

Future of Smart Farming with Internet of Things

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Abstract

Farming is an occupation which is playing the ultimate role for survive of this world. It supplies maximum needs for the human being to live in this world. But in the advancement of the technologies with invention of Internet of Things, the Automation (Smarter technologies) is replacing the traditional methodologies which in cause resulting in wide range improvement of the Fields. Now we are in the state of automation where the up gradation of smarter technologies are improving day by day in maximum sectors starting from smart homes, garbage, vehicles, industries, Farming, health, grids and so on. In the field of Farming, the improvement with the implementation of Automation is also taking place with the invention of Internet of Things. The main idea of this paper is focused on the review of the improvement in the Smart Farming sector

Keywords: *Automation, DSS, ICT, IoT*

INTRODUCTION

Smart Farming represents the application of modern Information and Communication Technologies (ICT) into agriculture, leading to what can be called a Third Green Revolution. Following the plant breeding and genetics revolutions, this Third Green Revolution is taking over

the agricultural world based upon the combined application of ICT solutions such as precision equipment, the Internet of Things (IoT), sensors and actuators, geo-positioning systems, Big Data, Unmanned Aerial Vehicles (UAVs, drones), robotics, etc. Smart Farming has a real potential to deliver a more productive

and sustainable agricultural production, based on a more precise and resource-efficient approach. However, while in the USA possibly up to 80% of farmers use some kind of SFT, in Europe it is no more than 24%.

From the farmer's point of view, Smart Farming should provide the farmer with added value in the form of better decision making or more efficient exploitation operations and management. In this sense, smart farming is strongly related, to three interconnected technology fields addressed by Smart AKIS Network:

Management Information Systems: Planned systems for collecting, processing, storing, and disseminating data in the form needed to carry out a farm's operations and functions.

Precision Agriculture: Management of spatial and temporal variability to improve economic returns following the use of inputs and reduce environmental impact.

It includes Decision Support Systems (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources, enabled by the widespread use of GPS, GNSS, aerial images by drones and the latest generation

of hyper spectral images provided by Sentinel satellites, allowing the creation of maps of the spatial variability of as many variables as can be measured (e.g. crop yield, terrain features/topography, organic matter content, moisture levels, nitrogen levels, etc.).

Agricultural automation and robotics: The process of applying robotics, automatic control and artificial intelligence techniques at all levels of agricultural production, including farmbots and farmdrones.

Smart Farming applications do not target only large, conventional farming exploitations, but could also be new levers to boost other common or growing trends in agricultural exploitations, such as family farming (small or complex spaces, specific cultures and/or cattle, preservation of high quality or particular varieties,...), organic farming, and enhance a very respected and transparent farming according to European consumer, society and market consciousness.

Smart Farming can also provide great benefits in terms of environmental issues, for example, through more efficient use of water, or optimization of treatments and inputs.

The farming industry will become arguably more important than ever before in the next few decades.

The world will need to produce 70% more food in 2050 than it did in 2006 in order to feed the growing population of the Earth, according to the UN Food and Agriculture Organization.

To meet this demand, farmers and agricultural companies are turning to the Internet of Things for analytics and greater production capabilities.

Technological innovation in farming is nothing new. Handheld tools were the standards hundreds of years ago, and then the Industrial Revolution brought about the cotton gin.

The 1800s brought about grain elevators, chemical fertilizers, and the first gas-powered tractor.

Fast forward to the late 1900s, when farmers start using satellites to plan their work.

