RESEARCH AND INNOVATION ECOSYSTEM

DRLE 22nd

The 22nd International Conference

Developing Real-Life Learning Experiences: Technology and AI Driving Research and Innovation

AI, Complexity and Research-Driven Innovation in Food Safety

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DRLE 2026 Keynote

The essential is (in)visible to the eyes: How AI is Redefining Food Safety

poor soil

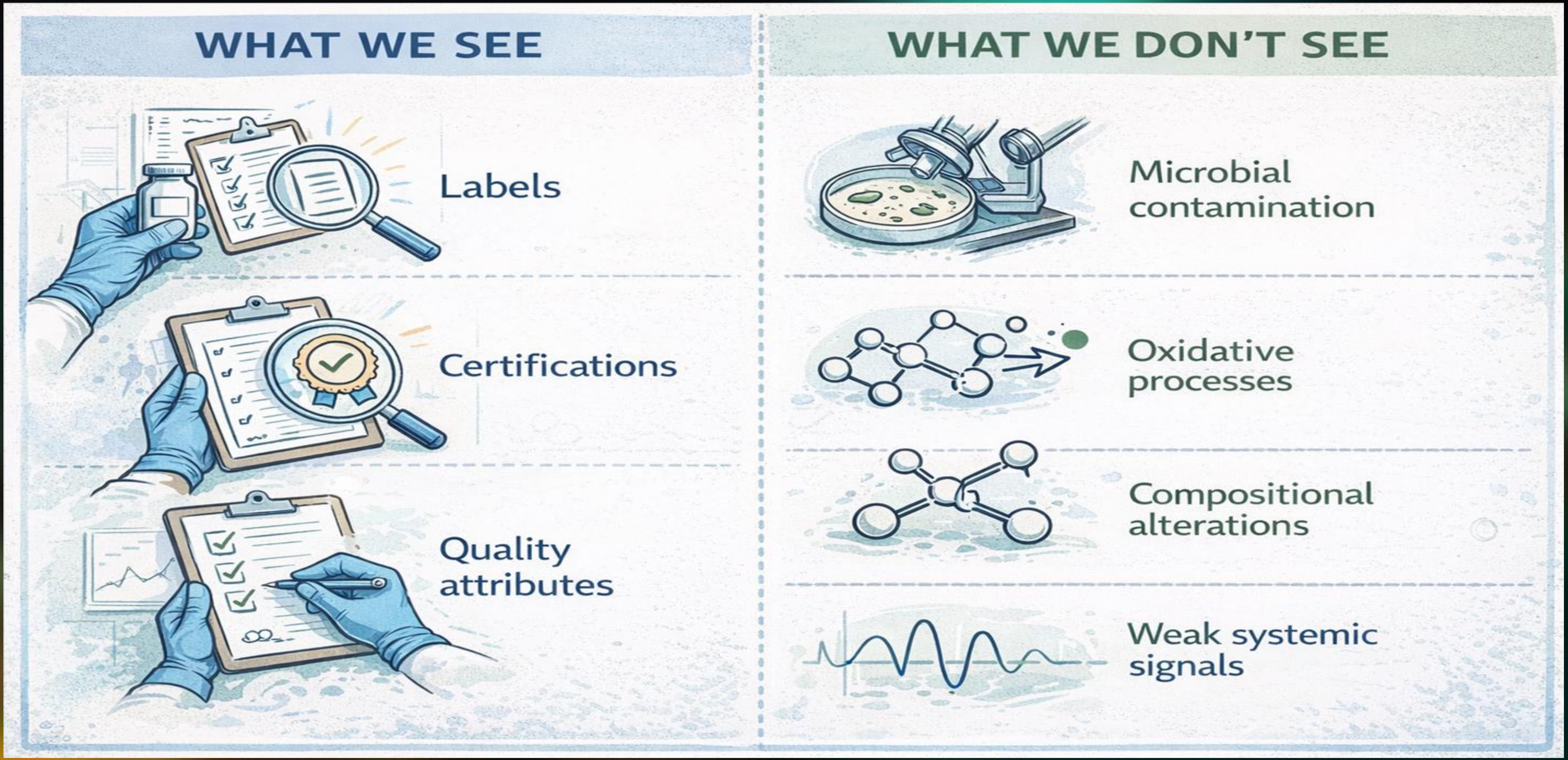
chemical pesticides

waste
(crops, water, etc.)

animal diseases

…

carbon emissions


WHAT WE SEE
Labels
Certifications
Quality attributes
WHAT WE DON'T SEE
Microbial contamination
Oxidative processes
Compositional alterations
Weak systemic signals

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Outline, discussion included

Questions should not wait until the end.

