

INDUSTRY 4.0 IN AGRICULTURE FROM IoT ASPECTS

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ABSTRACT: Industry 4.0 is the industrial fourth revolution which focused on automations in manufacturing technologies such as cyber physical systems, Internet of Things, artificial intelligence and cloud and cognitive computing. Farming is playing an important role in the survival of world. Currently, agricultural industry is facing several challenges. These challenges can be reduced or removed by using automation in the agricultural tools and techniques. The development and improvement of the connectivity between agricultural tools is leading to significant progresses in the agricultural practices. Advancement and automation of the technologies with Internet of Things (IoT), replacing traditional agricultural methodologies which causes wide range of improvements in the fields. The main purpose of this paper is focused on the review of basic concept of Industry 4.0, the number of new tools and techniques used by smart agriculture for the improvement in the fields and the list of benefits of smart agricultural solutions.

1. INTRODUCTION:

Industry 4.0 is focused on developing smart environment within production system. Industry 4.0 is the current trends of automation and data exchanges in manufacturing technologies. It includes cyber physical systems, cognitive computing, cloud computing and Internet of Things. Industry 4.0 is also known as industrial fourth revolution. The development of connectivity between agricultural tools leading to important progresses in the agricultural practices[9]. They enable the development of accuracy and transparency in agricultural industry. However, they also face some challenges in the key necessity to enable data exchanges in the business ecosystem and the need to invest in new infrastructure and tools. Smart Agriculture is using advanced technologies such as sensors, devices, machines and Information Technology, robots, GPS technology which will allow farms to be more profitable, efficient, safe, and environmentally friendly.

2. LITERATURE REVIEW:

Industry 4.0 is based on integration of the business processes, manufacturing techniques and all which are involved in the organization's value chain such as suppliers and customers. [4] 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. [3]

Agricultural digitalization will be happened by introducing and developing new machines and new tools in the production system such as automated tractors, measurement tools etc. [2] Currently[10], agricultural industry facing number of challenges which can be solved or reduced by using number of new technologies with Internet of Things in the farm. [1]

3. OBJECTIVES:

- To study the basic concepts of Industry 4.0.
- To study the challenges that the agricultural industry currently facing.
- To study digitalization of agriculture.
- To study the benefits of smart agricultural solutions.

4. RESEARCH METHODOLOGY:

Research methodology is the science of studying, as how research has to be done. The group of procedures used by the researchers for describing, predicting and explaining phenomena of their work is called research methodology. It is also defined as the study of methods used to gain the knowledge.

Type of research: Exploratory

Data sources: This research is based on the secondary data which is collected from various research papers, websites, online journals and articles.

5. DATA ANALYSIS AND INTERPRETATION:

Industry 4.0:

Industry 4.0 is the current trends of automation and data exchanges in manufacturing techniques[9].

Revolution of Industry 1.0 to 4.0:

Industry 1.0: In 19th century, water and steam powered machines were introduced and developed.

Industry 2.0: Electricity became the primary and important source of power instead of using water and steam. It happened in the beginning of 20th century.

Industry 3.0: Fully automated individual machines were developed to supplement or replace the operators in last decades of 20th century.

Industry 4.0: In 21st century, manufacturing techniques connects with Internet of Things (IoT), by which the systems starts to analyze and share the information and use it as a guide the intelligent actions[10].