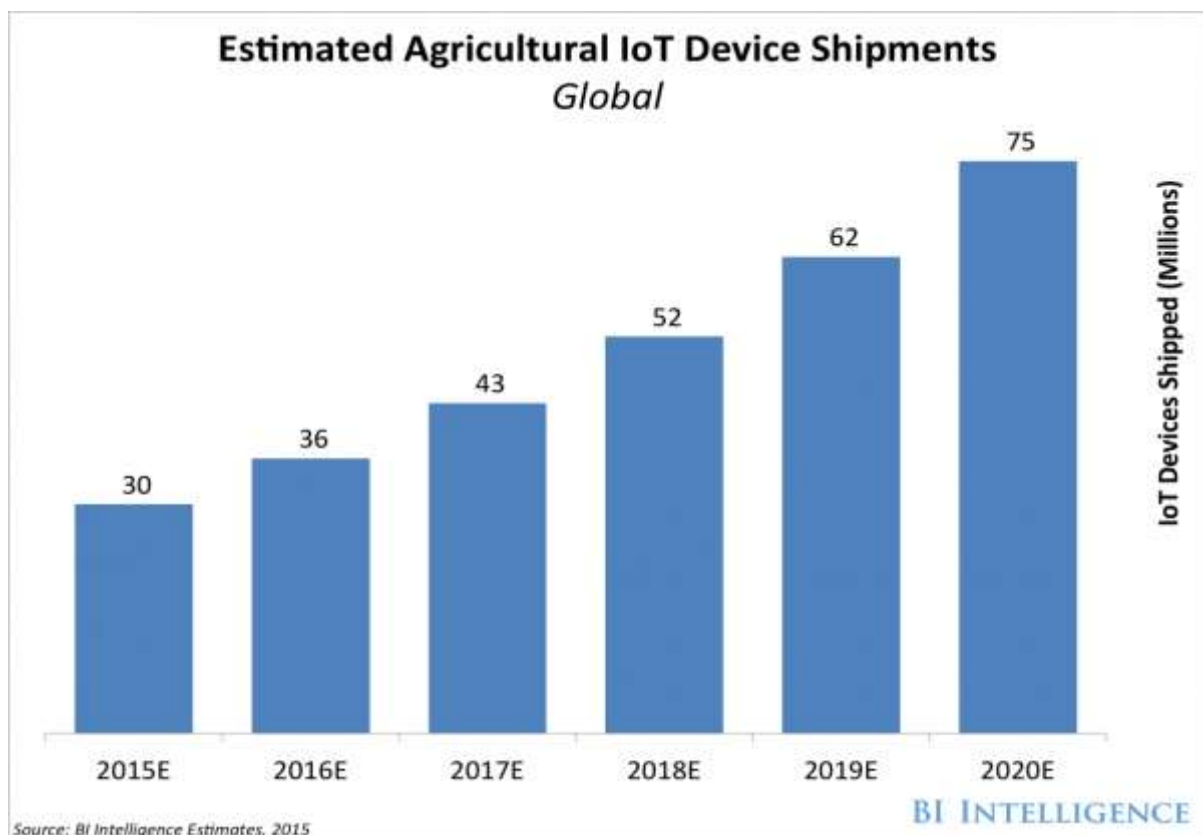


Figure 1

The IoT is set to push the future of farming to the next level. Smart agriculture is already becoming more commonplace among farmers, and high tech farming is quickly becoming the standard thanks to agricultural drones and sensors. Below, we've outlined IoT applications in agriculture and how "Internet of Things farming" will help farmers meet the world's food demands in the coming years.

High Tech Farming: Precision Farming & Smart Agriculture, Farmers have already begun employing some high tech farming techniques and technologies in order to improve the efficiency of their day-to-day work.

For example, sensors placed in fields allow farmers to obtain detailed maps of both the topography and resources in the area, as well as variables such as acidity and temperature of the soil.

They can also access climate forecasts to predict weather patterns in the coming days and weeks.

Farmers can use their smartphones to remotely monitor their equipment, crops, and livestock, as well as obtain stats on their livestock feeding and produce. They

can even use this technology to run statistical predictions for their crops and livestock. And drones have become an invaluable tool for farmers to survey their lands and generate crop data.

As a concrete example, John Deere (one of the biggest names in farming equipment) has begun connecting its tractors to the Internet and has created a method to display data about farmers' crop yields.

Similar to smart cars, the company is pioneering self-driving tractors, which would free up farmers to perform other tasks and further increase efficiency.

All of these techniques help make up precision farming or precision agriculture, the process of using satellite imagery and other technology (such as sensors) to observe and record data with the goal of improving production output while minimizing cost and preserving resources.