1. Invisible risk	why appearances are not enough
2. AI as augmented perception	when models help experts see weak signals
3. Real cases	wheat, efficient image classification, milk
4. Transferability	rice bran oil as a validation challenge, not a claim

I will pause three times

FOOD FRAUD:
AN ANCIENT PROBLEM

AN EPHAH THAT IS TOO SMALL

A SHEKEL THAT IS TOO BIG

TILTING A DISHONEST SCALE

SELLING GRAIN REFUSE AS GRAIN

Food fraud is not a modern issue.
It has deep roots in human history,
as denounced in **the Bible.**

THE PROPHET AMOS

8th century B.C., Kingdom of Israel

*"An ephah that is too small,
and a shekel that is too big,
tilting a dishonest scale,
and selling grain refuse as grain!"*

– Amos 8:5-6 (English Standard Version)

"We will diminish the ephah,
we will add to the shekel,
we will use false balances to cheat,
we will buy the needy for silver,
and the poor for a pair of sandals;
even the refuse of the wheat we will sell."

– Amos 8:5-6 (English Standard Version)

Modern food safety is a systems problem

Risk moves through climate, biology, logistics, markets and regulation.

- Global supply chains make local failures travel fast.
- Biological variability makes fixed rules fragile.
- Climate stress changes what “normal” looks like.
- Post-production checks arrive too late for many risks.

What is the weakest signal in your own food system?

Why AI now?

Too many signals. Too little time. Too much is invisible to unaided inspection.

Pattern recognition	turns large, heterogeneous datasets into operational cues.
Early anomaly detection	finds weak signals before defects become obvious.
Predictive modelling	moves food safety from late inspection to prevention.
Decision support	augments experts without removing responsibility.

Working thesis

Make invisible risk observable without making human responsibility disappear.

Observe

weak signals

images, spectra, sensors and reference measurements

Model

latent patterns

classification, regression, anomaly detection

Validate

real decisions

expert review, laboratory confirmation, governance

Prediction is useful only when we know what evidence it is based on.

Human vs AI is the wrong question

The useful question is: what should each one do better?

Live poll 1

If the task is early field recognition, who would you trust first?

- A trained agronomist
- A trained AI model
- Both, but with different responsibilities

Raise your hand: human expert, AI model, or both together?

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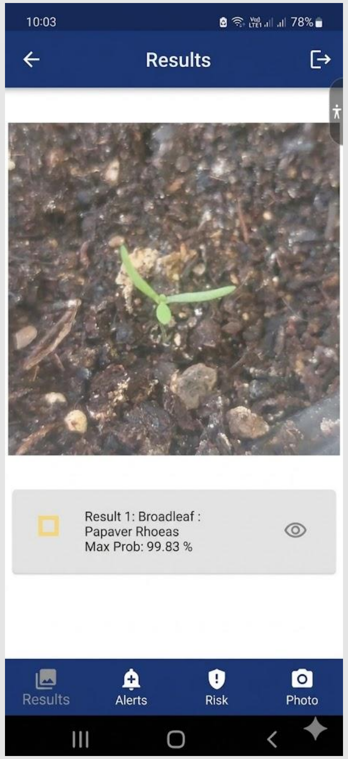
Case 1 — Wheat (GranoScan) & Maize/Weed

From field photo to early warning.

Input	RGB/mobile images captured in the field.
Task	classification of weeds, insects and plant diseases.
Decision value	early screening and more objective field support.
Limit	annotation quality and representativeness remain decisive.

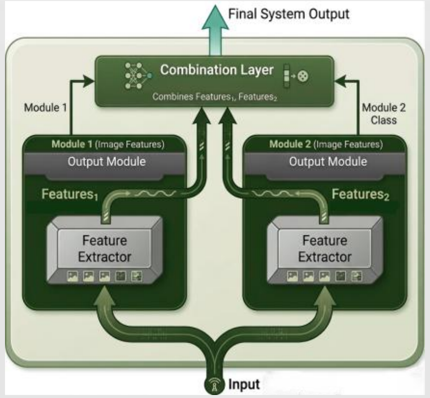
This is not AI replacing expertise; it is AI reducing inspection delay.



Maize/Weed

Method lesson

Bigger is not always better.



