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Improving agricultural research through Geoinformatics

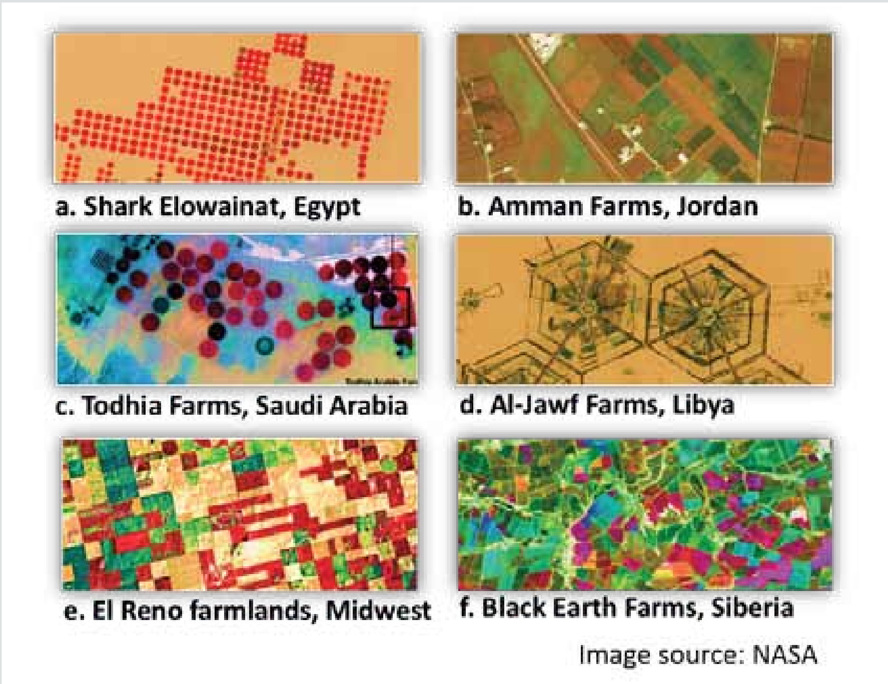
Enhanced geospatial technologies are helping improve agroecosystems

Enhanced geospatial technologies (remote sensing, global positioning system and geographical information system) upgrade ICARDA's integrated agroecosystems research and support the 'systems' approach for agricultural research for development. The high resolution data thus received gives a better understanding of the complexities related to dryland farming systems. Consequently, researchers can better diagnose vulnerabilities and suggest interventions to improve agricultural productivity.

In a bid to improve agricultural productivity, ICARDA recognizes that geoinformatics is critical in obtaining adequate data for tackling food security and improving livelihoods, particularly in dry areas of the developing world that struggle with limited natural resources. Geoinformatics has the ability to influence agricultural research, programs, and policies.

Defined as an integrated technology for the collection, transformation and generation of information from integrated spatial and non-spatial databases, geoinformatics includes the techniques of remote sensing, geographical information sciences (GIS), and global positioning systems (GPS).

The use of geoinformatics in agricultural research has recently increased due to advances in satellite sensor technology, and advances in the processing and handling of large amounts of data. Particularly, over the last five years, there has been a notable increase in the use of spatial data and the development of machine learning algorithms for thematic research. This trend has ushered in a new era of "open access."

