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Review Article

Smart Farming: A Better Technological Option for Modern Farming Society under Theme of Doubling of Farmers' Income

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A B S T R A C T

Keywords

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Agriculture is a key source for food over the world. Recently, climate change and variability exacerbated potential harmful effects on worlds' agriculture. Increasing population and abrupt weather fluctuations around the world has put huge pressure on agricultural food products for quality and sustainable food production. 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. Smart Farming represents the application of modern Information and Communication Technologies (ICT) into agriculture revolution and advancement in food growing agricultural practices become advanced with the passage of time. In this modern age, improved technology-based agricultural practices are replacing the existing old-fashioned farming practices. These novel technologies are quite efficient but still require the consistent attention of researchers and scientists for better application and output of this technology. Smart farming involves the integration of information and communication technology for better utilization of resources from sowing, irrigation, fertilizer, pesticide, and herbicide application, and finally harvesting. But this system involves autonomous vehicles, robots operated through GPS and connected through smart applications. The precise application of this technology along with Internet of Things (IoT) supposed to be the helpful technology for farmers to uplift their living standards, with high production and profit and also can be a good indicator for food security. Now we are in the state of automation where the up gradation of smarter technologies is improving day by day in maximum sectors starting from smart homes, garbage, vehicles, industries, Farming, health,

Introduction

Agriculture is a key source for food over the world. Recently, climate change and variability exacerbated potential harmful effects on worlds' agriculture. It is expected that over two billion more people will be part of the world in 2050. But weather uncertainty in some regions put negative repercussions on agriculture and food production. For sustainable food production, world agriculture has to use agricultural resources with more precision and in time decision for maximum resource utilization (Wheeler and von Braun (2013). Since farming, farms maintained by record-keeping and now farm management involves electronic devices with more precision and decision making. In the past, many efficient and resource-use technologies have been used in agriculture farm management but most of them were not effective. Net profit of farm can be increased through the coordination of available resources with their judicious and timely use. Now, this is managed by computer and electronic devices to get maximum food and net profit (Fountas *et al.,* 2015).

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. Estimated agricultural IoT Device shipments showed in figure 1.

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 farm drones. 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.

What do you mean by smart farm?

Smart Farm (SF) includes the integration of information and communication technologies into farm equipment and sensors for use in crop cultivation and food production system. In this advanced technical era, internet of things (IoT) and various electronic instruments (robots and artificial intelligence) with data transformation and signalling facilities worlds i.e. smart homes, smart health care and now it turned to the agriculture sector. Nowadays farmers can leverage IoT to enhance their farm efficiency such as irrigation, fertilization, harvesting information, and climate forecast by monitoring with sensors to improve their decision-making (Pivoto *et al.,* 2018). Estimated amount of data generated by the average farm per day showed in figure 2. This advancement enables farmers to make better decisions in the management of their farms by efficient utilization of available resources, producing suitable yield and more income (Supreetha *et al.,* 2019).

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 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. Future interesting internet of things (IoT) projects in agriculture showed in figure 3. 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.

Self controlled and robotic labour

The labour shortage is being considered as a major impediment in crop cultivation in recent years. The prevalence of the skilled labour shortage affected food production in almost all crops and even transforming permanent changes in the cultivation sequence. That will be a major threat to sustainable food production. The important causes for the labour shortage include higher wages for labour in the nearby cities and towns (Prabhakar *et al.,* 2011)

To tackle this issue for sustainable food security and modern agriculture looking to use autonomous robots and labour. Robotics and Autonomous Systems (RAS) are set of electronic and mechanical equipment's that operates through the software technology for special purposes.

Each set after integration can be used for one or more tasks. RAS can be more effective and time-saving technology in coming days, but now this technology is facing some hurdles such as low operation efficiency in extreme weather conditions (Duckett *et al.,* 2018).

Removing labour and mechanization in fields with automation, more produce with good quality.

Migration of the village population to the cities is a major cause of labour shortage, as well as low income in the village, is also considered as the main contributor in the current global labour shortage issue. Although the world population is increasing and expected to increase modernization has reversed the scenario. So, developed countries also attained much success in the field of robotic labour and automation.

Driver free tractor

In the 19th century, the intervention of the tractor is a big source of revolution in field crop planting and harvesting. This invention makes agricultural practices easier and more efficient and, in some soil, (heavy clay) put negative repercussion e.g. compaction. At that time this revolution diverted from animal-drawn tillage and transportation implements (Autonomous technology 2019). But in the near future, autonomous machinery is going to be a modern and electronic revolution for the farming community. Automated tractors (driverless tractor) integrated with hardware and special-purpose designed software are working more efficiently changing agricultural machinery (Sahi *et al.,* 2016).

