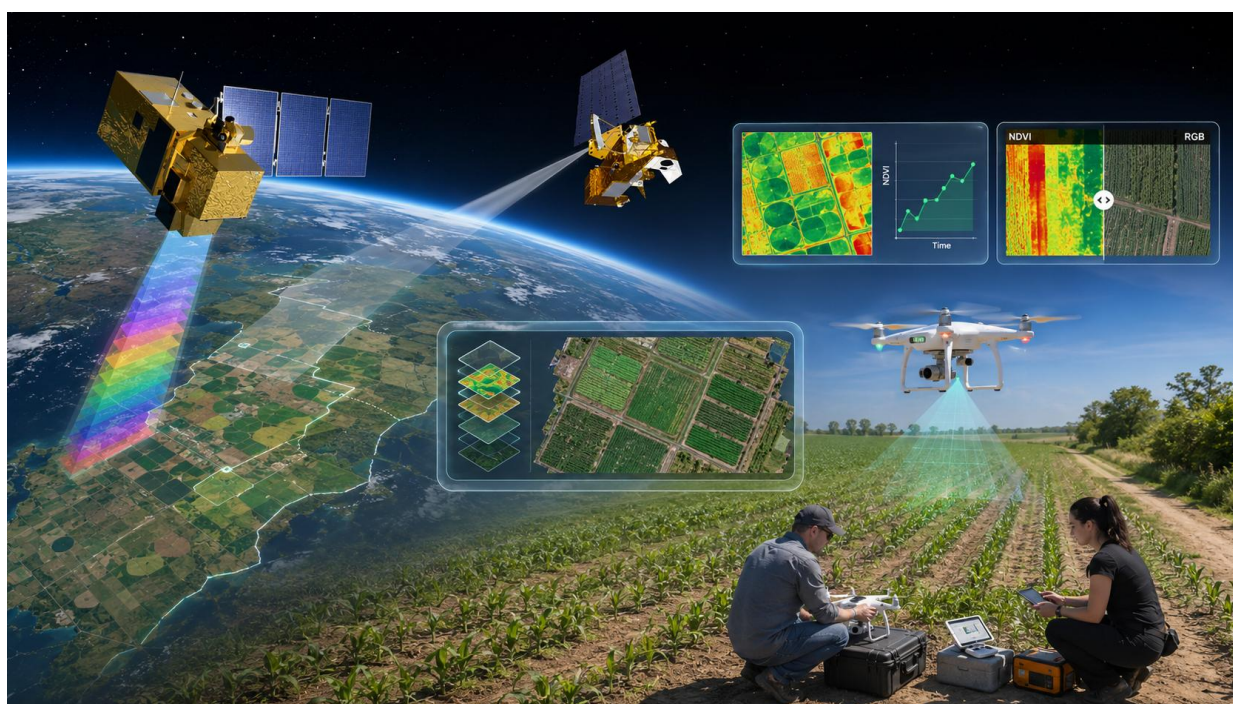


UAVs vs. Satellites: Which is Better for Crop Monitoring?

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ABSTRACT

It is one of the most common questions in precision agriculture right now — and the honest answer is: it depends on what you are trying to see, when, and at what scale. This review provides a structured comparison of satellite and UAV remote sensing technologies for crop monitoring, highlighting the complementary strengths of each approach and the case for integrated, hybrid workflows in modern agronomy.



1. WHERE SATELLITES EXCEL

Satellite platforms offer capabilities that no drone fleet can currently match at regional or national scales. The three most operationally significant advantages are summarised below.

- **Large-area coverage.** For regional crop health mapping, yield forecasting, or national-scale drought monitoring, satellites are unmatched. No drone fleet comes close in spatial extent or operational efficiency.
- **Long-term time series.** Satellites have imaged the Earth continuously for decades. Platforms such as Google Earth Engine enable retrospective analysis — drought, flooding, or frost responses going back 40 years — a capability entirely absent from UAV-based programmes.
- **Economic viability at scale.** For monitoring thousands of hectares, freely available datasets — Sentinel-1, Sentinel-2, Landsat — make the economics straightforward. No pilot, no battery management, no flight permissions.

2. WHERE UAVS EXCEL

Unmanned aerial vehicles compensate for satellite limitations in resolution, response time, and sensor customisation. Their principal operational advantages are detailed below.

- **Sub-decimeter spatial resolution.** Where satellites offer pixels of 10–30 m, a UAV captures centimetre-level detail — sufficient to identify individual diseased plants, count crop rows, or detect early-stage post-storm lodging.
- **Rapid deployment.** A UAV can be airborne within hours of a hail event, frost, or flood. Satellite revisit cycles — compounded by cloud cover — make near-real-time response impractical for event-driven diagnostics.
- **Sensor versatility.** UAV platforms support interchangeable multispectral, hyperspectral, thermal, and LiDAR payloads, enabling highly customised data collection tailored to specific agronomic questions.
- **Three-dimensional data products.** UAVs routinely generate high-quality digital surface models and canopy height maps — critical for biomass estimation, lodging detection, and drainage analysis.

3. COMPARATIVE SUMMARY

Criterion	Satellites	UAVs
Spatial resolution	10–30 m (typical)	< 5 cm (typical)
Area coverage	Regional / global	Field / farm scale
Temporal frequency	Days to weeks	On-demand (hours)
Time series depth	Up to 40 years	Limited to deployment period
Cost at scale	Low (open data)	Higher (operations, personnel)
Sensor options	Fixed per platform	Highly interchangeable
3D data products	Limited	High quality (DSM, CHM)
Cloud sensitivity	High	Moderate (flight planning)

Table 1. Key operational characteristics of satellite and UAV platforms for precision agriculture.

4. THE HYBRID WORKFLOW: AN INTEGRATED PERSPECTIVE

Relying exclusively on either technology leaves significant analytical capacity unexploited. The most powerful operational workflows combine both platforms. Satellites provide the wide-area, continuous baseline — identifying where anomalies are developing. UAVs then zoom in to confirm, quantify, and diagnose.

Think of satellites as your early warning system and UAVs as your diagnostic tool. Neither replaces the other; together they cover the full spatial and temporal range that modern agronomy demands.

The question is not which technology is better — it is which question you are trying to answer. Defining the agronomic objective first, and then selecting the appropriate observational tool (or combination thereof), is the hallmark of a mature precision agriculture programme.

REFERENCES & FURTHER READING

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