- State of the Art | Image Classification on CIFAR-10
- State of the Art | Image Classification on CIFAR-100
- State of the Art | Image Classification on CINIC-10
- State of the Art | Image Classification on Food-101
- State of the Art | Image Classification on Oxford 102 Flower
- State of the Art | Image Classification on Oxford-IIIT Pets
- State of the Art | Image Classification on Stanford Cars
- State of the Art | Image Classification on POCUS

+0.5%
accuracy gain
average improvement over state-of-the-art benchmarks

10–100×
fewer parameters
lower model complexity

100×
fewer FLOPs
more deployable in real conditions

In food systems, deployability is not a detail. It is part of reliability.

https://doi.org/10.1111/exsy.13424

Discussion checkpoint

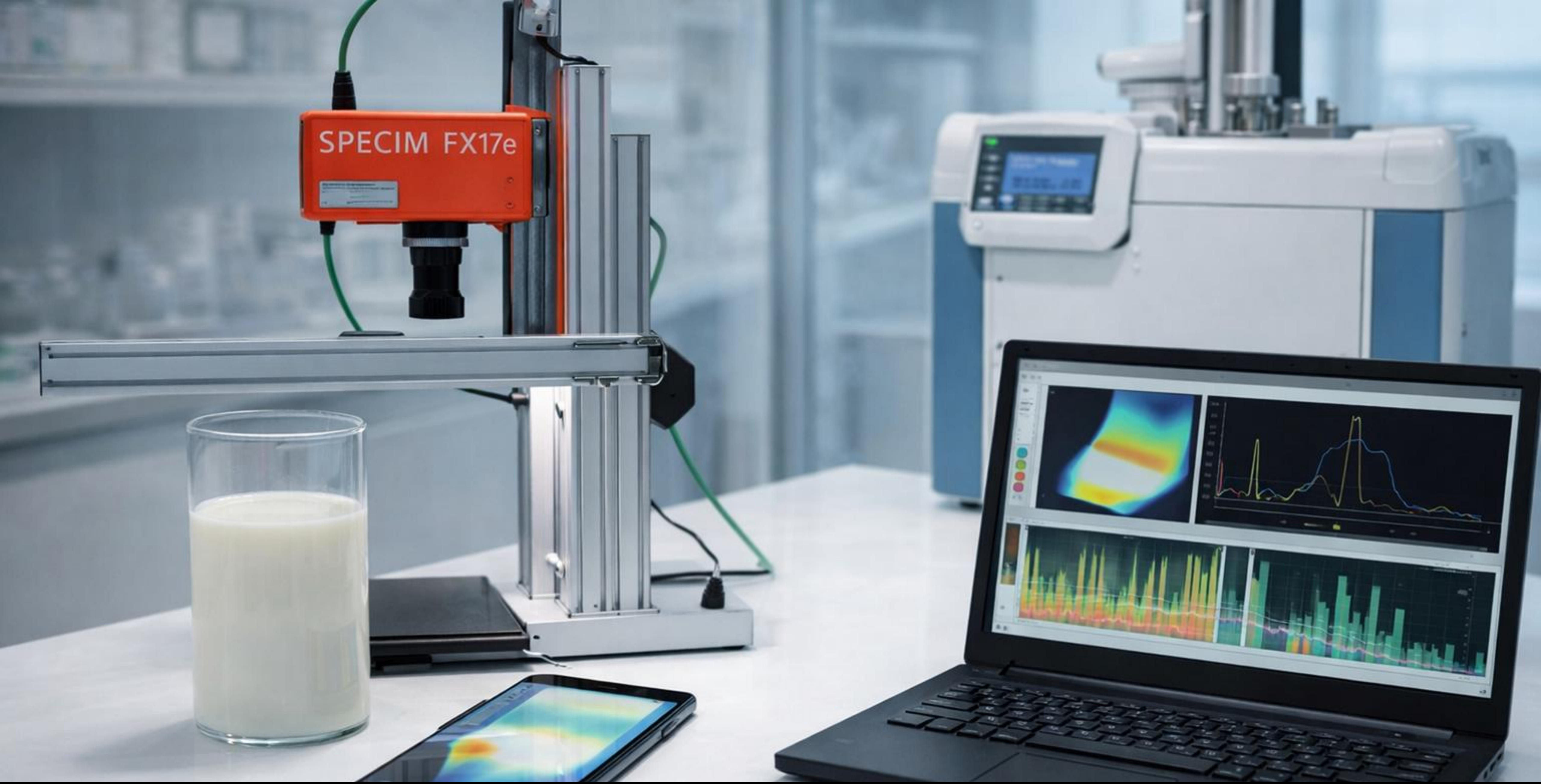
Where would low-cost AI help first in your context?