However, driverless tractors operated by monitoring sensors that help to run and recognize a tractor to field boundaries i.e. GPS for mapping and navigation, IoT connected to remote sensors and monitoring system, and radars for object detection in the field. This diverse system was developed to operate a tractor in several conditions and practices, such as spraying of crop canopy for the management of insects, diseases and selective weed treatments, either these weeds managed by spraying herbicide or flame burning in the fallow land driven by automated tractor (Conesa-Munoz *et.,al* 2015).But this technology is expensive and small-scale farmer cannot use due to higher implements cost. Moreover, the struggle is going on by the scientist to make this technology economically viable.

Pre-programmed watering & irrigation supplementation

Agricultural irrigation water is becoming scared not only in arid and semi-arid regions but also in the high rainfall regions. Because of the uneven distribution of rainfall pattern not successfully used by most of the crops (Moon *et al.,* 2018). In this modern age, subsurface drip irrigation (SDI) plays a vital role for judicious use of water as per the requirement of the crop. But this system still needs to maintained by the operators. In order to improve its efficiency and ensuring water demand of the crop, efforts for SDI assembling with moisture level detectors are helpful in better crop germination and yield.

IoT based and authorised sensor for moisture estimation

In order to acquire more precision in water utilization (IoT) solution, involves special ground-based sensors for data recording and processing, are narrowing the gaps between the computer application and applied science. IoT based smart irrigation system helpful to simulate the irrigation needs of the crop and field with sensing of edaphic factors like soil temperature, moisture and evaporation rate, and temperature air humidity and also can predict future water requirement of the crop linking with the weather forecast from the Internet in specific a region (Goap *et al.,* 2018). The structure of this system relies on an algorithm, which detects sensors data and integrating with weather elements e.g.

rainfall, humidity, temperature, and UV for future prediction (Elijah *et al.,* 2018).

This improved technology has the potential to increase judicious water application and use according to crop stage and requirement. Additionally, SDI can be linked with fertigation (irrigation water plus fertilizer), that not only increase irrigation efficiency (20–305) but also decrease fertilizer especially nitrogen losses (20–40%) as well as increase crop yield (10–20%) depending upon soil, crop and environmental conditions (Suman *et al.*, 2013).

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. We can expect IoT will forever change the way we grow food. See figure 4.

Weeding, spraying and crop health

Innovation in agricultural takes the faraway farming community from old agricultural techniques. Integration and application of machine learning and Artificial Intelligence (AI) make it easy for farmers to detect diseased patch, heavy weed infestation, and crop health through image processing (Veroustraete F 2015). Along with this innovation, drone technology is also widely adopted in many smart farms for spraying of herbicides, pesticides, fertilizer broadcasting by using image processing through Normalized Difference Vegetative Index (NDVI) or near-infrared (NIR) sensors that are linked with crop health index (Alimuzzaman. Md 2016).

Seed sowing operation

Induction of machine is not a new idea in the field of agriculture, but their efficiency is still a question. In the early 1960s autonomous machinery introduced into agriculture for research and development (Wilson J 2000). Automation and robotics introduced by western societies in last decade to tackle the problem like, large production area, increasing labour wages, health issues for labour to work in extreme conditions and to grow more food in order to compete with other countries to earn more revenue. Although automation and robotics have many challenges for efficient working in the field, for sowing and cultivation purposes it faced fewer challenges and snugly adjusted into the farming system because this technology is easy to operate (Henten *et al.,* 2013).

Figure 5: Sketch map of agricultural farms monitoring through advanced computer-based monitoring tools.

Current agricultural machinery needs more energy to operate but modern mechanization has the potential to save fuel consumption and the has the ability to work more efficiently then existed machinery (Buning EA 2010). Moreover, current agricultural machinery is heavy and reported many times for soil compaction. Whereas, modern machines are small light weighted that are easy to drive and operate. Before sowing each crop, seed require favourable conditions to grow as discussed below.

