showing how field and aerial observations can be aligned into one growth-monitoring framework (Zhang et al., 2025). More broadly, multimodal remote sensing improves crop monitoring because different sensing modalities complement one another and provide a more comprehensive representation of plant growth than single devices alone.

For Zhejiang medicinal plants, dataset integration should also be spatially explicit and cultivation-oriented.Machine learning combined with GIS can organize soil, subregion, and medicinal-plant information to identify suitable cultivation zones and support targeted management strategies (Roopashree et al., 2024). At the same time, UAV-based high-resolution imaging enables plant-level monitoring across the growing season, making it possible to estimate maturity and detect growth problems early enough for intervention (Vigneault et al., 2023). A further development direction is extending data integration beyond morphology into biochemical and omics layers.AI-driven multi-omics workflows are designed to integrate heterogeneous biological datasets so that fragmented information can be assembled into metabolic networks relevant to compound biosynthesis (Figure 1) (Chen et al., 2026). This is especially important in medicinal plants because multi-source data fusion has been shown to improve holistic quality evaluation and prediction compared with single analytical methods.

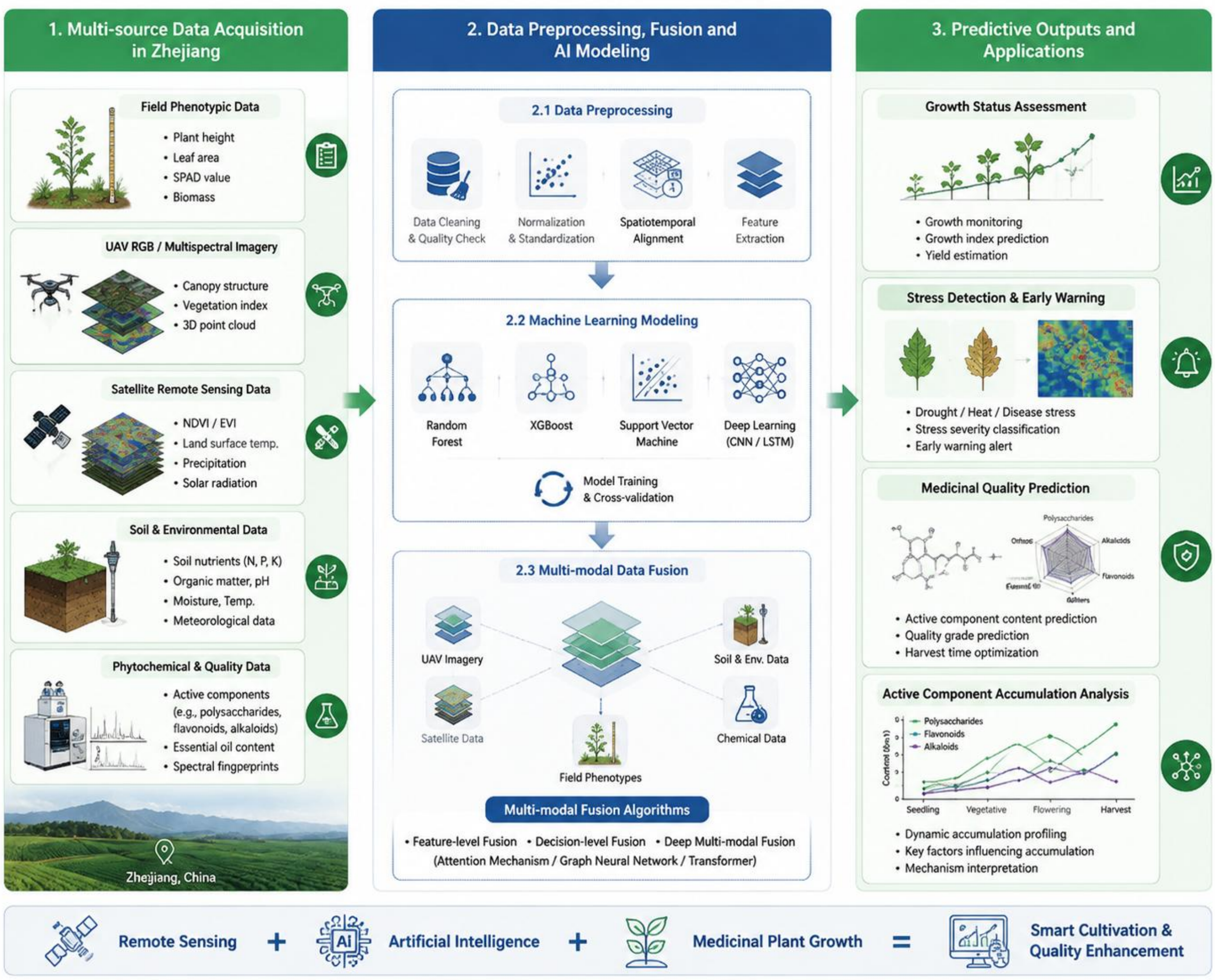

Figure 1 Multi-source data integration framework for computational analysis of growth traits and quality evaluation in Zhejiang medicinal plants

3.2 Machine learning and statistical modeling of growth characteristics

Once multi-source datasets are established, machine learning and statistical models become the core tools for extracting growth patterns and trait relationships.In medicinal plants, these methods help analyze the joint effects