Agriculture

Seeding change in smart farming

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Introduction

The world's agriculture and food (agrifood) systems are strained, and the challenges they face are mounting. In turn, this poses a major obstacle to making progress on, and ultimately attaining, the UN's Sustainable Development Goals (SDGs).

One of the major challenges being faced is that data in the agrifood sector is typically inaccessible and lacks interoperability. Therefore, data that can be universally shared and used is a key priority for the sector's growth and development – and standards form a crucial component.

Standards can better govern observations and measurements or cover the vocabulary that machines and software use. There are plenty of actions that can be taken to quickly improve the situation, while collaboration and better communication among standards organizations and with user groups is vital to creating and implementing longer-term solutions.

Through this lens, work has been under way since 2021, when ISO chartered its Strategic Advisory Group (SAG) for smart farming. Its goals have been to better understand the agrifood landscape in the context of addressing the SDGs, identify gaps where standards are incomplete or missing, and recommend a roadmap for standardization on smart farming.

To date, 180 experts from across 20 countries and a range of disciplines have been involved in identifying the best means to tackle the challenge of data interoperability so that smart farming practices and solutions can be brought to scale throughout agrifood systems.

Read on for key findings, outputs and recommendations of the SAG and access their full report at go.iso.org/SAG-SF-report.

Seeding change in smart farming

Trends in the agri-tech industry

Technologies like artificial intelligence, and open-source software, along with systematic approaches (mixed crop-livestock farming, plant-based substitutes, etc.) and data-led solutions, offer a means to greater efficiency and sustainability in food production and its value chain.

There is great potential for technology to contribute further to agrifood systems, ranging from improving productivity to reducing the negative effects on the environment. For the farmer, access to affordable, comprehensive data-driven services offers many opportunities, including access to financial services, market data and risk management tools.

But with technology must come interoperability whereby different kinds of equipment and software should be able to 'talk to one other'. To ensure the technology used in the sector meets these criteria, robust, widely accepted standards are needed. These bring everyone onto the same page, preventing duplication of efforts, reducing inefficiencies, and thereby reducing costs.

The global importance of small farms

Also referred to as **smallholder farms** or just **smallholders**, farms of less than two hectares account for 84% of farms worldwide, using 12% of agricultural land and producing 35% of the world's food supplies. In some regions, these figures are even larger. In Sub-Saharan Africa, the average farm size is 1.6 hectares and yet these farms account for 35% of food production regionally.

Seeding change in smart farming

Challenges *to farmers*

Limited access to capital for investments

Disproportionate impact of ***climate change***

Lack of access to high-quality inputs, which can lower the yield and quality of crops

Limited or single ***access to markets***

Greater impact from ***market downturns***

Lack of knowledge/ expert service advice to optimize the use of small parcels of land

Lack of knowledge to fully understand complex ***legal contracts*** and agreements

Limited to no broadband access

Issues with 'last mile' infrastructure needed to bring technological advances to the farm

Lack of open data standards as data that is hard to Find, Access, Interoperate with, and Reuse; in other words, un-FAIR

Limited access to labour

The producer must cover all or most of the items in their value chain and are therefore caught in an activity trap and unlikely to be able to perform those functions well

Lack of availability and scalability of crop services

While there is an emergence of local governmental and extension services available to small holders, the lack of interoperability in the industry limits the geographical area a crop adviser can service, and therefore increases the programme costs and/or the price of the services beyond the affordability to the smallholder.

The agrifood industry and the SDGs

Time is running out to attain the SDGs by the target date of 2030 and environmental, economic, security and political challenges only create more hurdles to progress. The 17 SDGs are interrelated, and there is the argument to be made that they can't be achieved until **Goal 2: Zero Hunger**, has been met. After all, if you can't feed people, you can't attain much else.

The Sustainable Development Goals (SDGs)

Also known as the Global Goals, they were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity.

The 17 SDGs are interconnected – they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.

These challenges underscore the importance of the agrifood sector, and more particularly, doing everything possible to ensure it uses available resources efficiently, produces food, feed, fuel and fiber products effectively, and can engage with its workers fairly. It is, however, a sector that faces significant challenges, including:

- **Climate change:** Extreme and unpredictable weather happens ever-more often, affecting crop cycles and production. Other effects like rising sea levels threaten to submerge low-lying areas, putting greater pressure on remaining arable land.
- **Population:** Globally, the world's population continues to grow and with this, the amount of land required for farming – along with other inputs like water for irrigation – is also rising. One estimate puts the amount of land needed to satisfy global food production as equal to the size of China, while another report suggests that an estimated increase of 60% in food production is required by 2050. Furthermore, expanding agriculture is a major driver of biodiversity loss and carbon emissions, contributing to the climate crisis.
- **Sector-specific:** Alongside this, the sector faces pressure from a host of different issues, including increasing regulatory pressure, changes in consumer preferences and diets, commodity price volatility, problems with the availability (and in some cases) the rising cost of critical inputs, such as fertilizers, and the fallout of geopolitical tensions affecting the supply chain.

