

### ABSTRACT

In developing nations like India, despite of technological advancement we have been less attentive towards our agriculture. Present condition of agriculture is not so satisfactory to produce maximum crop yield because of lack of technology awareness among farmers. As the literacy rates of farmers those involved in agricultural field is significantly low, applying and working with new technology is a major concern. If farmers can embrace new technologies properly, agriculture sector can be a major sector for generating employment as well as increasing GDP in developing countries like India. As of 2012, this sector contributes about 18% of the total G.D.P. of India but around 50% people are involved in this. IoT will help us to increase the productivity of this huge % of people involved in this sector. Application of IoT ecosystem can bring renaissance in agricultural field. IoT will aid in predicting crop yield, crop price, soil temperature, real time data about air quality, water level and proper timing of crop to be delivered to market, which will help to increase productivity. Study says we will have 9.6 billion people on Earth by 2050 which will increase demand for food and IoT in agriculture should be an important driver to meet this requirement. Therefore we need to develop such system which will enhance farming procedure. Objective of this paper is to present an idea how IoT ecosystem can enhance the overall farming output as well as increase GDP.

**KEYWORDS:** Internet of Things, digital world, smart farming, precision agriculture Wireless sensor Network

### INTRODUCTION

With the increasing population in India, there will be a huge requirement of food in coming days. More than 70% of Indian population relies on agriculture for their livelihood [6]. Agriculture plays major role in the economy of the country as India ranks second worldwide in farm output. Agriculture and allied sectors like forestry and fisheries accounted for 13.7% of the GDP (Gross Domestic Product) in 2014, about 50% of the total workforce[3]. Fig.1 shows how food supply need to be increased with growing population.

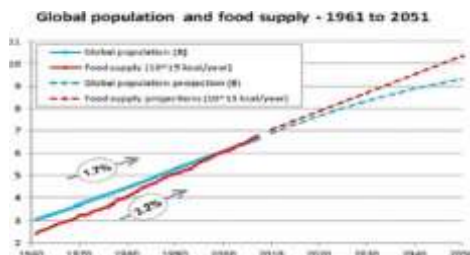


Fig.1 comparative study between population and food supply

In India agricultural growth is heavily dependent on the following factors.

1. Farming and crop technology
2. Cropping pattern
3. Environmental factors
4. Government policy
5. Market factors

Farmers need to perform a number of responsibilities while working in crop fields. Some repetitive tasks which are performed in the field, like seeding, weeding, fertilizing, and watering, may seemingly be mundane, and labor-intensive. But those tasks require precursory decision-making to be done prior to the actual activities in order to make farming cycle to be effective. Smart Agriculture helps to address many of those issues stated above by reducing wastage of crops, effective usage of fertilizer and thereby increase the crop yield. IoT based agriculture is running successfully in developed country but still at very budding stage in India. The major challenges we are facing the awareness of technical equipment among farmers. On top of that cost of implementation is also a big challenge in India. Therefore we should focus on developing more specific and effective sensors, should apply proper methodology to implement those. Smart farming does not target only large, conventional farming exploitation but boost family farming, organic farming also. It also helps in terms of environmental issues through efficient use of water. Fig2 shows country wise employment in agricultural field [23].

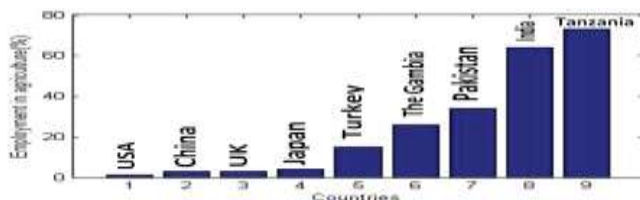


Fig.2.Comparitive study about countrywide employment

## WHAT IS IoT?

Internet of Things basically helps in automation. It helps to connect with physical object around us. Electronic device like microcontroller embedded within physical object behaves like a real object and starts communicating. According to study [1] number of things connected to internet will exceed no .of people on earth in near future. Cisco Internet Business Solution Group [7] analyses that total connected things will reach 50 billion in 2020. Basically fundamental goal of IoT is to connect everything around us and enable seamless communication between them with very minimum human intervention. It focuses connection anytime, anywhere with anything. Fig 3. shows a new dimension of IoT.



Fig.3. New dimension of IoT

## AGRICULTURAL ISSUE THAT IoT CAN ADDRESS

In this section several issues faced by farmers have been addressed [25].

**Climate Change:** It is the biggest issue of agriculture now days. In a conference in Lahore on “Climate smart Agriculture” experts from agriculture sectors found out that agriculture production will decrease 10-20% by 2050 because of climate change. Climate change affects directly all the factors related to agriculture. It directly impacts on quality and productivity of crops. Therefore a quick solution is required to address this issue .A recent report by Ericsson, in fact, claims that information and communication technologies (ICT) could help cut up to 63.5 Gt of GHG emissions by 2030[20].The Internet of Things can help decarbonizes our energy system, provide modern energy systems to every human being, manage our infrastructure, and allow us to adapt to and address climate change.

**Disease Detection and Diagnosis:** Due to lack of proper pesticide control mechanism many crop gets spoiled because of disease [26]. IoT enabled system can help in capturing images of plant leaves being investigated for diseases, then preprocessing those images, and transmitting the processed images to remote laboratories. The

image preprocessing step was necessary for saving transmission cost of sending diseased leaf images to plant pathologists in remote laboratories. Clustering algorithm helps to segment leaf images.