- Crop disease and weeds
- Storage and shelf-life monitoring
- Fraud and authenticity screening
- Industrial inspection and foreign-object detection

Choose one domain; what would make it useful enough to test?

Reality is dynamic

Field data are inconsistent, biological, and context-dependent: this is not an exception, it is the norm.



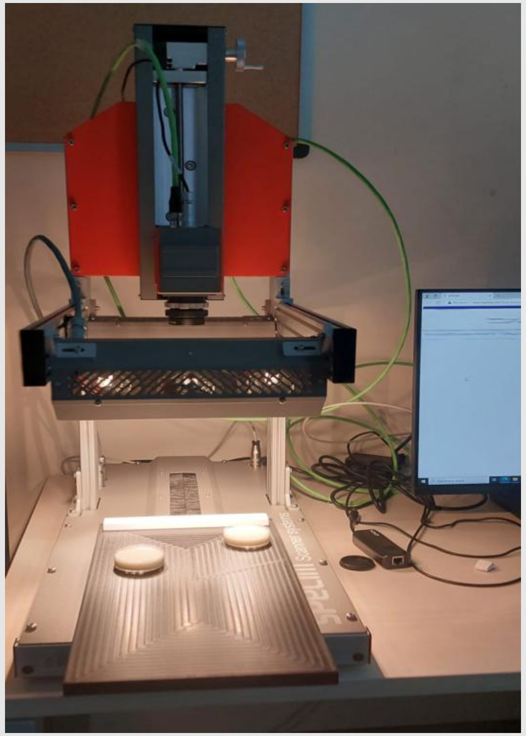
Case 2 — Milk quality assessment

Visible and hyperspectral imaging turn appearance into biochemical questions.

Five-second test

Same appearance does not mean same composition.

- A visible image may contain useful low-cost cues.
- Hyperspectral data connect more directly to chemical variation.
- Laboratory reference values remain the anchor for validation.



When would you accept visible imaging as screening, but not as final proof?

Limits are part of responsible AI

The risk is not weak AI. The risk is unvalidated AI.

Bad data	biased or partial datasets produce brittle models.
Unknown cases	novel contaminants and edge cases can be missed.
Wrong evaluations	false positives waste product; false negatives create safety risk.
Missing context	a model detects patterns; only human experts judge meaning and accountability.

Bridge to rice bran oil

Algorithms can travel across domains. Evidence cannot.

Wheat	visible morphology and early field decisions.
Milk	visible + hyperspectral signals linked to biochemical properties.
Rice bran oil	authenticity and quality depend on compositional markers.
Core point	same AI logic, different material reality.

The common DNA is pattern recognition. The living part is the data.

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Rice bran oil

Not just “does the oil look different?”

- Relevant markers include fatty acids, γ-oryzanol, tocopherols/tocotrienols, FFA and oxidation indices.
- Visible imaging can be a low-cost screening hypothesis.
- Spectral / hyperspectral data are stronger for compositional questions.
- Transferability from wheat or milk must be rebuilt with product-specific evidence.

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Validation roadmap

Rice bran oil is the next validation challenge.

1
collect
representative oil samples, processing histories and storage conditions

2
measure
visible, spectral/hyperspectral and laboratory reference markers

3
validate
external test sets, failure cases and expert-confirmed decision rules

The safe statement is not “it works”; it is “we can test transferability rigorously”.

Live poll 2

For rice bran oil authenticity, what evidence would convince you?

- A visible/RGB model with strong screening performance
- A spectral model tied to reference chemical markers
- A multimodal model validated on external batches
- A protocol accepted by experts and regulators

Which evidence matters most before you would trust the system operationally?

