Industry 4.0 implications on Agriculture Sector: An Overview

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Abstract

Agriculture Sector, worldwide, is at the threshold of a needful paradigm shift, towards adaptation of the smart solutions, mostly while facing climate change, volatility, shifting nutrition needs and the increases shortage of productions' physical factors. The rapid advancements in technologies and applications in agriculture helps in increasing productivity. Industry 4.0 technologies assists to overlay an efficient, optimize cost, ingenious upcoming for industries in different industry on the globe. Agriculture provides humans with food and raw materials. Precision farming under agriculture 4.0 (The Future of Agricultural Technology) is a promising pathway to increase the sustainability of farming by increasing farm profitability, reducing manual labour and reducing environmental impact. The objective of this work is to review fundamentals of Industry 4.0 revolution and elaborates the potential of fourth industrial revolutions in agriculture sectors. This paper also presents changes and a new challenge in Industry 4.0 on agriculture sectors.

Keywords: *Industry 4.0, Precision Farming, Agriculture 4.0.*

1. Introduction:

The main income source in India is an agriculture sectors because more than 50% population depend on farming and related works and hence agriculture in India is a backbone for Indian Economy. So, improve traditional farming into precision or smart farming; industrial development reaches to fourth level is initiated to use this revolution in agricultural sectors on large scales so that it can be effectively utilized to improve the farming yield effectively.

The fourth industrial revolution: Industry 4.0, or IR 4.0 is defined as the crosscutting impact of information and communication technologies, especially the Internet of Things (IoT) in various industrial sectors translates itself into a phenomenon. Its purpose is to revolutionize the industry through "smart factories" that will allow greater flexibility in production needs, efficient allocation of resources and integration of processes; from equipment monitoring to final delivery with the use of technologies such as integration of Cyber-Physical Systems (CPS), IoT and IOS, and the real time interaction between machinery, software and individuals. The concept of Industry 4.0 is a reality in consolidation and will become a new milestone in industrial development, which will undoubtedly set significant changes in the way of production and trade during the upcoming years. This revolution is supported by the development of systems that transfer the ubiquitous advantages of the Internet and information systems towards physical systems; the core of the revolution is the interaction of digital systems with physical production systems.

Industry 4.0 will provide great flexibility and robustness, along with the highest quality standards in engineering, management, manufacturing, operations and logistics processes. It will explode dynamic value chains, optimized in real time and with an automatize organization, which will consider various variables such as costs, availability, and use of resources and market demand. The following figure 1 shows revolution takes place first since 1782 to smart automation in 2015.

The revolution in 4.0 concepts renovating capabilities of production of industries along with the agricultural areas. This revolution in agriculture equipment uses the

key technology of Internet of Things (IoT) which is based on connectivity of all system with equipments.

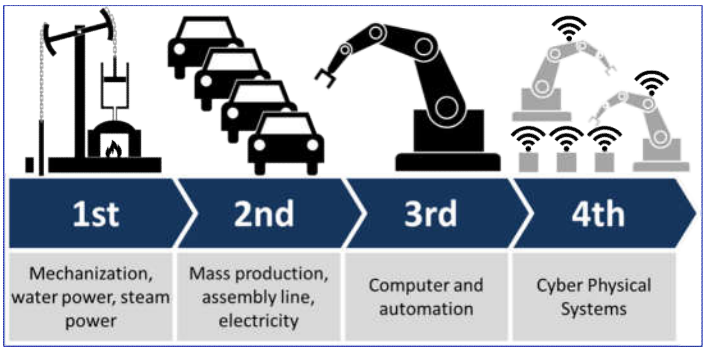

Fig. 1 The 4th Industrial Revolution – Industry 4.0

The Industry 4.0 trend is seen as a transforming force that will deeply impact the industry. The structures of Industry 4.0 are consisting of following digital technologies such as Big Data Analytics, Artificial Intelligence and Internet of Things (IoT). Also, this revolution uses some of digital practices like open innovation, cooperation and mobility. In fourth industrial revolution transform agriculture infrastructures into connected tractors and machines, connected farm and new production equipment. This results in productivity improvement, environmental protection and quality of agricultural products. Also, some of process improvement in value chain modification and business models based on analysis, exchange and collection of knowledge.