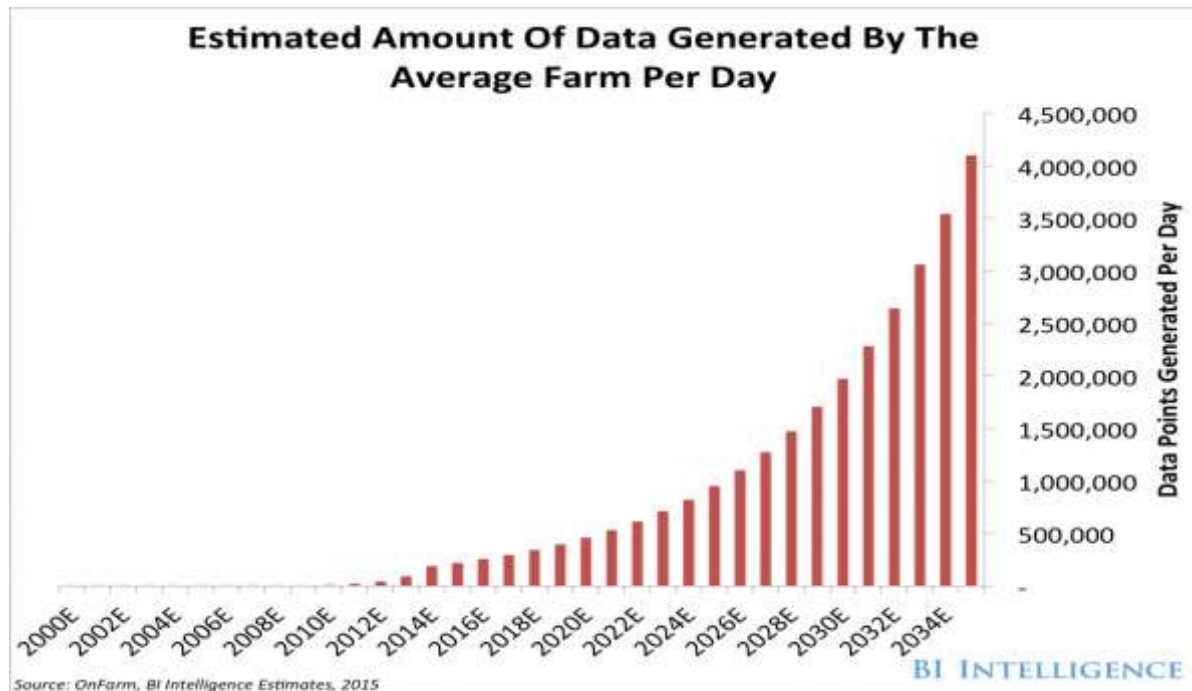


Figure 2

Future of Farming: IoT, Agricultural Sensors, & Farming Drones. Smart agriculture and precision farming are taking off, but they could just be the precursors to even greater use of technology in the farming world. BI Intelligence, Business Insider's premium research service, predicts that IoT device installations in the agriculture world will increase from 30 million in 2015 to 75 million in 2020, for a compound annual growth rate of 20%. The U.S. currently leads the world in IoT smart agriculture, as it produces 7,340 kgs of cereal (e.g. wheat, rice, maize, barley, etc.) per hectare (2.5 acres) of farmland,

compared to the global average of 3,851 kgs of cereal per hectare. And this efficiency should only improve in the coming decades as farms become more connected. OnFarm, which makes a connected farm IoT platform, expects the average farm to generate an average of 4.1 million data points per day in 2050, up from 190,000 in 2014. Furthermore, OnFarm ran several studies and discovered that for the average farm, yield rose by 1.75%, energy costs dropped \$7 to \$13 per acre, and water use for irrigation fell by 8%. Given all of the potential benefits of these IoT applications in agriculture, it's understandable that farmers are increasingly turning to

agricultural drones and satellites for the future of farming.

The Future of Smart Farming with IoT and Open Source Farming: Smart farming is a concept quickly catching on in the agricultural business. Offering high-precision crop control, useful data collection, and automated farming techniques, there are clearly many advantages a networked farm has to offer. Smart farming is a concept quickly catching on in the agricultural business. Offering high-precision crop control, useful data collection, and automated farming techniques, there are clearly many advantages a networked farm has to offer.

A recent Beecham's report entitled Towards Smart Farming: Agriculture Embracing the IoT Vision predicts that food production must increase by 70 percent in the year 2050 in order to meet our estimated world population of 9.6 billion people. It also describes growing concerns about farming in the future: climate change, limited arable land, and costs/availability of fossil fuels. So, what's the solution? Smart farming.

Of the many advantages IoT brings to the table, its ability to innovate the landscape of current farming methods is absolutely

groundbreaking. IoT sensors capable of providing farmers with information about crop yields, rainfall, pest infestation, and soil nutrition are invaluable to production and offer precise data which can be used to improve farming techniques over time. New hardware, like the corn-tending Rowbot, is making strides by pairing data-collecting software with robotics to fertilize the corn, apply seed cover-crops, and collect information in order to both maximize yields and minimize waste. **See figure 3.**

Another direction in which smart farming is headed involves intensively controlled indoor growing methods. The Open AG Initiative at MIT Media Lab uses "personal food computers" (small indoor farming environments that monitor/administrate specific growing environments) and an open source platform to collect and share data.

The collected data is termed a "climate recipe" which can be downloaded to other personal food computers and used to reproduce climate variables such as carbon dioxide, air temperature, humidity, dissolved oxygen, potential hydrogen, electrical conductivity, and root-zone temperature.



Figure 3

This allows users very precise control to document, share, or recreate a specific environment for growing and removes the element of poor weather conditions and human error.

It could also potentially allow farmers to induce drought or other abnormal conditions producing desirable traits in specific crops that wouldn't typically occur in nature.

