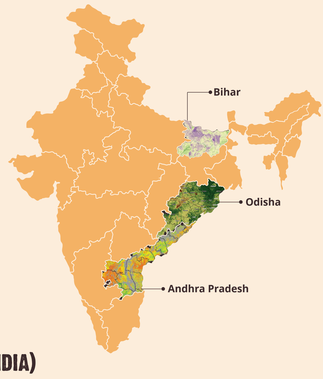
Soil Intelligence System (SIS)

Soil is the foundation of agriculture and it is a complex material that is different all over the world. Soils vary greatly in their chemical and physical properties and each type has particular strengths and weaknesses for agriculture. Soil health and its fertility are paramount for producing sufficient nutritious food for world's growing population.

To understand the productive capacity of our soils, we need high-quality soil data. The need for good soil data is true at the field level, but even more pressing at a broader scale across regional landscapes. Large variability in soil properties and crop management practices across this broader scale makes it challenging to create products, policies, or agricultural services efficiently for large numbers of farmers.



Soil Intelligence System (SIS India)

The Soil Intelligence System (SIS) of the Cereals Systems Initiative for South Asia (CSISA) supports people in the agriculture sector to make better decisions by providing accurate, spatially referenced digital soil and crop information at a larger scale. Funded by the Bill & Melinda Gates Foundation the SIS initiative is currently being implemented by CSISA in the states of Andhra Pradesh, Bihar and Odisha, under the partnership of International Maize and Wheat Improvement Centre (CIMMYT), ISRIC - World Soil Information, Cornell University and International Food Policy Research Institute (IFPRI).

Soil Intelligence System (SIS) integrates remote sensing, digital soil mapping, technological changes in soil testing like spectroscopy, and new statistical tools to create an "intelligent" system that provides the best information possible to India's agriculture industry. Predictive mapping and state of the art data analytics help generate predictions of soil parameters to develop comprehensive soil information at scale (i.e., over large areas), reducing the need for spatially intensive soil sampling.

Further, SIS provides site-specific nutrient and crop management recommendations based on machine-learning data mining techniques with geo-spatial crop response assessment.

Soil Spectroscopy

Spectroscopy measures the amount of light reflected by a soil sample in the visible (Vis) and infrared (IR) spectral regions, reacting to its organic and inorganic composition.

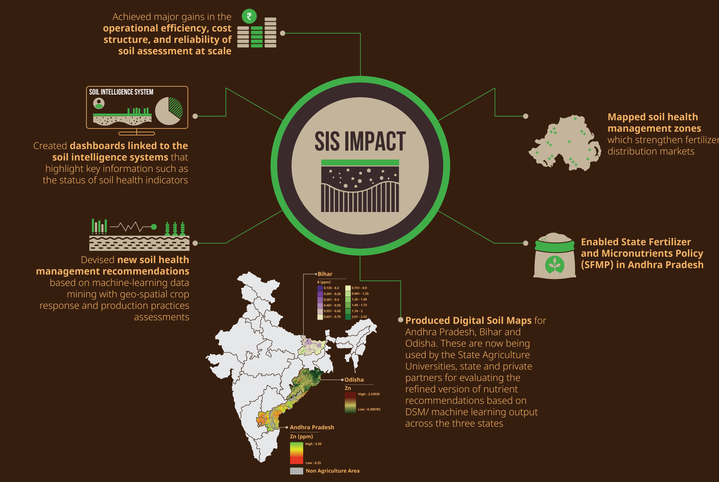
Soil spectroscopy and geo-statistical sampling methods reduce the costs of collecting and analysis of soil sampling while generating high-quality soils data.

Digital Soil Mapping (DSM)

DSM makes use of geo-statistical models that predict the soil type or properties. DSM is the computer-assisted prediction and production of digital maps of soil types and soil properties from a limited number of soil samples and a set of environmental covariates covering the area of interest.

SIS's DSM dashboard is a one-stop shop for information on soil, nutrients, and crop-favourable conditions.

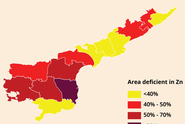
Modern Soil Intelligence Systems Impact



Soil Intelligence System in Andhra Pradesh

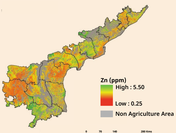
1 Conventional method

- Generalized information and blanket fertilizer recommendations per district -- not considering soil and cropping practice differences.
- First generation digital soil map for different soil properties made in Andhra Pradesh, made from >500,000 soil data points combined with >300 covariates.



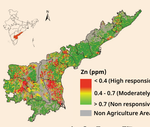
2 Digital Soil Mapping (DSM)

- Couples legacy soils data collected at sampling points with environmental co-variates known over the entire area (e.g., satellite imagery, digital elevation models) to predict soil properties at fine resolution (from 1 km to 30 m) using machine learning.



3 Soil zinc (Zn) management zones

- Derived from digital soil map. Approximately 40-50% of Andhra Pradesh soils are reported as deficient in available Zn.



4 On-farm validation of DSM output on Zn crop response

- Crop response data is the 'gold standard' for guiding site-specific nutrient management. In the 2019 kharif season, 161 on-farm trials provided new insights into the association between soil variability and crop response to Zn fertilizers.
- Paired on-farm trials (+/- Zn) were conducted based on DSM output. The results showed that Zn application resulted in a yield gain of 0.41 t ha-1 compared to no Zn plots across the 9 districts in Andhra Pradesh. The response to Zn application varied across the districts and across the low and medium Zn villages within each district.

5 Closing 'Big Data' gaps

- Digital data on crop, soil, and management practices collected from farm trials can be combined with crop response data and digital soil map outputs to derive better management recommendations.

6 Precise recommendations

- The core outputs of the Andhra Pradesh Soil Intelligence System are site-specific nutrient and crop management recommendations based on machine-learning data mining techniques with geospatial crop response assessment.

Partners

CIMMYT · ISRIC · IFPRI

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