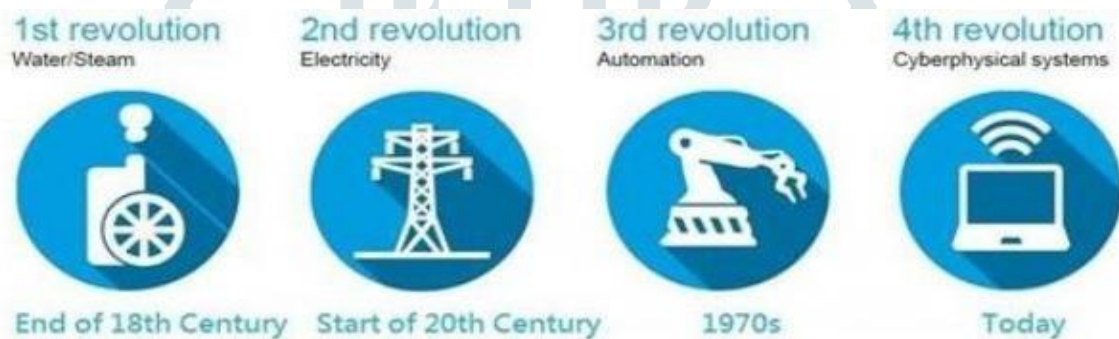


Figure 1: Revolution of Industry 1.0 to 4.0 [8]

The Industry 4.0 is also called as I4.0 or I4, which is originates from the project in high- tech strategies of the German government, which are promotes the computerization of manufacturing. Industry 4.0 is now across in manufacturing, processing, logistics, agriculture, shipping and more. Within smart factories cyber physical systems uses for monitor physical processes and creates a virtual copy of the physical world and can make decentralized decisions. By using Internet of Things (IoT) cyber physical systems can communicate and cooperate with each other and with the humans in real-time.

Design principles of industry 4.0:

The important and basic principle of Industry 4.0 is that by connecting systems, work pieces and machines, businesses are creating intelligent network extend in the entire value chain that can control each other independently.

There are four design principles of Industry 4.0. These principles can support companies to identify and help in implementing the Industry 4.0 scenarios.

- **Interconnection** – The ability of systems, sensors, people and machines connect and communicate with each other through Internet of Things (IoT).
- **Information transparency** - The information transparency given by Industry 4.0 technology which provides huge amount of useful information to operators which can be needed to make the appropriate decisions.
- **Technical assistance** – Technical assistance system is support to humans by visualizing and aggregating information for solving short noticed problems and making important decisions. It also helps by conducting list of tasks which are unsafe, unpleasant or too exhausting for human co-workers[9].
- **Decentralized decisions** – The cyber physical systems support to perform tasks and make decisions as independently as possible. The tasks can be delegated to the higher level only in case of conflicting goals, exceptions or interferences.

Challenges while implementing Industry 4.0:

- Issues related to IT security.
- For machine to machine communication, the stability and reliability is required.
- Change management, something that is too often overlooked.
- The genuine interconnection of all departments.
- The IT controlled and automatic processes can be cause for loss of jobs for lower educated part of the society.
- There is not much clarity for data security and the legal issues.
- The excessive investment required for developing this system and also there is no clarity for economic benefits[10].
- Insufficient qualification of employees.
- Recruiting and developing new talents.
- Rethinking about the organization and processes to maximize new outcomes.

Benefits of Industry 4.0:

- **Improved efficiency**
More automation can help to make decisions of company rapidly and keep efficiency high. Automation, also tends to keep quality high, and that's an area that further boost efficiency.
- **Improved productivity**
Production can be improved by using Industry 4.0 technologies by allocating resources more efficiently and cost effectively. Also there is less downtime for machines because of automated decision making and improved machine monitoring.
- **Increased knowledge sharing and collaborative working**
Business processes, departments and production lines can communicate with each other from any location, at any time, or regardless of platform and other factors because of Industry 4.0 technologies[9].
It is possible that communication or data exchanges between system to system and machine to machine without human intervention, because of automation, so data can be improved from one sensor can be applicable to across multiple locations in the world.
- **Agility and Flexibility**
In smart factories, it is easier to scale the production as up and down. Also it is easy to add or introduce any new product in the production line and creating new opportunities of high mix manufacturing and more.
Enhanced agility and flexibility is one of the important benefit of Industry 4.0. In a smart factory, it will be easy to scale the production level up and down. Also it is easier to introduce new products to the production line and high mix manufacturing.
- **Improved Customer Experience**
Industry 4.0 technologies help to increase the customer experience and provide improved services to the customers. With the help of automation, can track the problem easily and can solved it quickly. As quality has improved the issues related with quality of product and availability of product are decreases and can offer more choices for the customers.
- **Innovation opportunities**
Industry 4.0 increase the knowledge of the business performance, supply chains, manufacturing processes, distribution chains and product manufacturing. This creates innovation opportunities of the developing a new product, changing the business processes and optimizing the supply chain etc.