With a future of efficient, data-driven, highly-precise farming methods, it is definitely safe to call this type of farming smart. We can expect IoT will forever change the way we grow food. **See figure 4.**

Solutions for Smart Farming with Kaa:

For farmers and growers, the Internet of Things has opened up extremely productive ways to cultivate soil and raise livestock with the use of cheap, easy-to-install sensors and an abundance of insightful data they offer.

Prospering on this prolific build-up of the Internet of Things in agriculture, smart farming applications are gaining ground with the promise to deliver 24/7 visibility into soil and crop health, machinery in use, storage conditions, animal behavior, and energy consumption level.



Figure 4

The Kaa open-source IoT Platform is a crucial middleware technology that allows walking safely into the agriculture IoT field. By tying together different sensors, connected devices, and farming facilities, Kaa streamlines the development of smart farming systems to the maximum degree possible.

Kaa is perfectly applicable for single-purpose smart farming products - such as smart metering devices, livestock trackers, or failure prediction systems - as well as for multi-device solutions, among which

are resource mapping and farming produce analytics solutions. Kaa is feature-rich and, as an open-source platform, grants full access to its modules for any necessary modifications, extensions, or integrations.

Out of the box, Kaa already provides a set of ready-to-use components for a quick start with smart farming applications. After all, farming is all about connecting with nature - leave everything else to Kaa. The below diagram shows some of the applications that can be possible with Kaa.



Figure 5

Future interesting internet of things (IoT) projects in agriculture:



Figure 6

- **Cold chain management tracking,** produce temperature at the point of harvest to local flash cooling

facilities to mobile or fixed cooling facilities to improve shelf life, etc. Using sensors and wireless

connectivity. 2/3rds of all produce in India spoils before it ever gets to market. China is not terribly better.

- **Smarter irrigation** through better temperature, humidity, and other sensors networked wirelessly.
- **Condition based, rather than scheduled, maintenance** of agricultural machinery and tools based on the use of sensors, wireless, and wireless location.
- **Animal tracking.** The number of cows in the USA is ~90 million. Optimize feeding, breeding, animal health, etc.
- **Product recall/security.** Track with precision the source of, say, some e coli outbreak to minimize the cost of executing a recall.
- **Remotely piloted equipment.** Tractor drones. We might as well also invent scarecrow drones as well while we are at it.
- **Storage Mapping:** with IoT you can set the auto temperature for storage house and cold store and all data you can save and access from a back end

system. No need to set manually temperature for any floor or segment.

- **Soil Quality Checking:** A sensor connected through IoT to your system can give all soil quality and ratio of essential component.
- **Auto Irrigation for Crop:** Through IoT can cover whole land water system and set custom irrigation that can be access and monitor from a single end.
- **Smart Dairy with IoT:** In dairy you can track any individual animal with efficiency, production ration, filling station control and much more. Weather Monitoring - #IoT based weather station is nothing different from the earlier station just that, now data is available in real time on a web-app using GPRS communication instead of SATCOMM.
- **Greenhouse / Agriculture warehouse / Cold-chain monitoring** - With #IoT , you can drop battery powered low power wireless sensor nodes communicating to each other using

RF or BLE, form a mesh network, show data locally or push it to cloud using any back-end connectivity.

- **Farm monitoring / livestock** -

Some time back, we meet a company who was doing RFID tagging for livestock monitoring - Roxan ID. Again with the help of #IoT they were able to track position, counting and other variables of cattle's.

- **Milk Farm monitoring** - Real time

monitoring of milk levels in a diary, if chilling temperature is properly maintained or not. There is a company in India which was doing the same. Final Stellapps Home.

- **Home gardening** - I wrote a blog

some time back with respect to Home gardening. Have a look here - Indoor Irrigation Project - Technical Blog. It has a list of all the companies who are doing home gardening products and solutions.

- **Remote Control of farm irrigation system** -

Remotely controlling motors irrigating fields either with an Android application or DTMF.

- **NDVI based imaging using Drones**

- Agricultural Intelligence. Drone Enabled. Not exactly IOT but must be counted in smart agriculture.

- **GPS based navigation for Tractors**

in order to cover most of the filed in a timed and efficient manner.

- **Automatic tractors and drones**

taking care of orchards and fields.

Conclusion

As the future is moving towards the Smart ideas with improving the technologies replacing with smart applications (Automation) with the invention of Internet of Things. Farming is the major source for the survival in this world, here the future Farming is also wearing foots towards these smarter technologies with newer improvements in order to increase the productivity with in short time. This paper gives a brief review of the automation that is taking place with the figures and also the applications that are implemented in the present world, with the future graphs.

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