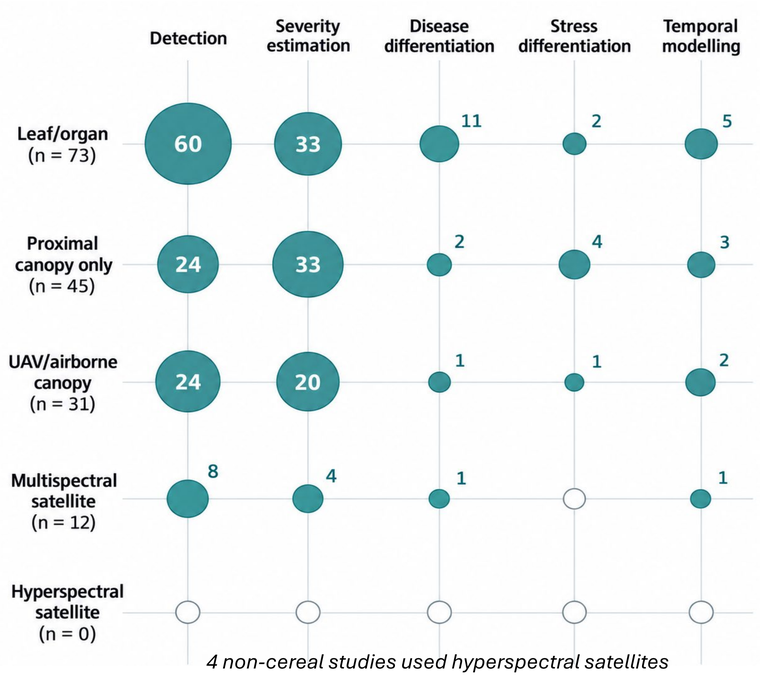
A Review on Hyperspectral Remote Sensing of Cereal Fungal Diseases: From Leaf Spectrum to Spaceborne Detection

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ABSTRACT

Hyperspectral sensing captures biochemical and structural changes associated with fungal infection, but leaf-level evidence may not translate directly to field conditions. Reviewing 197 peer-reviewed journal articles published between 2000 and March 2026, we examine how disease signals change across sensing scales, how emerging models represent these signals, and the key challenges limiting reliable operational monitoring. Conducted within the AAGI–ASII Hyperspectral Disease Detection project, the review establishes evidence gaps and priorities for scaling disease detection from leaves to satellite observations.

Evidence Overview



Evidence concentration:
Most studies remain at leaf and canopy scale.

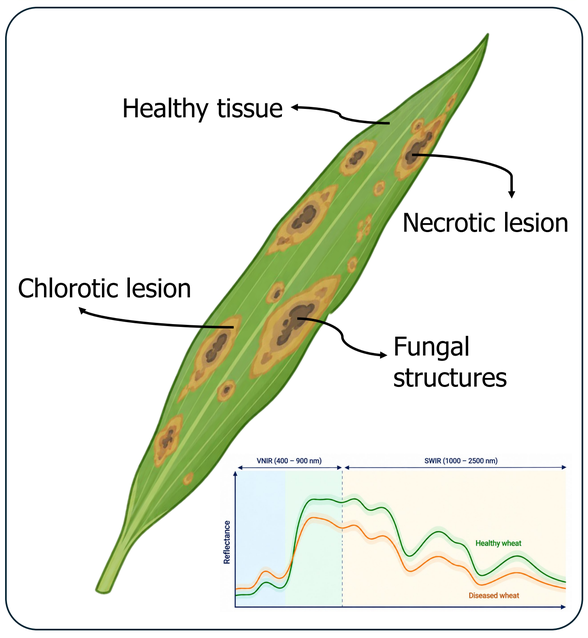
Task imbalance:
Limited studies on disease differentiation and temporal modelling of disease development.

Scale gap:
Narrow evidence base for satellite-level applications.

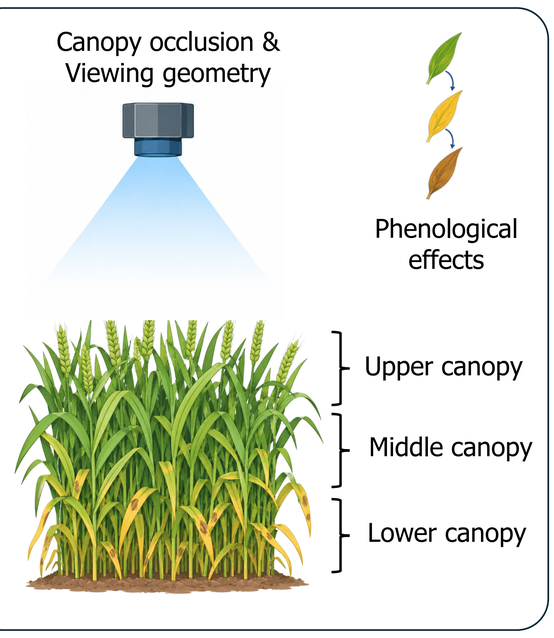
Bubble area represents the number of studies. Task categories are non-exclusive. Grey outlined circles indicate zero studies. UAV: un-crewed aerial vehicle.