Sowing to resowing under proper land preparation for fine seed bed

Land preparation is the primary focus of each farmer, in conventional farming heavy machinery is used to invert and manipulate the soil in order to make fine seedbed. Although modern robotics have not the ability to invert the soil in-depth (i.e. as like chisel plow) on the other way, these robotics and machines do not put huge pressure onto the soil surface to make tough for seed sowing. Therefore, that can be managed with consistent use of autonomous machines and robotics (Blackmore *et al.,* 2005). The next step is the sowing of seed into the soil that can be done through geo-positioning seed on the seedbed. This needs only RTK GPS connected with the seed drill and attachment of infra-red sensors below the penetrating chute. When seed goes into the soil, it cuts infra-red ray and activates a data logger that navigate the position of seed. In the end, a simple kinematic model calculates the actual position of seed placement (Griepentrog *et al.,* 2005).

Reseeding is mainly used for again plantation of seed due to seed germination failure or false seed placement before. In this regard, modern machinery and robotics are the best choices because conventional seeded cannot do this job because in continuous planting only gaps need to be filled. Similarly, transplanting or gap-filling also related to this phenomenon. A punch planter through image processing and identification can be used for this purpose.

Aerial planting (or) sowing with helicopter

Seed planting form air is mainly practiced due to large sowing area, areas with a steep slope or for the areas where seed sowing is very difficult. Particularly, forest seeding and early plantation method are very useful through helicopters. Helicopters are more efficient as compared to airplanes for seeding purposes because the helicopter can hangover relatively near the ground surface and cost-effective (Scott J. 2010).

For this type of planting, Chadwick and a barrel seeded mainly used in the helicopter. Chadwick seeded is suspended beneath the helicopter with a cable that contains seeds and operated through the small engine, seeds are dropped by automated seed gate and seed dropping intensity controlled by the inside of the helicopter. Whereas, the barrel seeded controlled manually and can cover an area of about 14 m. But Chadwick seeded is more efficient and superior than barrel seeded (Pedersen *et al.,* 2008)

However, the seed rate of each crop varies for air planting. On the other hand, lighter and smaller seeds are difficult to spread over an area (Scott J. 2010). No doubt, this planting method brought a revolution in the field of agricultural but in developing countries, it is difficult to implement due to their small landholding and less revenue.

Harvesting, picking of produce from farm

Harvesting from the field involves picking only those parts of the plants that are economically viable, according to the required size, shape, colour and the, more importantly, maturation stage of the fruit. Harvesting through robotics involves mainly two objectives,

(i) The efficient ability of the robot to sense the fruit part and quality (i.e. maturity),
(ii) picking of fruit without damaging the fruit (Blackmore *et al.,* 2005). Mainly is robotic for picking in tunnels or from field fixed with three CCD cameras, one is used for illumination and other two facilitate a stereo vision for reorganization (detection and localization) of fruit. When fruit is detected, third camera (positioned on end effector) then used for detection of fruit shoot, at last with the previous data the end effector modified through tilt mechanism and reaches to specified fruit. After fruit grasping, fruit attached to the shoot is cut with the help of scissor-type tools and placed into a tray successfully (Hayashi *et al.,* 2011).

For harvesting of different crops, different algorithms, 3D environments, a sensor for object detections (mainly cameras with near-infrared light spectrum range) are required due to different shape, colour, and size of the fruits. For each crop, different angels needed to detect the fruit of the crop. For example, at least five viewpoints are required to detect the sweet pepper crop (Hemming 2014). Hayashi *et al* reported 52.6% of success rate from strawberry harvesting that still needs to be improved. As well as damage rate after harvesting should be taken into consideration.

Drones for agriculture lands

In the recent past, the drones have made an entry into human life and augmented lifestyle in many ways such as insecurity, agriculture and many more. An autonomous flying tool that has a pre-planned flight or controlled by remote is called a drone. In agriculture, mainly drones are used for imaging for the identification of weeds, planting area, fertilizer and weedicide application, and real-time weather forecasting (Kvrkou *et al.,* 2019). For agricultural use autopilot drones with a camera are mostly used connected through GPS. In the near future, drones are considered as best farmer tool that will reduce labour load, precise fertilizer, and pesticide application and save the environment.

In one-way drones facilitate human life, on the other way these drones have some limitations such as expensive technology and limited load for spraying and carrying. Different sensors are used for take-off, flying, and landing of the drone. Sensor (Accelerometer, gyroscope, digital compass, and barometer) helps the drone while the flight to detect motion (position and speed) in the environment. In agriculture, drones controlled through GPS. The GPS sensors detect specific field information from geostationary satellites. Minimum three satellites are required to define longitude and latitude and one satellite assessed the altitude of the UAV. Basically, the satellite data is merged with other data for a higher level of precision and accuracy. Furthermore, attached cameras with drones are basic equipment in most drones, use of vision algorithms to fly drones autonomously (Kvrkou *et al.*, 2019). This vision helps in agricultural field through disease and weed identification and for crop health monitoring (Alimuzzaman Md 2016).

