



Spatial Data Applications in Geospatial Agronomy for Improved Crop and Soil Management

Qiting Tilahun *

Department of Agro technology, Greenfield Agricultural University, Rome, Italy

DESCRIPTION

Geospatial agronomy combines agricultural science with geographic information technologies to understand how crop and soil conditions change across agricultural landscapes. Conventional field management often relies on observations made at selected locations, while geospatial approaches provide information across much larger areas. Geographic coordinates, satellite observations, drone imagery, soil measurements, weather records, and crop data can be combined to create detailed maps that assist agricultural decision making. These methods allow farmers and agricultural researchers to examine spatial differences in crop growth, soil characteristics, water availability, and production performance.

Agricultural fields are rarely uniform. Soil texture can differ from one part of a field to another, while nutrient concentration, organic matter, drainage, and moisture availability may also show substantial variation. Crops growing under these different conditions may develop at different rates and produce different yields. Geospatial agronomy provides a means of recording and analyzing these variations. By associating agricultural measurements with geographic coordinates, each observation can be placed at its actual field location and compared with measurements from surrounding areas.

Satellite remote sensing is one of the most useful sources of geospatial agricultural information. Earth observation satellites collect images at regular intervals and provide coverage over extensive agricultural regions. Different spectral bands can be used to evaluate vegetation condition, soil characteristics, surface moisture, and changes in land cover. Vegetation indices derived from satellite imagery can indicate differences in plant vigor and canopy development. Farmers and agricultural specialists can use these observations to identify portions of a field that may require additional inspection.

Unmanned aerial vehicles provide another source of high-resolution agricultural information. Drones can collect images at

much lower altitudes than satellites, allowing individual fields and small sections of crops to be examined in considerable detail. Cameras installed on drones can capture visible and multispectral imagery that helps identify variations in plant growth. Repeated flights during the growing season can show how crop conditions change over time. This information can be useful for detecting water stress, nutrient deficiencies, weed distribution, and areas affected by disease.

Geographic information systems are used to organize and analyse spatial agricultural information. Geospatial platform can combine soil maps, field boundaries, satellite images, weather records, irrigation locations, yield data, and crop management information. Each layer represents a particular characteristic of the agricultural landscape. When several layers are analysed together, relationships between soil properties, crop growth, and production outcomes can be examined. Such analysis helps agricultural professionals determine why certain areas perform differently from others.

Water management also benefits from spatial information. Soil moisture sensors, weather observations, remote sensing data, and irrigation records can be combined to identify areas with different water requirements. Some sections of a field may retain water for longer periods because of soil texture or topography, while elevated or sandy areas may lose water more rapidly. Spatial irrigation management can account for these differences and reduce unnecessary water application. This can improve water-use efficiency and support healthier crop development.

Topography influences drainage, erosion, soil moisture, and crop productivity. Digital elevation models generated from satellite or drone data can show changes in field elevation and slope. Areas with greater slope may experience increased runoff during heavy rainfall, while lower locations may collect excess water. Understanding these patterns assists with drainage planning, erosion control, irrigation design, and crop placement. Topographic information can also be combined with soil and yield maps to identify recurring production differences.

Correspondence to: Qiting Tilahun, Department of Agro technology, Greenfield Agricultural University, Rome, Italy, E-mail: qiting.tilahun@greenfield-agri.com

Received: 29-Aug-2025, Manuscript No. AGT-25-32490; **Editor assigned:** 01-Sep-2025, Pre QC No. AGT-25-32490 (PQ); **Reviewed:** 15-Sep-2025, QC No. AGT-25-32490; **Revised:** 22-Sep-2025, Manuscript No. AGT-25-32490 (R); **Published:** 29-Sep-2025, DOI:10.35248/2168-9891.25.14.416

Citation: Tilahun Q (2025) Spatial Data Applications in Geospatial Agronomy for Improved Crop and Soil Management. Agrotechnology. 14:416.

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CONCLUSION

Geospatial agronomy therefore provides a practical framework for understanding agricultural variation across space and time. The integration of remote sensing, geographic information systems, soil sampling, drone technology, positioning systems, weather observations, and yield monitoring allows agricultural professionals to develop more detailed knowledge of crop and

soil conditions. As data collection becomes more accessible and analytical tools continue to improve, geospatial approaches can support more efficient use of agricultural inputs, improved crop monitoring, better soil management, and informed field planning. The continued application of spatial information can contribute to productive agricultural systems while supporting careful management of soil, water, and other resources.