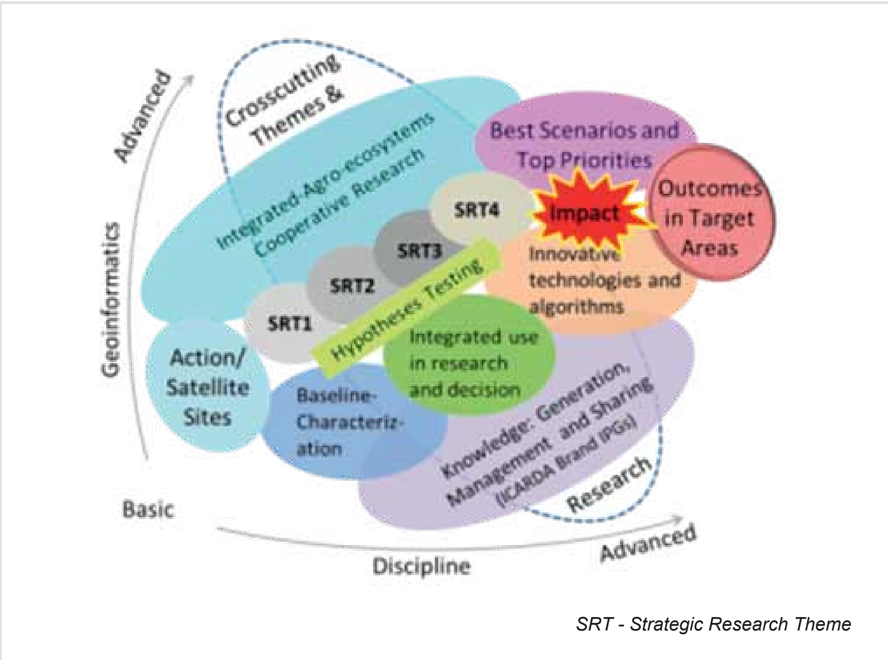


Diversity of agro-ecosystems in dry areas observed from the space

Complexities of agroecosystems

While efforts are underway throughout the world to increase agro-geoinformatics data, in many instances the information is collected at very coarse resolution, ranging from several hundred meters to tens of kilometers. At these scales, the data may fail to reflect ground realities that are often very different from information or data collected at larger scales. As a result, the information is incapable of capturing the complex nature of agroecosystems.

This problem is especially prevalent in the developing world, where landholdings are small, and production systems are highly diverse and complex. Such complexity includes various factors such as soils, water availability, elevation, localized weather events, poverty distribution, infrastructure, migration, market access, conflict, and more.



Role of Geoinfotmatics in the ICARDA-led CGIAR Research Program on Dryland Systems

Increased resolution

Recent developments in advanced sensor technology, platforms, satellite constellation, multiple-clone satellites, onboard capacity, and grounding stations have resulted in a new era of remote sensing applications.

These advancements have enhanced the ability to obtain satellite imagery on a near real-time basis at sub-meter (even at <30cm) for any given location. The quality and details of the imagery have increased dramatically. As a result, the inherent information contained in each image is more detailed and fulfills the needs of agricultural researchers.

Simultaneously, software companies and open-access platforms are developing necessary calibration and processing tools to make information easily available to a range of end-users.

Improved processing

Enhanced processing – including increased computation power and speed for faster image processing, better GIS infrastructure, new algorithms for modeling, and other tools – has allowed the geoinformatics community to study and characterize agricultural production systems at various scales. These improved tools have contributed to the ability of researchers to enhance pixel-based image analysis of high resolution data acquired over complex and greatly variable agroecosystems.

It is important to note that there are still limitations associated with time-variant identical spectral characteristics among different land use and land cover types. However, the combined use of higher spatial, spectral, and temporal resolution images has enabled researchers to produce better thematic maps with higher classification accuracy.

Decreased costs of operations

In the past, costs associated with satellite image acquisitions, and cyber infrastructure for processing and handling the satellite data, made geoinformatics very expensive.

These costs have recently been declining due to increased open access to data, open source program and algorithms, decreased cost of mass storage, and increased computational efficiency. This drastic reduction in operational costs has led researchers to use geoinformatics tools and technology across wide areas of application in agricultural research, starting from molecular level research to landscape level assessment.

Integrated approach to drylands research

As a result of improved geoinformatics techniques and increased access to data, the ICARDA-led Dryland Systems Program heavily relies on these innovative tools in conjunction with traditional knowledge to mitigate risks and increase overall agricultural productivity.

> "Geoinformatics enables researchers to effectively incorporate the constellation of biophysical, climatic, socio-economic, and institutional factors controlling the adoption of new innovations and technologies. As a result, these spatial data and knowledge base are critical to supporting 'systems' approach to agricultural research for development."
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> *Dr. Chandra Biradar*
> *Head, ICARDA*
> *Geoinformatics unit*

One of the primary objectives of the CRP on Dryland Systems is to develop detailed baseline databases for different "action sites." This is intended to enhance researchers' understanding of the various production systems in terms of land use, land cover, land degradation, water use, and more. These databases will allow researchers and stakeholders to track the progress and assess the impact of various program interventions. For example, the capability to identify different land management units or production systems through their associated spectral properties is a major step forward in ICARDA's ability to classify and monitor dryland systems.

Given the complexity of dryland farming systems, it is necessary to characterize these systems at very high spatial resolutions to understand the risk and vulnerability factors. Mapping presents emerging and future land use trends, status and processes (e.g., land degradation, climate change). It allows researchers to better diagnose vulnerabilities and intervene to improve livelihoods.

Such maps allow researchers to take into account different factors such as land cover dynamics, cropping patterns and intensities, water use and availability, changing demographics, infrastructure, poverty, markets, climate change, and more. Information generated can be used to assess vulnerable areas for possible pathways to increased resilience and mitigation of risks, whether biophysical (land degradation and drought), or socioeconomic (price shocks or policy changes in land tenure).

CGIAR Research Program: Dryland Systems

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