Yield mapping and yield analysis

Mapping is devised management strategy to cope with grain shortage and availability. This strategy is not being used in this era of technology. Previously it is used for estimation through the flow of the grain in the combine and based on rotations the yield estimated. Greater fluctuation in environmental conditions needs to estimate yield production from the field after each and every weather disaster. Although, in this stage, yield mapping is modified through GPS, satellite and drone imaging. In 90s many scientists tried to evaluate yield based on spatial and temporal variability (Bratney and Whelan 1999) from Australia in 1995–1996 to the USA and they found large differences in spatial and temporal in yield. Figure 5 showed Sketch map of agricultural farms monitoring through advanced computer- based monitoring tools. Grid-based information is collected from the space in many ways (online, imaging) and estimated the yield of a specific location. But there are still limitations for yield mapping due to moisture variations and soil heterogeneity (Luck and Fulton 2015).

Future prospects, opportunities and challenges

Without any doubt, smart farming is helpful for farming community with real-time alerts, help in managements and precise use of agricultural resources for sustainable food production. But this system involves innovative technology that is expensive, as well as the farming community, is not well aware, especially in the developing countries.

The main challenge is the small landholdings and the farmers are unable to adopt smart farming with limited knowledge and skills. The main identified reasons from the developing countries are as follows:

Internet connectivity: Smart farming relies on the internet and builds a connectivity bridge between farmer smart communication device and field-based sensors for real-time information and management. But in most villages and farming communities have not to access all the time to the internet. That makes difficult for the adaption of smart farming.

GPS signals: GPS signal transmission is difficult in some areas such as hilly, forests and field with a dense tree planting. That system has to be improved for better communication and alerts.

Energy requirement: Data collection and processing centers and many IoT based sensors need energy for a successful application. Whereas, already developing countries are running out of energy resources. So, this maybe a major hindrance for the adaptation of smart farms.

E-wastes: Technology is rapidly growing and updated hardware’s needs to be adjusted with the passage of time and the older one will be obsolete. The major problem maybe the disposing of the e-wastes during the developing stage.

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.

On Farm, 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, On Farm 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 & 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.

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 6. 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.

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.

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.

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 figure 7 shows some of the applications that can be possible with Kaa.

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:

Figure 1

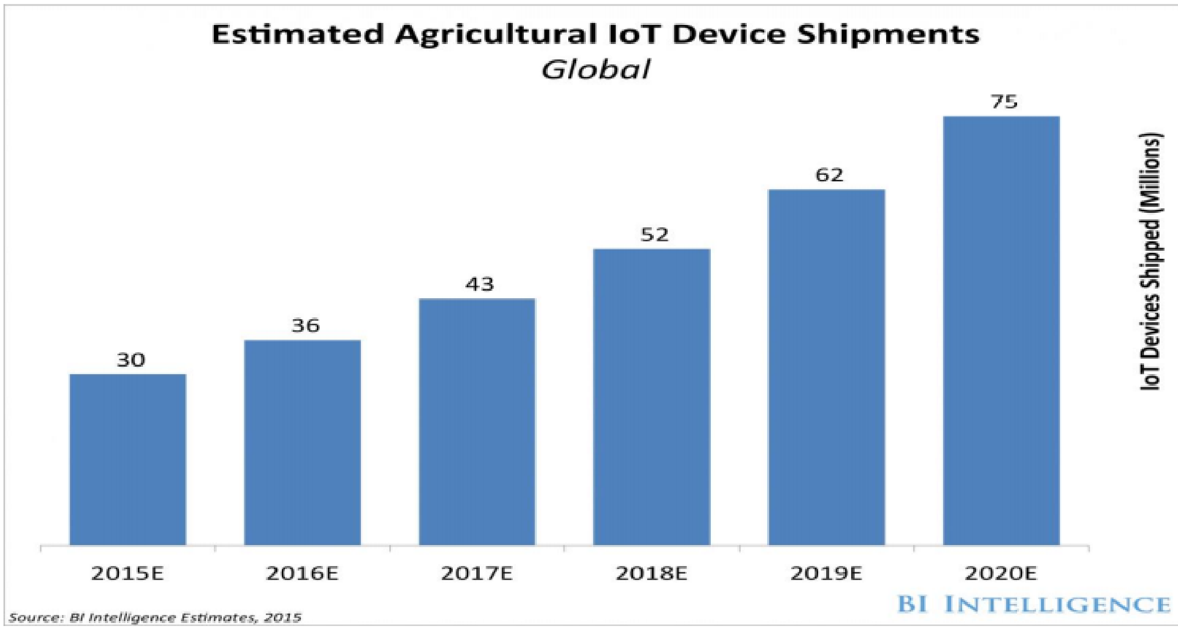


Figure 2

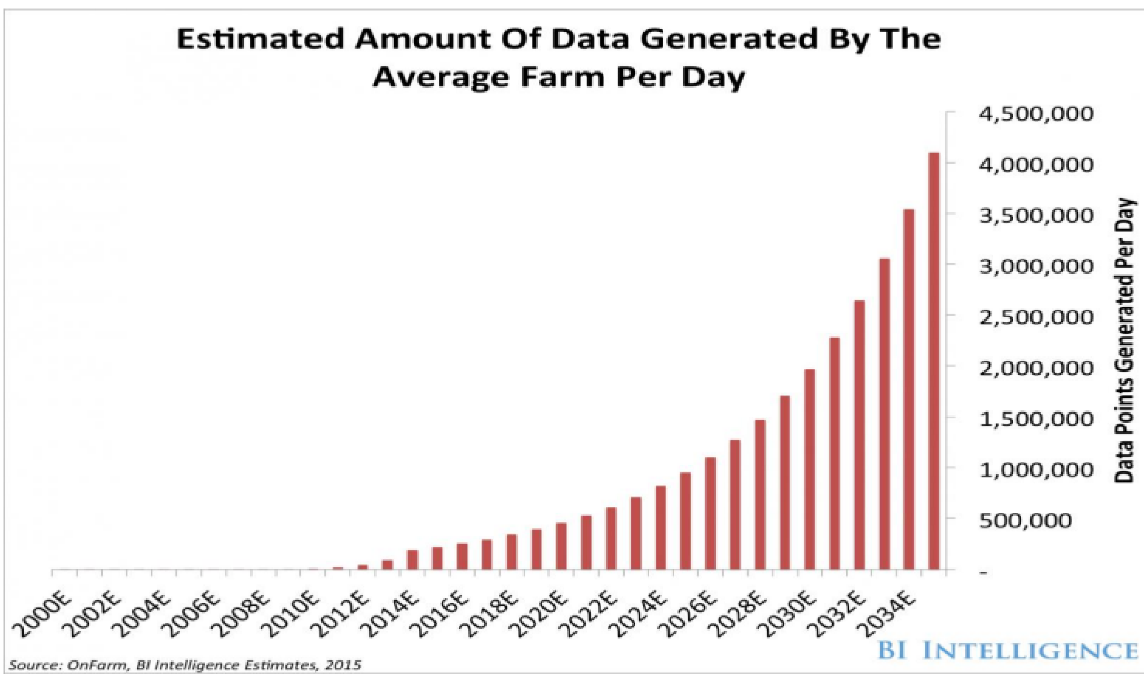


Figure.3 Future interesting internet of things (IoT) projects in agriculture

Figure.4

Figure.5 Sketch map of agricultural farms monitoring through advanced computer- based monitoring tools