**Fertilizer Calculator:** Applying fertilizer is an important farming activity with a potential to greatly affect farm productivity. Decisions on which chemicals to apply and their crop-specific appropriate quantities need to be made by farmers.

**Soil Study:** Soil is another major component in farming which has a great impact on the success of agriculture. Farmers equipped with soil data receive an advantage in farming, including in precision agriculture.

**Water Study and Crop water estimation:** Water quality affects farming and agricultural output. Farmers need to make decisions on the amount of water their crops need. Crop water requirements depend on various conditions: crop types, season, climate, and growth stages of crops [17]. Crops lose water through transpiration, and canopy loses water through evaporation. A project in Scotland, iDee, developed a Smartphone application which encourage users to submit information of water conditions, i.e. water level, water clarity, obstruction in river, algae cover, temperature, nonnative plants in water, and accompanying photographs of the River Dee [15].

**Crop Produce Readiness Analysis:** If farmers are supplied with the information of crop price in advance, they can sell their crops in specific time to earn well. An innovative use of smart phone-based sensors is to determine ripeness of fruits. In [8,16], IoT based application, smart phone camera is utilized to capture pictures of fruits under white and UV-A light sources to determine ripeness levels for green fruits. Farmers could integrate the system into their farms by separate fruits of different ripeness levels into piles before sending them to markets.

## HOW SENSORS CAN HELP IN AGRICULTURE

Fundamental of IoT lies in sensors and actuators. Sensors will be playing important role to capture all data. The data from sensors are sent to web server database using wireless transmission. By employing IoT and cloud services, and through precision farming tactics, the efficiency and quality of agricultural production, storage and transportation can be tremendously improved. The sensor is interfaced with Arduino microcontroller and programmed. Once it is programmed, it is placed inside a box and kept in the farm. Following [24] are some functionalities of different type of sensors used for better farming.

- Soil moisture sensor helps to manage irrigation efficiently. This sensor with two probes is inserted into the soil. The probes are used to pass current through the soil. The moisture in soil has less resistance and hence passes more current through the soil whereas, the dry soil has high resistance and passes less current through the soil. The resistance value help detecting the soil moisture.
- The DHT11 is called as temperature and Humidity sensor. The total amount of water vapor in air is defined as a measure of humidity. When there is a change in temperature, relative humidity also changed. The temperature and humidity changes occur beforehand after irrigation. The amount of water droplets in air is increased after irrigation. This causes decrease in temperature which in turn increases the relative humidity of the surroundings. The temperature and humidity reading are often notified to the user so that the user can be able to know the field conditions from anywhere.
- Light sensor helps to detect light intensity of the environment. Light being a major source for crops responsible for photosynthesis. Light Dependent Resistor(LDR) is used in which the resistivity decreases with increase in light intensity and vice versa. Measurement of resistors is done by voltage divider circuit due to light intensity variations. Light intensity increases voltage level. The analog reading is taken from the board. It can be used in green houses where artificial lighting is done using any of the incandescent lamps, fluorescent lamps instead of sunlight.

## SMART AGRICULTURE USING IoT

IoT is not just a technology but an ecosystem of technologies or amalgamation of different sets of technology that can have a profound impact on our lives – personal, professional and social. With respect to agriculture, IoT devices provide precise information on a wide range of parameters that are required for enhancing farming methods and cultivation of fresh produce. These include environmental factors, growth conditions, soil, farming equipment [14], greenhouse production environment [15], water irrigation, pest and fertilizers [16]. WSN helps in real-time monitoring and management. The initiative Digital India taken by our current Prime Minister should reach rural people more. It is therefore, heart rendering that the government of India has recognized it and in some ways laid down the vision for the digital rural India through Smart Agriculture. ‘Financial Inclusion’ and ‘IoT for Agriculture’ can be the two pillars to kick-start the journey of rural India towards socio-economic equality. It is now upon the private sector and start-up communities to bring innovations that can help realize these dreams. There are many companies like Onfarm, Farmobile, CropX, Farmx and Farmlogs are working towards smart farming. IT major TCS has come with their pilot project where farmers from Uttar Pradesh and

Punjab are able to detect blight disease in potato season. Basically agriculture reforms can be depicted as a sum of three main domains [21].

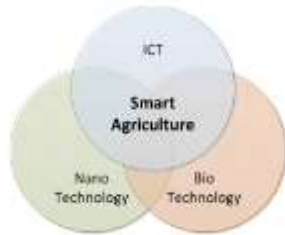


Fig.4 Three domains

### HOW SMARTPHONE CAN HELP IN SMART AGRICULTURE

Smartphone and IoT are complementary to each other. Therefore it has a huge role to play in smart agriculture. Now a days, because of cheaper smart phone available in market, farmers can easily have access to it. Moreover their computing power helps user to create a variety of practical applications. The android mobile application i.e android app helps to monitor and control the field from anywhere. The mobile application uses PHP script to fetch data from MySQL database [22]. All the data captured by sensors are stored in MySQL database. The android fetches the data and encode it in JSON format to display in android device. The user interface for the application is designed in a way that enables both the monitoring and control of field from the device. The internet connection should be provided to monitor and control the field. Inexpensive smart phones equipped with various sensors are opening new opportunities for rural farmers who previously had limited access to up-to-date agricultural information (e.g., market, weather, and crop disease news) and assistance from agricultural experts and government extension workers. On top of that farmers will be notified through smart phone in emergency condition arise at farms.

### CHALLENGES IN IMPLEMENTING IoT IN RURAL AREA

As agriculture sector runs in low margin, getting investments is quiet difficult. Although IoT related technology is growing, still there are some challenges in implementing IoT especially, in rural areas. