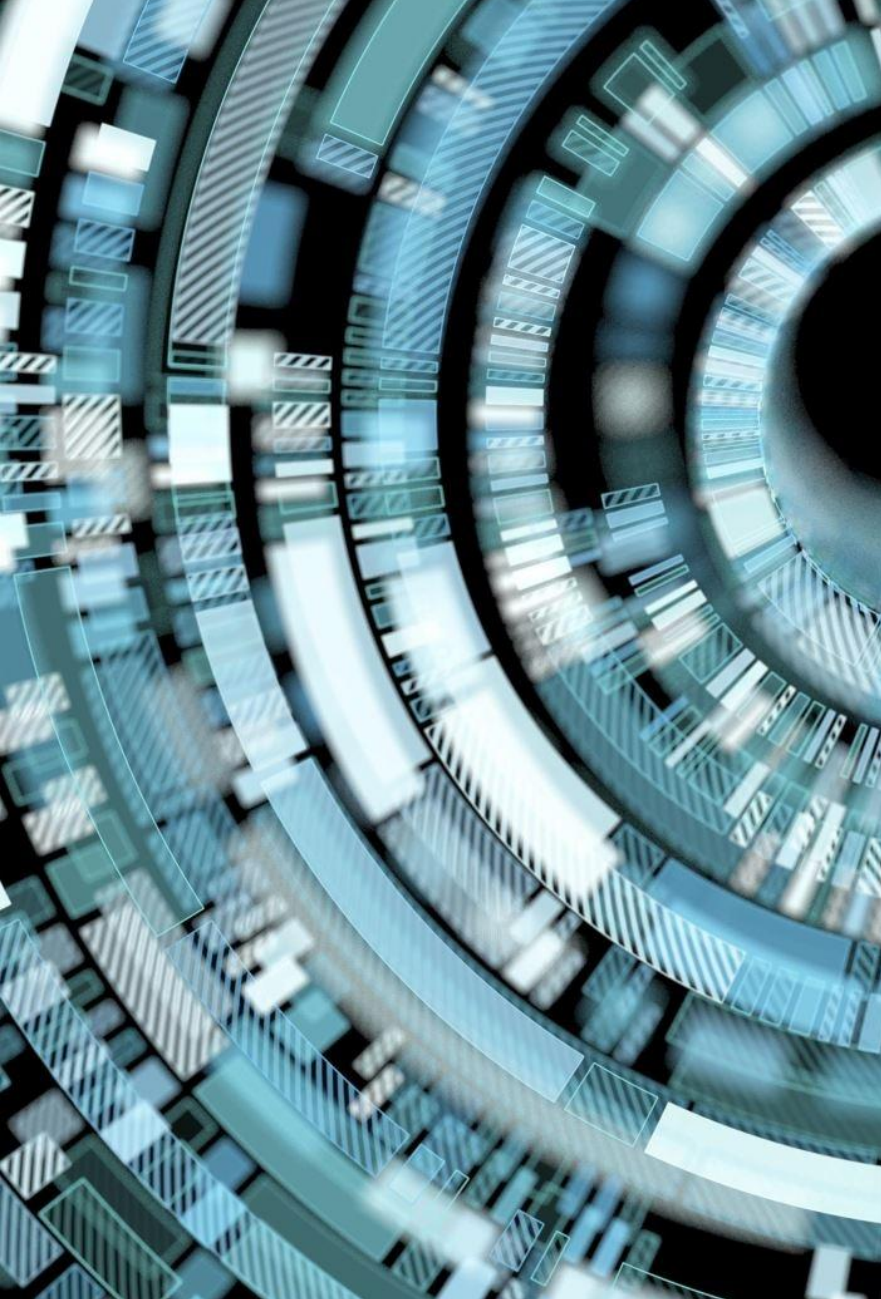
USE OF CHEMICAL TRACERS AND VISIBLE-NEAR INFRARED SPECTROSCOPY FOR WET-BLUE LEATHER

Chemical Tracers in Leather

Chemical tracers embedded in wet-blue leather enable identification of origin and processing variations effectively.