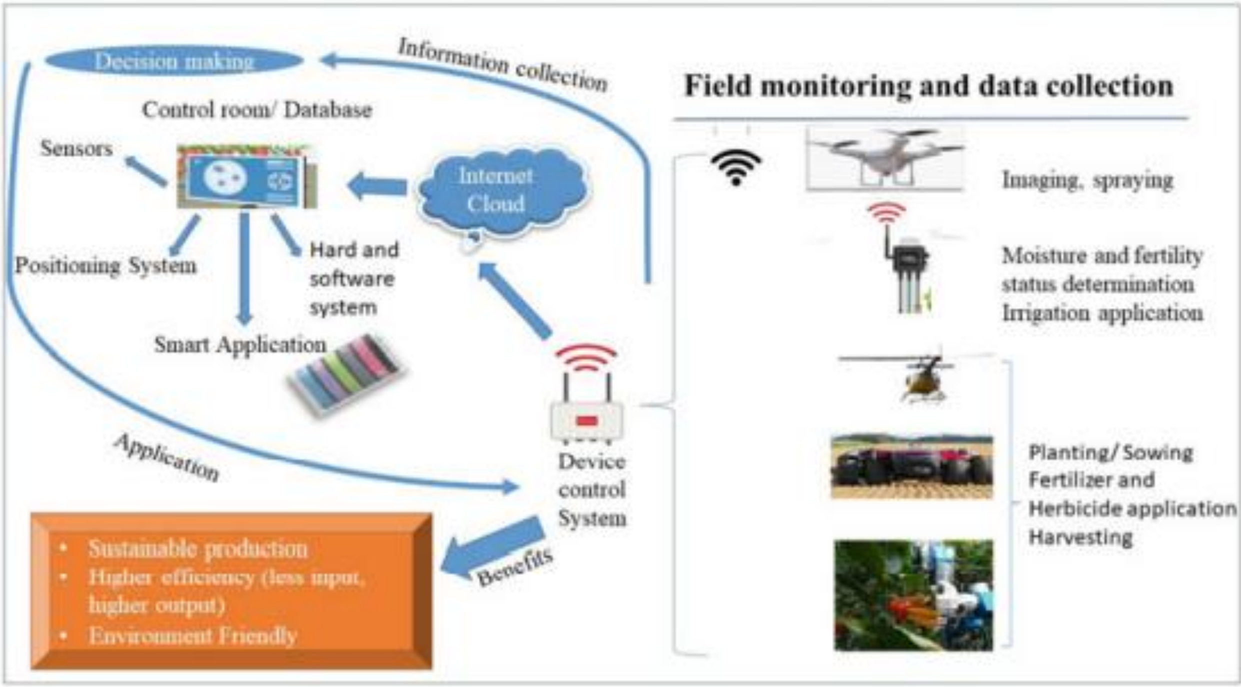
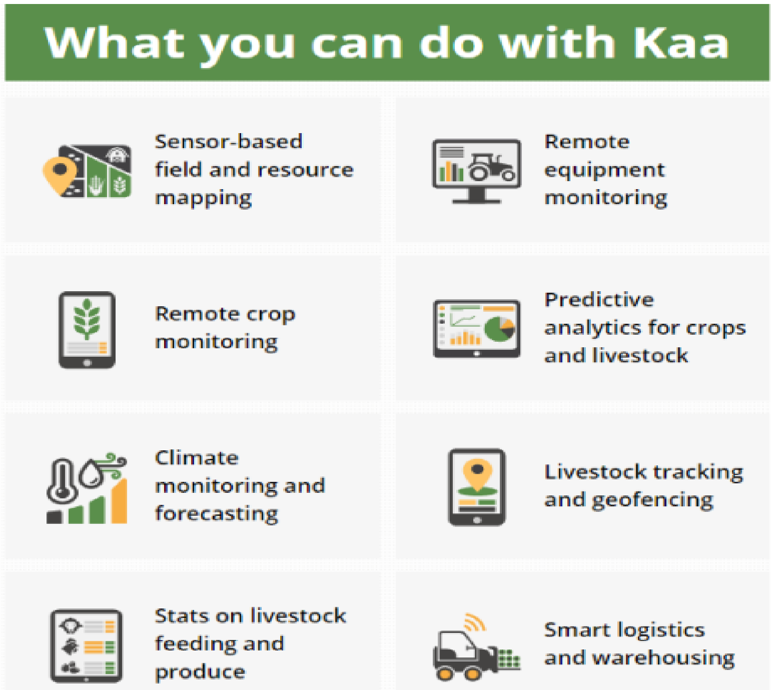


Figure.6

Figure.7



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 able to track position, counting and other variables of cattle.

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.

In conclusion, agriculture production is experiencing a modern revolution and has involved the use of communication and information technology. The technological revolution in agriculture farming led by the improvements in robotics and sensing technologies looks set to disrupt the advanced practices. Use of modern agricultural technologies is must because it can increase production and can reduce the input cost. Several aspects of modern autonomous machinery can give great benefit when applying them in agriculture, especially in smart farming. In the future, smart farming can be a powerful tool for farmers for the efficient use of resources and real-time management. But this is a sketch of farming controlled by a high input of revenue and technology. That might be difficult for some developing farming communities until they will be provided by subsidy. This relief can create a revolution in every part of the world and can secure food availability for the growing population. 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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