The Industry revolutions 4.0 is used for three, communally interrelated factors:

1) Digitalization and its integration in simple economical and technical relations to complex networks.
2) Services and product digitalization.
3) Updated market models. [1]

Industrial, economic and business models are changing fundamentally and humans are being removed from immediate production and monitoring of manufacturing processes.

This industry 4.0 revolution takes places in the area at the developed and developing stages. Country like India has large scope for development agricultural land where this revolution is divided in robotics part which leads the world through automation with artificial intelligence and Internet of Things (IoT) and e-business which helps to reach technology at each and every corner of the world. [2]

The fourth industrial revolution progressed in different sectors. This revolution has been modernized in commercial applications like Google car and Drone delivery system. this industry 4.0 also overcome the future problems in different activities. [3]

The slogan Agriculture 4.0 draws on the term “Industry 4.0” and refers to increased integration of IT and communications technology with agricultural production as shown in figure 2 where the past, present and future perspective are explained using smart, networked systems combining various different types of data from multiple sources promises to increase productivity and efficiency. The transparency arises in supply chain management. Agriculture 4.0 is benefits to agriculture as well as the environment in which downstream economic activities reaches to end customer. The model for the future is a fully automated and autonomous agriculture. [4]

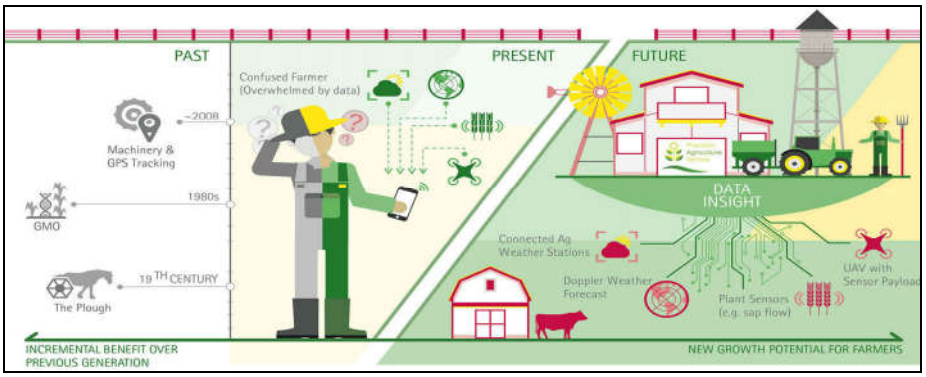

Fig. 2 The 4th Industrial Revolution in agriculture 4.0

Agriculture in India is highly dependent on the agricultural equipment used, resources and labour work. The portable tools and devices used infield and outfield processes comprises of agricultural tools for different operations traditionally. The data collected by digitalization of agricultural sector provides improved equipments for analysis of condition of farm. Due to the financial status, every farmer has not contributed to digitalization in agricultural equipment which unaware of benefits to increase productivity in agriculture. Yet, the revolution of agriculture sectors using digitalization is familiarized due to development results after all, farmers were in the vanguard of electronic data capture for livestock farming. [4]

1.1. Need of Industry 4.0 in Agriculture sector:

Regular machines in agriculture is being converted to self-aware and self-learning machines needs Industry 4.0 to enhance overall performance and maintenance management with the surrounding interaction. The main needs of Industry 4.0 in agriculture sectors aims at the construction of an open, smart manufacturing platform for real time data monitoring, tracking the status and positions of product as well as to hold the instructions to control farming processes.

Digitalization in agriculture sectors exposed new standpoints for youth generation with all elements in supply chain is being intricated through co-innovative approach which set to correct direction.

2. Industry 4.0 and agriculture 4.0 overview:

Industry 4.0 is the information-intensive transformation of manufacturing and other industries in a connected environment of statistics, public, methods, services, systems and Industrial assets based on IoT system with leverage, generation and actionable information application outcomes to escalate smart industry and ecologies of industrial innovation and collaboration.

In Europe, the Precision Agriculture (PA) and the digital technology integration are set to becoming the most influential trends in the sector and farmer number continuously increases who runs their business with adoption of digital technologies. Higher yields, less crop damage with smaller amount inputs such as water, fuel and fertilizer produced with potential of Precision Farming. This utilization of agriculture 4.0 techniques through Industry 4.0 revolutions intended the following reviews.