Arguably, the situation is most dire for small farmers, who face an increasing set of challenges.

Achieving the SDGs

By supporting farmers and food production, progress can be made towards the SDGs.

Large, global, interconnected problems require large, global, interconnected solutions. Standards are the basis for scalable solutions. Standards support the push towards greater production, and also reduce the impacts of farming on SDGs, including clean water (SDG6), climate action (SDG13) and life on land (SDG15).

There are many ISO standards for agrifood systems, but not enough deal with helping make agrifood systems' data FAIR. A significant number of areas have been identified where either a change to, or the creation of, a new standard could provide a boost to SDG progress.

Some examples include:

- Livestock production is resource-intensive, but using standards to optimize this would be a straightforward way to boost SDG12 (responsible consumption and production). The report proposes creating an ISO group that will look at animal and herd management.
- Food loss and waste (FLW) is a major problem worldwide. It is estimated that more than 30% of the world's food is either lost or wasted from the point of harvest. This undermines food security and creates additional problems, such as greenhouse gas emissions from rotting food. Accurate data collection is imperative to solving this problem. There is a forthcoming ISO standard designed to address FLW, and the report's authors call for the inclusion of detailed data collection as part of the standard.

This calls for the development of a standard for a controlled vocabulary and framework to describe the sources, provenance and upstream energy requirements for producing and using agricultural inputs (e.g. fuel, machinery, fertilizer and animal feed). Improving the capacity to make informed comparisons will help identify optimal management strategies suited to regional characteristics in support of SDGs 12, 13 and 15.

‘There’s farming, and then there’s smart farming – data’s role

Modern farming is heavily data oriented, a trend that the pandemic accelerated. **Smart farming refers to the modern use of Information and Communication Technologies (ICT) in agriculture.** If done right, it will optimize and increase the efficiency of food production – improving sustainability and thereby supporting biodiversity and planetary renewal – and help eliminate food waste.

The term is interpreted differently by different parties, and even more so in an international context. The SAG on smart farming offers offered the following definition:

“Smart farming is data-driven, principled decision making in agricultural and food value chains occurring as multi-objective optimization in the context of global volatility, uncertainty, complexity and ambiguity.”

The fundamental idea is **to interconnect the entire value chain**, from farm input manufacturer to retailer, to the farm (including its equipment) and ultimately to the consumer – also known as "from farm to fork" – as shown in Figure 1. Seamlessly connecting the different organizations' systems requires open interfaces and standardized data formats. Current industry reality is that we still have much to do before this happens in practice.

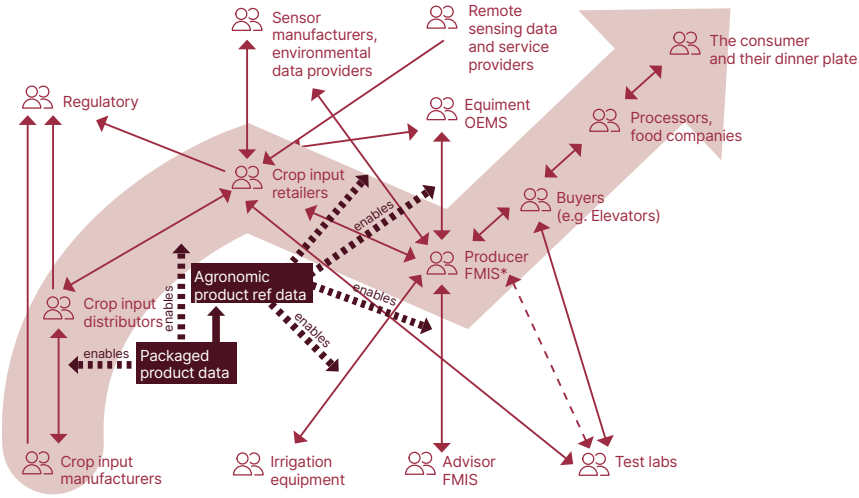

Figure 1: Agrifood systems are complex with many actors exchanging different kinds of data

In the face of increasing challenges and with profits under pressure, those involved in the agrifood sector must collect, interpret and exchange progressively more information in a system that is already complex. This underlines the need for greater standardization. Among the opportunities identified are the standardization of interfaces, and the ways in which data is collected, formatted, stored and exchanged throughout the food supply chain, as well as the optimization of production methods that build on precision agriculture and new techniques in cultivation.

* Farm management software, also called farm management information systems (FMIS)

Smart farming – how did we get here?

Smart farming can be described as the third generation of technology in farming. Preceding it were precision agriculture and digital agriculture (primarily based on farm management software, also called farm management information systems (FMIS)).

Precision agriculture has existed for decades in different forms; it currently includes the use of technology like artificial intelligence (AI), drones and the Internet of Things (IoT), to capture, process and interpret data quickly enough to provide valuable in-season insights to farmers. As its name suggests, it focuses on precision, noting site-specific variations in growth, soil conditions or pest and disease levels. In terms of application, it provides information aimed at delivering, for example, the right quantity of a product, say fertilizer, to the area where it is needed. Using inputs like seed, fertilizer, chemicals and water efficiently cuts production costs and maximizes environmental stewardship.

FMIS provide a quantitative overview of all farming operations. Again, the concept isn't new, but the connectivity and capacity to store and access operational information is. This helps those involved in the process with their decision-making, providing insights into production costs, market demand, net returns, sustainability metrics and regulatory reports. By making these aspects more efficient and less overwhelming, challenges like waste and post-harvest losses can be tackled, regulatory compliance ensured, and the farmer can better exchange information with business partners like agronomists, bankers and customers.

Precision agriculture has existed for decades in different forms; it currently includes the use of technology like artificial intelligence (AI), drones and the Internet of Things (IoT).

Smart farming based on interoperable data is the natural next step in response to these technologies and their limitations. If two farmers in a region use different systems, unless these systems can talk to each other, no insights into, for example, local growing conditions or pest management can be drawn. Similarly, if a farmer programmes a weeding drone with GPS coordinates that come from their FMIS but aren't compatible with the drone, they may end up weeding an unintended part of their farmland.

Interoperable data, on the other hand, opens up countless possibilities to all agrifood players. As smartphones become increasingly affordable, it's getting easier for the most vulnerable of farmers to access a large set of tools, from crop insurance to market access and value-added pricing, and even diagnostic tools that help them take better care of their crops in the absence of trained agronomists. In this respect, there is **a clear role for standards in enabling interoperability and compliance with evolving legislation.**

Why (interoperable) data matters so much

Bringing about smart farming at scale requires data standardization. The need to capture, use and share massive amounts of data throughout the agriculture and food system – from crop input and equipment manufacturers to distributors, producers, consumers and government agencies – becomes a necessary part of doing business. Observations and measurements in the field and the supply chain, as well as accurate crop management records, can drive decisions based on sound, scientific principles.

It is currently impossible to use data beyond small-scale applications because the data from equipment and software are not standardized. As a result, not all data is equally usable. Enabling smart farming at a large scale requires data that is 'findable, accessible, interoperable and reusable' (FAIR), alongside robust and trustworthy governance mechanisms.

Automating and standardizing data supports producers of all sizes, but is particularly beneficial to smallholders in the developing world. For them, and others in the sector, standardized data can help provide:

- **Greater access to more cost-effective crop inputs** (e.g. crop varieties, fertilizers, chemicals) tailored to a smallholder's environment and field conditions, even in the small quantities used by smallholders.
- **Greater participation in the agrifood value chain**, from giving farmers greater access to advice, capital and risk management instruments (e.g. crop insurance), to improved field operations and better market access.
- The **opportunity** for local suppliers and crop advisers **to offer** their smallholder customers **better and more affordable products and services**.
- **Safer field operations** due to better access to product safety data.
- **Improved soil testing** and **faster test results**.
- **Better identification of problems** like plant stresses and nutritional deficiencies.
- **Decision support tools** and **highly contextualized expert help**.
- **Understandable contract language** (including icons), and enhanced transparency in business transactions.

Examples of data use in farming

The steps listed below describe the example shown in Figure 2 of how data participates in the application of crop inputs such as fertilizer, irrigation water or crop protection products.