Publications retrieved from the Web of Science core collection.

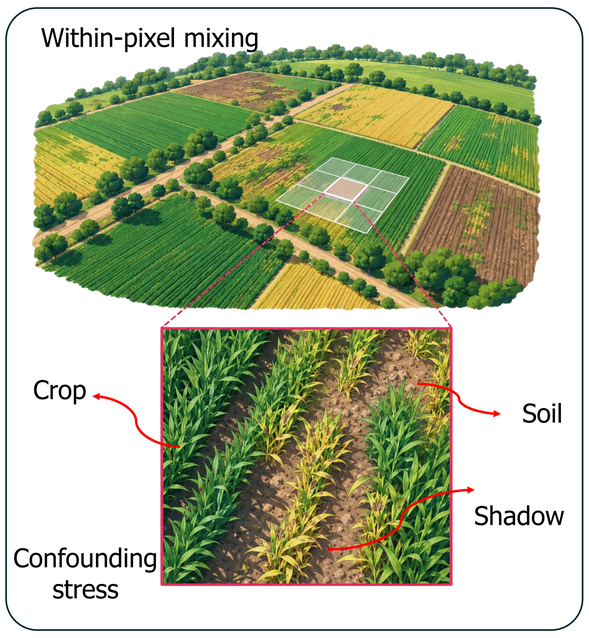
Diseased Leaf



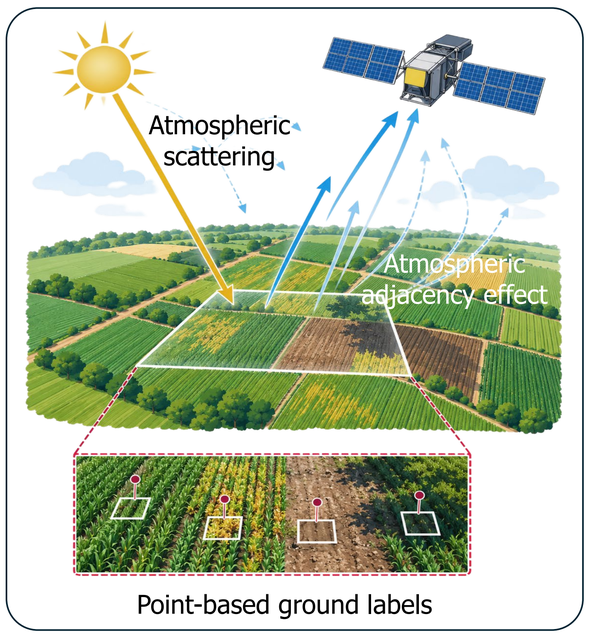
Crop Canopy



Agricultural Field



Satellite Pixel



Leaf: Resolves disease-related spectral and temporal responses, supporting mechanistic interpretation.

Canopy: Adds spatial context, but introduces occlusion and confounding effects.

Satellite: Enables repeated, large-area monitoring, but increases signal mixing.

Increasing spatial and temporal coverage, as well as environmental variation and signal mixing.

Evolving Methodologies

The field is moving towards models that integrate spectral, spatial and mechanistic information.

Single-index to multivariate modelling: Increasing adoption of machine-learning methods that integrate information across wavelengths and derived features.

Spectral to spectral–spatial: Imaging enables texture and spatial-pattern analysis, extending disease characterisation beyond spectral signatures alone.

Empirical to process-based: Radiative transfer model inversion retrieve disease-sensitive traits or explicitly simulate disease effects through modified models and spectral mixture analysis.

Handcrafted to learned features: Spectral–spatial deep-learning architectures learn features jointly, but require representative, scale-matched labels.

Scaling to Satellites: Evidence and Rigour

Reliable satellite disease monitoring depends not only on better imagery, but on rigorous validation using representative, spatially and temporally matched ground labels.

Evidence

- **4** hyperspectral satellite studies, 0 for cereal crops.
- **40%** used multiple image dates.
- **1** conducted sequence-based time-series analysis.

Rigour

- **40%** reported sample size, ranging from **20–500** observations.
- **50%** did not report the time lag between image acquisition and ground truthing.
- Point- or plot-scale ground labels may not represent heterogeneous satellite pixels.

Percentages refer to the reviewed satellite-study subset.

Research Priorities

- Match labels to pixels in space and time.
- Differentiate disease from phenology, abiotic stress and background effects.
- Integrate temporal, spectral, spatial and mechanistic information.
- Validate transferability across fields, seasons, cultivars and sensors.

Disclaimer: This poster contains AI-generated images.

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