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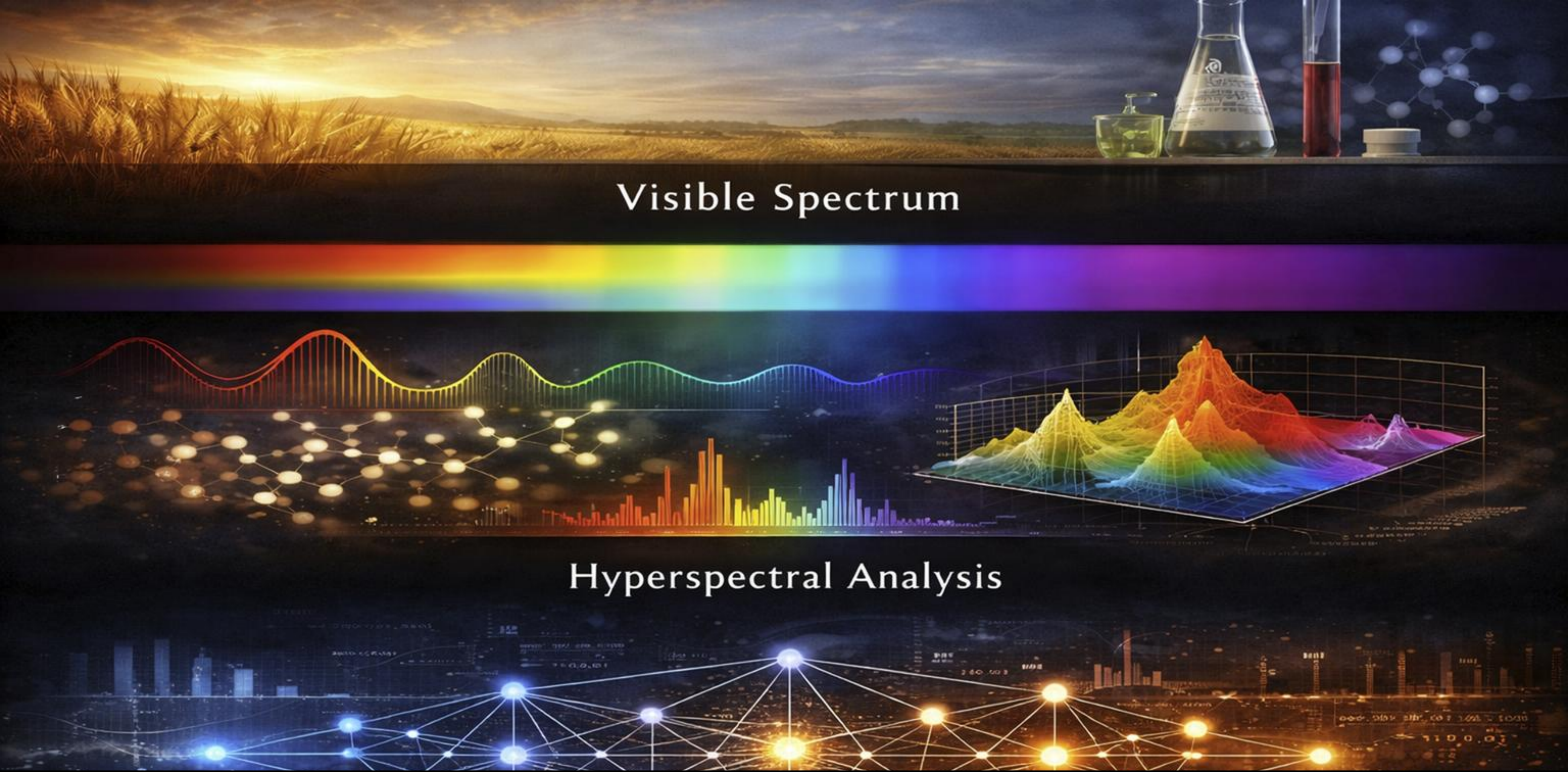
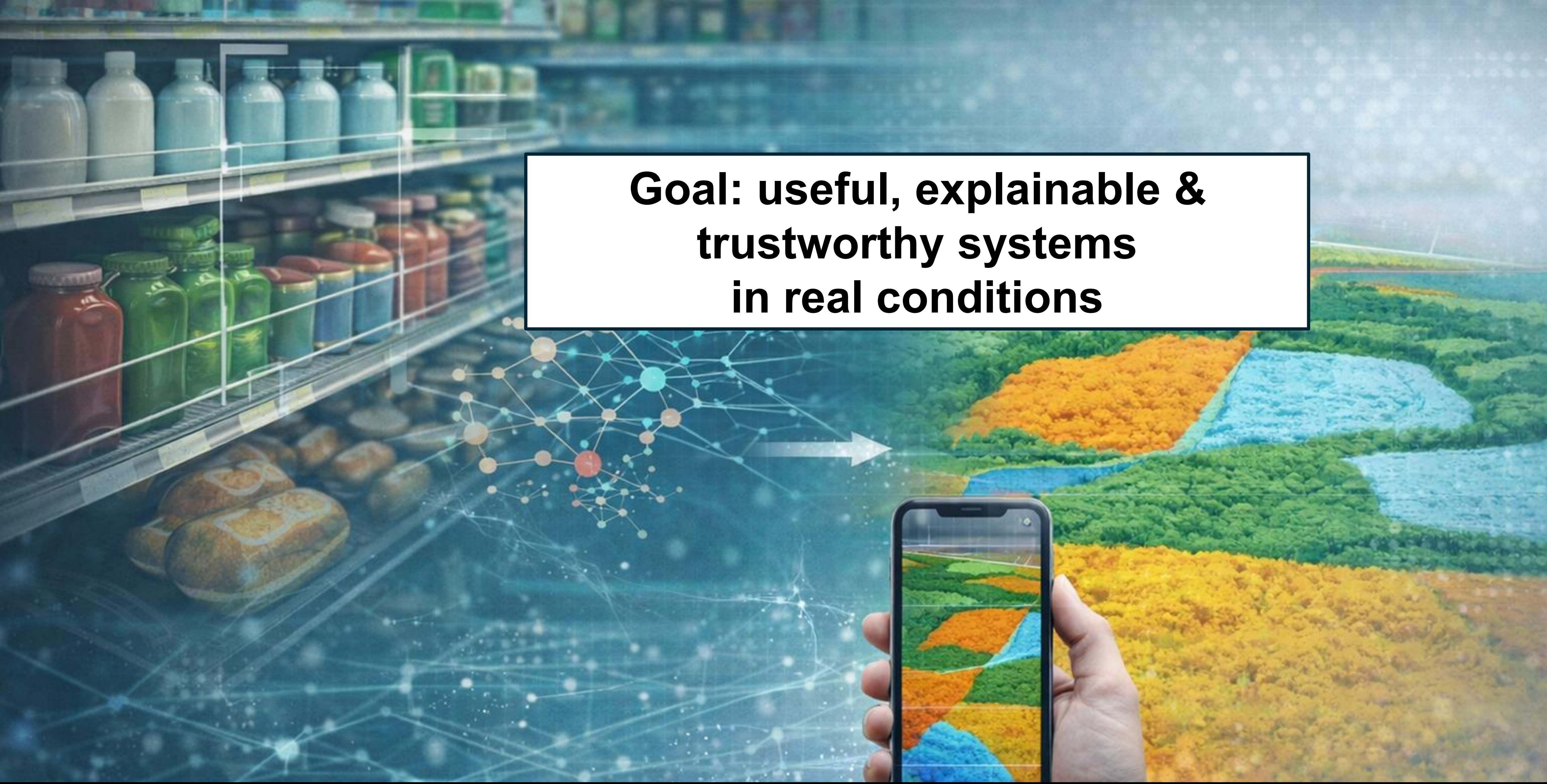