Visible-Near Infrared Spectroscopy

Visible-near infrared spectroscopy detects chemical tracers non-destructively for precise product differentiation.



MACHINE LEARNING MODELS FOR SAMPLE CLASSIFICATION AND ORIGIN VERIFICATION

Machine Learning Algorithms

Advanced machine learning algorithms enable precise classification of leather samples based on complex data patterns.

Spectroscopic Data Analysis

Spectroscopic data provides detailed chemical information vital for accurate sample classification and origin verification.

Authenticity Verification

Verifying provenance of leather samples strengthens product authenticity and helps prevent counterfeiting.

FEATURE SELECTION AND MODELLING

Key wavelengths: 950 nm, 1300–1500 nm, 1700+ nm

Signals linked to water, tracer, and chromium salts

Genetic algorithm identified optimal spectral bands

Modelling: Support Vector Machines (SVM)



Sagitto

900–1700 nm, 10 nm resolution

Grain side: 88% accuracy

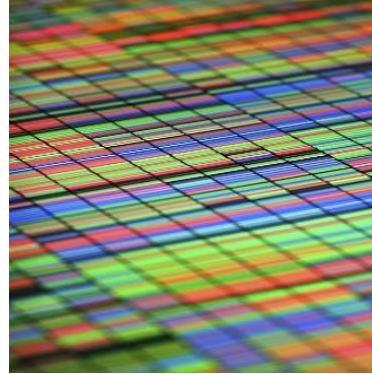


Labspec 4

350–2500 nm, 3–10 nm resolution

Grain side: 99.5% accuracy

DEVELOPMENT AND VALIDATION OF ROBUST CLASSIFICATION MODELS



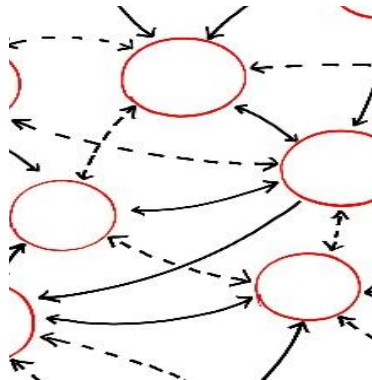
Spectral Data Training

Machine learning models are trained using spectral data representing various leather origins to identify unique features.



Model Validation Process

Validation ensures models achieve high accuracy and perform reliably under diverse real-world conditions.



Robust Classification

The final models classify leather origins accurately, enabling dependable application in practical scenarios.

Environmental and Industry Implications of Spectroscopic Approaches





ALIGNMENT WITH GLOBAL SUSTAINABILITY GOALS

Rapid Spoilage Detection

Advanced spoilage detection helps reduce waste by identifying leather defects early in the supply chain.

Traceability Systems

Traceability ensures transparency and accountability in leather production, supporting sustainable consumption.

Supporting Sustainability Goals

These innovations align with global sustainability goals by promoting responsible production and consumption.



ALIGNMENT WITH ENVIRONMENTAL STANDARDS AND REGULATIONS

Compliance with Environmental Standards

Advanced technologies assist manufacturers in meeting current and evolving environmental standards effectively.

Reduction of Ecological Footprint

These technologies contribute to lowering the ecological footprint of manufacturing processes significantly.

Enhanced Regulatory Adherence

Manufacturers improve adherence to regulations through the adoption of innovative environmental technologies.

FUTURE PROSPECTS FOR INTEGRATING ADVANCED TECHNOLOGIES IN LEATHER PRODUCTION

Spectroscopic Tools Integration

Spectroscopic methods enable precise quality control and material analysis in leather manufacturing.

Machine Learning Applications

Machine learning optimizes production processes and enhances decision-making for sustainable leather goods.

Sustainable Industry Practices

Advanced technologies promote greener, smarter, and transparent practices in the leather industry.



CONCLUSION

Spectroscopic Technologies

Spectroscopic methods allow rapid detection of leather spoilage, enhancing quality control processes significantly.

Machine Learning Integration

Machine learning algorithms improve traceability and data analysis, ensuring accurate tracking of leather products.

Environmental Benefits

These technologies contribute to reducing waste and environmental impact, fostering a sustainable leather industry.





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