2.1. Industry 4.0 survey:

Industry 4.0 is an extensive vision with clear contexts and reference architectures, principally categorized by the bridging of physical industrial resources and digital technologies in so-called cyber-physical systems. The basic techniques of Industry 4.0 which consists of Big data, additive manufacturing, Automation, Intelligent robots, Internet of things, Cyber security, cloud computing is particularized in figure 3.

Fig. 3: Industry 4.0- Technologies [5]

Today's industrial requirement of manufacturing development are intelligenitization of manufacturing process and Digitalization. Productivity of industries is increases with rapid improvement in manufacturing technologies and applications. With the utilization of Industry 4.0 in manufacturing process included integration of human for continuous improvement and focus on value adding activities and avoiding waste. This works enlightened the nine important pillars of industry 4.0 such as Big Data and Analytics, Autonomous Robots, Simulation, System Integration: Horizontal and Vertical System Integration, The Industrial Internet of Things (IOT), Cyber security and Cyber Physical Systems (CPS), The Cloud, Additive Manufacturing and Augmented Reality with its applications in various field. [6]

Industry 4.0 is embracing the Intelligent manufacturing where Typical resources are transformed into intelligent objects so that they are able to sense, act and behave within a smart environment through different pillars of Industry 4.0. the combination of embedded production system technologies with intelligent production processes in Industry 4.0 to overlay the new technological era that will principally renovate industry to business models with value chains and production value chains. Intelligent manufacturing used the key technologies such as the IoT, cyber-physical systems (CPSs), cloud computing, big data analytics (BDA) and information and communications technology (ICT). An application perception, IoT-based manufacturing has been effectively employed, with a large number of industrial cases being reported and maintained by professional training and educational ideas. Intelligent manufacturing and cloud manufacturing are still in the research results in a limited number of real-life cases. [7]

Development of Industry 4.0 is often including the digitization or full-scale automation. Industry 4.0 is a model shifted to decentralized smart manufacturing and production from centralized system. Industry 4.0 refers to the automation of manufacturing and the creation of a smart factory. The works reviews the different aspects in industry 4.0 encompasses developments in previously split and disconnected fields such as artificial intelligence (AI) and robotics, nanotechnology, 3D printing, genomics and biotechnology. The impact of Industry 4.0 on various aspects like global value chains, education, health, environment, labour markets and many economic and social is to be expected. [8]

The author specified the recent important technology phenomenon and to clarify industry 4.0. background platform for Cyber- physical and informatic. author presented both models RAMI (reference architecture model industry) 4.0 and components models required for any industry 4.0 applications. The case studies for different industrial 4.0 applications are developed through this model. [1]

Continually increasing in demand of various products results in to adapt changes in incoming and outgoing logistics. Unavoidability of Information and communication technologies (ICT) evolution and Industry Internet of Things (IIoT) promoted new challenges in logistic domain, requires technological changes like high need for transparency; integrity control in the supply chains management. The advanced

digitalization enables man-machine communication in real time with the increase in internet use. The authors reduce this application to logistics 4.0 for follow 1) Resource Planning, 2) Warehouse Management Systems, 3) Transportation Management Systems, 4) Intelligent Transportation Systems and 5) Information Security. [9]

2.2. Agriculture 4.0:

Agriculture 4.0, in analogy to industry 4.0, stands for the integrated internal and external networking of farming operations. This indicates that digital form data is present in agriculture processes like suppliers' communications with end customer performed electronically. Agriculture 4.0 revolution the processes like data transmission, processing and analysis are automated.

Farmer fields utilized with technology and innovation results in sustainable agricultural production and productivity growth. The study presents that agriculture growth, quality of the environment and other sustainable aspects results by agriculture 4.0 and hi-tech agriculture implementation. This study focusses on agriculture 4.0 current applications and hi-tech for sustainable farming development with factor influencing the adoption of agriculture revolutions of the farm operation in Vietnam. [10]

The impacts on labor-intensive agriculture fields causes due to Fourth Industrial Revolution. This revolution created two technologies artificial intelligence which benefits in decision making ability and big data which helps in analysis of statistical data collected by different techniques. These technologies are developed by several hi-tech organization under precision agriculture sectors. These sectors used in agricultural activities like analysis of soil moisture, healthiness of crop, prediction of exact harvest time of crop, scheduling of pest control. System termed Internet of things (IoT) making possible to operate farm via remotely through mobile devices measures temperature, humidity, and amount of sunlight in production farms which increase the production with value added. [3]

Farming nowadays transforming in technology and production practices, business size, resource control and operation, business model with buyers and suppliers. This works presents innovative farming operations with agriculture development results in new agriculture in U.S. They presented policies for farming transformation to industrial business model through increased quality safety and traceability demands of processors, consumers of food products, process control technologies that facilitate biological manufacturing of crop and livestock products. [11]

Industry 4.0 refers to the smart factory, consists of processes interrelated by Internet of things (IOT). Companies that produce, process, manufacture, sell and serve food, beverage and dietary supplements referred as food business which contains all stages of the process, including design, construction, maintenance and delivery of solutions to the customer. In this business, innovations with agriculture 4.0 specially development of the Internet of Things (IoT) use to serve good and healthy food, production in efficient and sustainable manner without harming environment. [5]

3. Digital transformation Technologies in Industry 4.0 in agriculture sectors:

In global food market, India is the leading contributor. India in Agriculture contributes to food grain production increases from 252.23 million tonnes to 271.98 million tonnes in 2016-17 from last year. Similarly, in horticulture sectors consists of Fruits and vegetables, floriculture, plantation crops and honey in 2015-16 was 283.4 283.4 million tonnes superior than food grains leading the India move to one of the leaders in horticulture production in the world. [12] The Agritech sector where companies using new technology models to implement agriculture 4.0. These hi-tech organization uses new technologies in precision agriculture which is utilized to monitor the farm with measurement and analysis of suitability in crops in different atmosphere. This new method increases crops productivity with a higher environmental sustainability.

3.1 Blockchain technology:

Block chain refers to system used to create everlasting, constant and clear record of exchange and processing. In this system used digital technology with data and information in previous generation is recorded and exchange this information faster and securely with decentralized manner. [8]

Block chain technology in agriculture involved smart contracts leads possible to stored data from its origin to the last customer end ensuring the legitimacy and origin of each transaction which helps to eliminate dishonesty in several actors in supply chain. Bock chain technology avoid potential frauds on the quality of products by controlling the treatment given throughout chain up to the point of sale. In Block chain technology stored data in following three ways:

- **Unencrypted data** - This data is transparent and read by every node in network.
- **Encrypted data** – This data is available for participants. The decryption token is provided access to data in block chain and also verify data added into the system.
- **Hashed data –** This data presented the function. Hashed data consists of small unit name soil basic unit (SBU) of historical records continuously recorded using Blockchain Technology. The fourth revolution in agriculture 4.0 developed block chain which is used to store old record and a decision taken by the analytics is being carried out on these SBU. These SBU stores a data like variety of crops, diseases, soli contents, nutrients required by the crop at current stage. is all devices connected to the Internet, which interconnect and [2]

3.2 IoT technology:

The potential growth of IoT industry is in Agricultural sectors. Internet of Things (IoT) technology opens a worldwide the possibilities of deploying IoT devices in agriculture with capability of sensing data remotely. The farming data collected by devices attached with sensors affects growth of crops is real time monitor as well as statistical survey shows further processing thorough IoT.

The use of IoT logic and Cloud Computing, depth of the system by verifying each parameter in supply chain network offers an improvement in terms of prescion agriculture based on sensors in marketing environments, processing and production. [13]

The fourth industrial revolutions extended their arm in agricultural field interconnected by all instruments through Internet of things (IoT). The agricultural data monitored by IoT and this data is transfer to analysis software comes under revolution. IoT is a sensor-based technology which is use to improve the performance of existing system by inspecting the collected information from IoT through instruments and action has been taken to improve it. This Hi-Tech technology is operated by organization which utilized the different sensors to measure the data regarding Atmosphere, soil structure, intensity of fertilizers and its effects on the plants. Once this parameter is monitored is being transferred to decision making system where it gives indication for atomization of process to be followed necessary according to collected data different agricultural applications. The farming techniques are also analyzed by IoT by sensors and remedial action is being suggested to the farmer for improvement in the traditional process. [2]

The IoT bridge the boundaries between virtual and real world. The IoT allowed physical objects in world to become intelligent with online communications. This system crossed Machine to Machine communication towards machine to infrastructure and machine-to environment communication. [8]

3.3 Drone analytics:

Agriculture sectors are developed with agriculture 4.0 technologies which uses Drone analytics use to capture images of crops analyses by big data how the crops are yielding. With the use of drone farmers identified which part of agriculture needed watering or

fertilizers, weed removal area easily. Nowadays this drone used as remote fertilizer vehicles in farming so that specific area or individual plant covers easily.

These systems are used for public administrations to make control tasks for public grants depend on the farmland extension and the number of plants that are eligible for a grant. Drone techniques under the fourth industrial revolution used for monitoring various activities in agriculture sectors through variety of sensors developed by hi-tech organization. This data collected by drone forwarded through orthomosaic maps for analysis. [2]

3.4 Big Data Analytics:

Different techniques use to collect the data improve agricultural sector development. "Big Data" denotes processing massive amount of data collected from information and communications and technologies (ICT) leads to rapid decision-making data for improving productivity. Since all data is available from last decade in storage regarding crop cycle, yield problems, stresses each famer take preventive measures with new tools in agriculture 4.0 for different whether conditions. Recently under Industry 4.0, development of new technique of machine learning defined as Artificial Intelligence (AI) increases demands in various activities. This Artificial intelligence (AI) used the previously stored data for decision making and requirement of agricultural sectors with preparation of schedule of these activities. [8]

4. The Fourth Industrial Revolution changes in agriculture:

The concept of Agriculture 4.0 draws on the term "Industry 4.0" and refers to the increased integration of IT and communications technology with agricultural production. Smart, networked systems, combining various different types of data from multiple sources, promise to increase productivity and efficiency. This revolution changes the tools used in agriculture sectors replaces leads to smart farming.

High average age of agricultural tools arises the demand to integrate it into the digital world. Currently these tools with robust, universal and interoperable and not required with no special extra training. Due to inadequate telecommunications infrastructure in rural areas they develop tools in agriculture 4.0 that work even where there is no mobile phone signal across parts of the cultivation areas. [4]

4.1. Agricultural robots:

Agriculture robots will operate in different field like production, processing, distribution, and consumption. One of type of artificial robot is shown in figure 4. These robots distinguish the service atmosphere and separately offer intelligent work. The fourth revolution results in utilization of robots in many farming equipments for selection of appropriate product and proper distribution of pest for insect control. This technique also fixed with aerial vehicle used to control the health with regular monitoring of fruits, vegetables and animals in agriculture field. Robots specially designed under agriculture 4.0 are first is Open-field robots use in farming operations like water irrigation and cultivation of crops, the second robot is known as facility robots used to monitor the yield of crops and controlling farming activities, the third robot named livestock robots used to take care of animals used in agriculture sectors. This revolution in agriculture sector with the objective to enhance productivity through automation, unmanned farming and the eco-friendly farming promotion. [3]

Fig. 4: Agriculture robots examining plants

MARS (Mobile Agricultural Robot Swarms) is an agricultural robot developed for autonomous farming operations using a coordinated swarm of robots. These robots are equipped with a smaller number of sensor technology results in low individual intelligence. [14]

4.2. Precision agriculture:

The smart farming technology under prescion agriculture used to measure crop yield and healthiness. Also, these revolutions in agriculture sectors used for observing different types of crop, its growth during nurturing and post harvesting periods.

The agriculture 4.0 concepts develop the precision agriculture which is used for managing different activities in agriculture. The hi-tech organization implemented precision agriculture on large scale through a decision support system (DSS) in various fields of agriculture sectors. This helps to enhance returns from agriculture and increases demand of these technology.

The fourth revolution in agriculture is divided in three division as shown in figure 5. The first division involving sensor-based technology for collection of several parameter related to crops, land and whether conditions feasible for effective growth. Also, these techniques involving the processing the data with development of decision-making ability in real-time application in field of agriculture.

The second division is stimulated on the basis of first division analysis regarding requirement by the agriculture crops regarding water content and fertilizers on appropriate timing. Digitalized farming equipment is used to performed the action stated by system of decision making in the first division.

The third division consists of control systems of various farm machineries is inputted by processing database collected from computerized geographical information and farmers' input. Lack of third decision making process, it is difficult to carry out precision agriculture though the the first two divisions are well developed. [3]

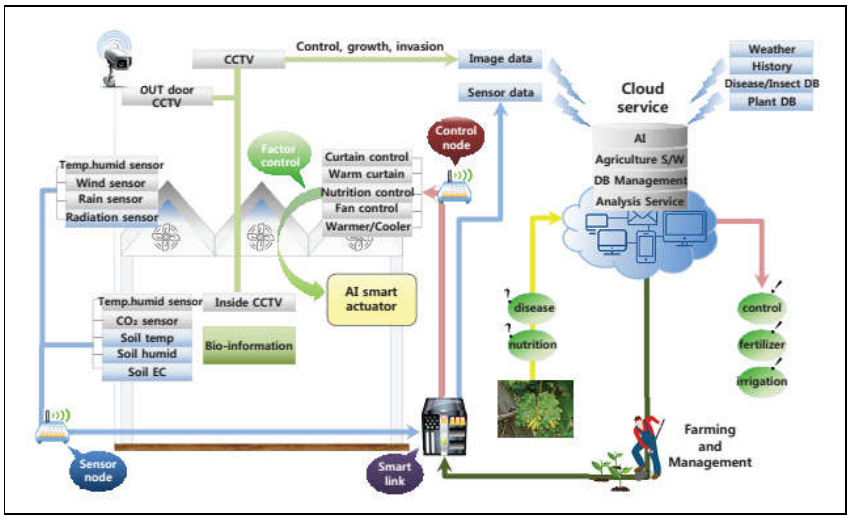

Fig. 5: Crop Production environment through biometrics and artificial intelligence [3]

4.3 Bluetooth "beacons" in agriculture:

The working process of beacons is shown in figure 6. Beacons" is a tool as transmitters that send their thorough energy-saving Bluetooth protocol signals. When devices come within the transmitter range; data are collected and processed. If this installed on equipment, tractors, combine harvesters, lorries or in the cattle shed, it is clearly identified as they allow a vehicle, device or a person. Every vehicle with different age, manufacturer or purpose, can be fitted with one of these beacons. Due to their low electricity consumption, batteries only need to be replaced every four years. This device performs the task of machinery Identification and other points of interest. And used for recording working hours, identifying workforce. [4]

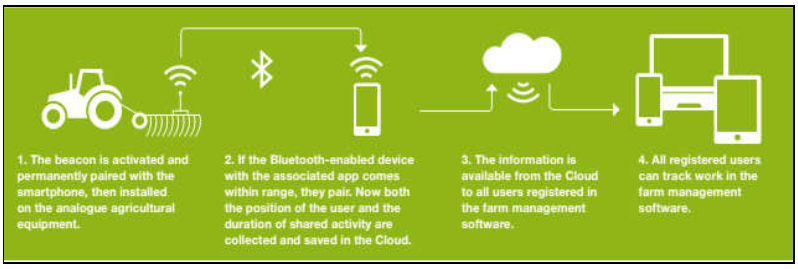

Fig.6: Bluetooth operated Beacon in agriculture.

4.4 GPS in agriculture:

The figure 7 shows positioning of Irrigation system operated by GPS.

The "Global Positioning System" (GPS) is a global satellite system used for positioning and navigation. This system is originally developed for the military and now a days this system with agriculture 4.0 is use in various fields in agricultures. GPS have been used in agricultural equipment for both as fixed units or hand-held devices. The task performed by GPS system like Recording positions and movements, autonomous or assisted driving with applications such as Monitoring and support on parallel journeys, autonomous driving. [4]

Fig.7: GPS operated Irrigation system.