Two invisibilities chemical/physical + technological (black boxes)

Food safety needs both detection of hidden signals and interpretation of model logic.



Goal: useful, explainable & trustworthy systems in real conditions

Where the field should go next

From classification to segmentation; from isolated predictions to adaptive, validated systems.

Three takeaways

1 Food safety is a powerful methodological domain for AI

2 Complexity is not noise around the problem

3 Research-driven innovation matters when it improves real decisions

Design methodology for complexity,
not after complexity.

A place where to talk about this

4th Thematic Session on AI in Agriculture (AgriAI’26)

in the context of the 21th IEEE Conference on Computer Science and Intelligence Systems FedCSIS

Riga, Latvia, 23-26 August, 2026

Topics:

Computer vision in agriculture
Signal and image processing in agriculture
Computational intelligence in agriculture
Generative AI for Agriculture
Intelligence systems and decision support in agriculture
Expert systems & predictive systems
LLM for AKIS (Agriculture Knowledge Information System)
AI-based precision agriculture
Machine learning and pattern recognition
Federated AI for Agriculture
IoT, Edge efficient AI & Low-Connectivity ML in agriculture
Biosecurity & surveillance AI
Food and livestock management
Big data
Water Management
Remote sensing
Phenotyping & Genomics
Uncrewed aerial vehicle vehicles
Autonomous driving in agriculture
Geospatial AI in agricultural
Harvesting automation
Robotics and robotic perception in agriculture
Digital twins for agriculture
Data space for agriculture
AI for biodiversity and sustainable agroecology
Ethics and social impact of AI on agriculture
AI-based crowd-sensing and participatory approaches in agriculture

You are invited to take part

Thank you!

ขอบคุณครับ 🙏

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- Questions were part of the talk. Now we can continue the conversation

https://iris.cnr.it/handle/20.500.14243/585281?mode=complete