INDUSTRY 4.0 IN AGRICULTURE FROM IoT ASPECTS:

As increasing automation by Internet of Things (IoT), connected devices included in every part of our life from automation of home, health and fitness, automotive and logistics and industrial IoT to smart cities. The development of connectivity between agricultural tools is most the significant progress in agricultural industry. It leads the development of quality agriculture and improve the transparency of an industry. It also face some important challenges as need to invest in new tools and infrastructure and also necessary to enable the data exchanges in business ecosystems. From last decades, there are number of transformations of technologies in farming, farming becoming more technology driven and industrialized. Famers have gained control over the processes of growing crops, raising livestock by using various types of digital agricultural gadgets[10].

Challenges that the agricultural industry is facing currently:

- Population growth will boost demand for food.
- Uses of natural resources are highly stressed.
- Deforestation or overcutting of natural forests has led to water erosion and wind erosion, resulting in land less suitable for food crops.
- When soil fertility has declined, farmers attempt to maintain crop yields through fertilizers. But this has led to soil-nutrient imbalance.
- Changing in the climate is reducing the productivity in the Agriculture.
- Overgrazing leads to decreases in the quantity and quality of vegetation cover, which lead to a decline in the soil's physical properties and resistance to erosion.

Digitalization of agriculture:

Connectivity is the cornerstone of this transformation and Internet of Things (IoT) a key enabling technology that is increasingly part of agricultural equipment. Automation that increases productivity by reducing the need for human workforce. This can take several forms, from the automation of vehicles, to the development of task specific robots that automate parts of the production process. The digitalization of agriculture is based on the development and introduction of new tools and machines in production.

From Industry 4.0 to Agriculture 4.0:

The Industry 4.0 trend is seen as transforming force that will deeply impact the industry. The trend is building on an array of digital technologies: Big Data, Internet of Things (IoT), Artificial Intelligence, and of digital practices: cooperation, mobility, open innovation. They imply a transformation of the production infrastructures: connected farms, new production equipment, connected tractors and machines. They will enable both an increased productivity and quality and environmental protection. But they also generate modifications in the value chain and business models with more emphasis on knowledge gathering, analysis and exchange.

IoT and Sensors in the equipment:

Connectivity and localization technologies (GPS) are optimizing the usage of these agricultural tools. Tractors can drive by themselves, map the fields and within inches, can check its own motion so it doesn't waste fuel, fertilizers or seed. It also relies on the deployment of sensors on implements to enable precision agriculture (PA). The sensors are monitoring and control over crop treatments enable important gains in efficiency and productivity. While sensors are monitoring that when tractors need to be serviced. So that the downtime of machines or tractors can be reduce. Connectivity is also enabling business model evolutions with more precise tracking of usage of equipment and thus more precise billing of equipment use by contractors.



Figure 2: Sensors in the tractors [9]

IoT and Sensors in the field:

IoT (Internet of Things) is a streamlining and simplifying investigation, collection and overall distribution of resources using sensors on materials and equipment. Sensors are placed around the field with image recognition technology which allowing the farmers to view their field or crops from any location in the world. The sensors provide updated information in real time to farmers so it will be easy to made changes accordingly for their crops. The particular application (known as app e.g. FarmWave) suggested that when the plants will need water or some other type of nourishments[10]. IoT (Internet of Things) sensors in the field are doing the same but on a larger scale which resulting in higher food production and with less waste.

Weather Tracking:

Weather is an important factor for livestock and crops. Sunlight, temperature and rainfall have major effects on the crops. Weather forecasting technology is a science to predict the condition of the atmosphere in future time for a given location. Weather forecasting technology is determine the weather condition will evolve in coming days by collecting the data about present state of atmosphere which includes wind, humidity and temperature etc. In order to predicting weather conditions accurately for future time, weather forecasters need to analyze the information which is received from weather balloons, weather observations, satellites, weather stations and drones. The need of accurately predict the weather has therefore led to the growth of the weather forecasting departments in nearly all countries across the world. This departments are responsible for advising the farmer on the expected rainfall in a given place, the temperature that will prevail in a given place, the humidity levels among many other aspects of the weather. The study and use of the information given by the forecasting departments has ensured that the farmers are making the right farming decisions.