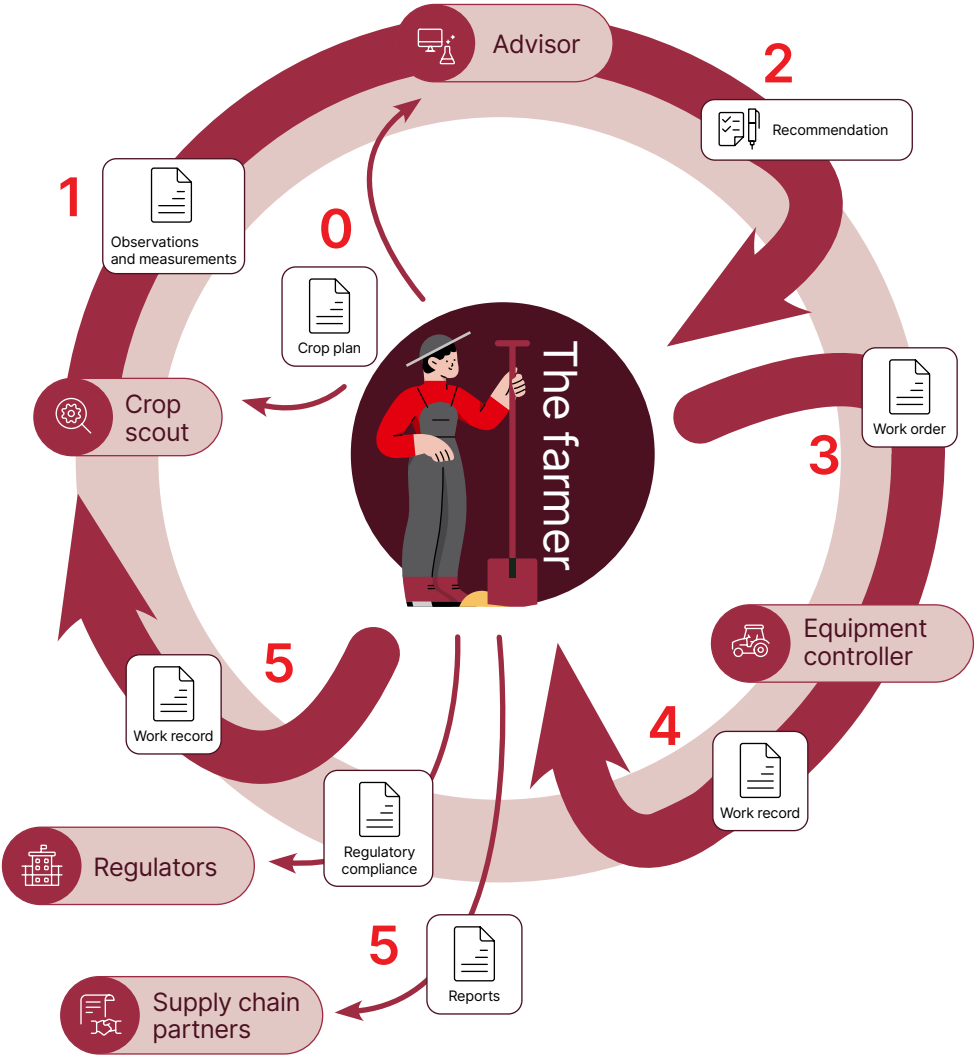

Figure 2: Example of data flow and use in farming.

Report outputs

The report of the SAG on smart farming offers a capability model, which describes the ***different kinds of data-related activities that must be standardized to perform smart farming on a large scale***. It also provides ***a roadmap*** (with six-month to six-year timeframes for action and measures), ***recommendations for the ISO's Technical Management Board***, and ***a list of existing standards*** (as well as omissions) that are relevant to smart farming and its data management.

It provides recommendations, which underline the need to better publicize existing and forthcoming standards to avoid duplication and confusion, greater coordination with stakeholders and other standards' agencies, the creation of new committees within the ISO, more unified vocabulary as well as a set of specific standards to enable interoperability.

Solutions and recommendations – the highlights

Issue and recommendation	Importance
Promote and emphasize standards related to Observations & Measurements (O&M).	O&M drive decision-making in agriculture and the food industry, from when to plant, irrigate or harvest, to food quality.
Standardize key controlled vocabularies (e.g. crop, active ingredients, modes of action, units of measure, products, operations, crop development stages).	This can help different parts of the agrifood system 'talk the same language' and unlock smart label checking, scalable integrated pest management, and other capabilities.
Develop standards that can help preserve the meaning of agrifood systems data.	Standardizing data type definitions, metadata and data quality measures in agrifood systems can reduce ambiguity and data loss.
Implement standards to help smallholders.	Standards can enable low-cost forms of crop insurance, value-added market access, and other functions that can help smallholders.
Engage user communities. Help them get the most value from, and help further develop standards.	Standards are only relevant if they are used, and users can greatly contribute to making the standards better.
Make it easier to exchange data in mixed crop-livestock systems.	Mixed systems are an important way to tackle food waste and manage carbon emissions.
Develop a standard for representing field boundary data.	Field boundaries are very important in digital agriculture, but there are no standards for managing them consistently.
Enable clear data contract labelling.	A lack of legal knowledge and literacy hinders informed consent and transparency (and therefore data sharing and use) in digital agriculture tools, especially when targeting smallholders.

Download

Scan the code below to download a copy of the full report of the ISO Strategic Advisory Group on smart farming.

go.iso.org/SAG-SF-report

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ISO has published more than 24 900* International Standards and related documents covering almost every industry, from technology to food safety, to agriculture and healthcare.

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International Organization for Standardization

ISO Central Secretariat
Chemin de Blandonnet 8
1214 Geneva, Switzerland

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