4.5 RFID in agriculture:

Technology used for detecting animals at automatic feeding machine in RFID (Radio-Frequency Identification). This system is equipped with transponder and it is connected with IT devices. This system consists of automatic, contactless, identification and localizing of objects and animals. Recently these systems are used for tracking of Cereal crops in agriculture sectors. RFID performs the task of Identification, positioning of object in agriculture sectors and has applications like Identifiying and localizing of livestock, cereal batches, equipment in farm. [4]

The figure 8 indicates the changes in agricultural sectors caused due to fourth industrial revolution with digitalization:

Fig. 8: Digital transformation in agriculture [2]

5. Challenges in agriculture 4.0 [10]

Naturally, Agri 4.0 has its challenges too. The Digital Transformation Monitor believes that adoption will be one of its biggest due to some of the following reasons:

- **A need for standards to ensure compatibility of equipment:**

The major challenge in industry 4.0 requires technological standards to ensure the compatibility of equipment and also applicability of equipment in rural areas. The new challenge of Agriculture 4.0 is the needed data exchange process with communication standards that associate with different systems together in a unified system covering all aspects of the agricultural sectors.

- **The ability of farmers to modernize from a financial aspect:**

The essential challenge in the Agriculture 4.0 adoption is farmers ability to invest and to revolutionize their production practices. The economic tight situation of farmer leads to limited investment ability in new production tools and limited access to credits. The farmers in rural area needed additional investment in training with new technologies in agriculture 4.0. this arises gap between traditional and smart farming. Adoption of new techniques shows positive correlation with the impact of income, gross income and farm profitability on adoption revealed a positive correlation.

- **The development of communication infrastructure in rural location:**

Lastly the important challenge faces in rural areas in the IoT adoption for agriculture is communication infrastructures development. Currently communication network is deployed in urban area specially to capture markets but the success of Agriculture 4.0. is depends on the ability to exchange and analyses data. Thus, communication networks will have to be established in rural areas.

- **Farm household characteristics:**

Adoption of agriculture innovation corelated positively to education. Household characteristics such as house Head education, family size, gender may affect decision for adopting new technologies in Agriculture 4.0.

- **Farm size**:

As farmer with large size of farm are interested in deploying new technologies instead of farmer possess small size farm denied because of more investment as compared to yield of farming.

- **Extension:**

Media, meetings, and extension these information source positively influences other farmer for adoption of new technology. The extensions are the midway between information and farmer where farmer contact directly to extension agents or through others farmers. So, like this extension are established in region where implication of Industry 4.0 in agriculture sectors possible.

6. Benefits of industry 4.0 in Agriculture sectors:

Industrial 4.0 Technologies and IoT have the potential to transform agriculture in many aspects. Namely, there are five ways can improve agriculture:

- **Data, tons of data, collected by smart agriculture sensors:** data collected by sensor are analyzed and states weather conditions, soil quality, crop's growth progress or cattle health. This data can be used to track the plants and equipment efficiency.
- **Better control over the internal processes and, as a result, lower production risks**: This new technique help in planning for better product distribution depends on output prediction by data processing.
- **Cost management and waste reduction thanks to the increased control over production**: with continuous monitoring in industry 4.0 helps to reduce waste and cost management to be used for particular farm. This increases the yield of crop.

- **Increased business efficiency through process automation**: with the utilization of smart automized device in maximum activity in production cycle like irrigation, fertilizing, pest control increases business of farmer in form of greater yield.
- **Enhanced product quality and volumes**: controlling all the agriculture processes and maintaining high standard of grain quality, the productivity is increases.

7. Conclusion:

The overview indicates that societal consent respect to agriculture should not be industrialized. The utilization of fourth industrial revolution enlighten the agriculture sector as business opportunity where modernization of agricultural processes plays an important role in current market demand. The digitalization of private sector with public sector in the que with revolution of IT sectors helps to implement Industry 4.0 in our developing country. Almost in 2014 India started implementation of Industrial fourth revolutions. Different techniques in digital transforming plays an important role in Industry 4.0 in agriculture sectors which improve productivity. The working conditions of farmer is improving with the utilization of automation and Hi-tech technologies for agriculture sectors which reduce the environmental effects on the plant growth with farming operation. Finally, this paper review changes in agriculture sector recognized with agriculture 4.0 strategy under fourth industrial revolutions and challenges aimed at transformation with agriculture 4.0 needs to overcome for agricultural problems effectively. The extensions and organizations involvement with modern facilities is required to aware the farmers for accepting the new era of agriculture 4.0 easily at remote destinations.

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