Figure 3: sensors for monitoring the climate condition [10]

Soil and Water Sensors:

Soil moisture sensors being used for measuring volume of water content in the soil. Soil moisture is very important factor in the life of crops so it is very important to measure the soil moisture. Water is essential for controlling the plant temperature through transpiration process. Roots of the plants are well developed when growing in the moist soil. If soil moisture is become excessive it can lead to soil pathogens and anaerobic conditions. Soil water sensors have been used for water management and irrigation in agriculture since last many years. This sensor insert into the soil which need to be tested and volume of the water content in the soil is measure in percentage. By measuring dielectric permittivity of soil which is the function of water content, soil moisture sensors measure the water content of the soil.



Figure 4: Soil and Water sensor [11]

Drones and crop monitoring:

Now a day's drone technology is being used for the crop or field monitoring. Drones that can be produce 3D imaging which helpful while planning seed planting pattern and also useful to predict the quality of soil through analysis. Drones are being used to spray chemicals on the crops which is five times faster than other types of equipment or machinery.

**Figure 5: Drones and crop monitoring [12]****Farming and Robotics:**

Same as using artificial intelligence and robots in other industries, robotic technology improving productivity within agricultural industry which results in faster and higher yields. Such type of robots like weeding and spraying robots (acquired by John Deere) can be useful for reducing agrochemical usage by almost 90%. Weeding robots with camera and laser guidance are being used for identifying and removing weeds independently without human intervention. These type of robots can use as a guidance to navigate between the rows of crops independently on its own, so that manpower will be reduced. There is also a robot or automation is being tested for plant transplanting, nut harvesting and fruit picking which are add efficiency in traditional methods.

Figure 6: Farming and Robotics [13]

Blue River Technology:

Blue River Technology is the next or future generation of smart agriculture equipment. It includes see and spray technology, which enable to count each and every plant or crop. Farmers are currently facing challenges related to weed control, blue river technology has a solution for the same. It sprays herbicides only on required places. It sees each and every plant and sprays herbicides only on weeds and can avoid chemical applications on the crops which are without weeds.



Figure 7: Blue River Technology – See and Spray [14]

Benefits of smart Agricultural solutions:

- Provide useful, real time and quick information for the management decisions.
- Stored a farm records which can be used in sale and succession.
- **Farming innovations**
Farming is now becoming more accurate, smart and scientific by using GPS systems, data analytics and remote sensors included in farming equipment and machinery. So farmers are ready to adapt new technologies in their farming to make it more precise[10].
- **Obtain useful data in real time**
The sensors or devices in the field allow continuous monitoring of the significant parameters and will provide real time data with up to date information related to plant parameters and status of the field at all the time.
- **Save time and costs**
Reduce chemical applications and fertilizers costs and also help to reduce pollution though less use of chemicals.
- **Other significant benefits**
Reduce the fuel usage, reduce the compaction of the soil and reduce the labor requirement etc.
So, by using smart technologies for managing the fields it seems that having more benefits and ultimately increase in the profit.

6. CONCLUSION:

The review of basic concepts and revolution stages of Industry 4.0 and smart farming tools and techniques has presented in this paper. Industry 4.0 is basically focused on the automation with Internet of Things (IoT) in manufacturing technologies. Agriculture industry plays very significant role in our life. Agriculture industry has been facing several challenges. Automation with IoT (Internet of Things) helping to reduce these challenges by developing lots of changes in the fields, innovating new agricultural equipment, tools and techniques. Smart farming is mainly focusing on connectivity between tools by automation, so that tools and equipment can work independently in the fields and provide real time information to the farmer. Because of smart farming, farming will be easy and farmers are getting lots of benefits and will increased profit.

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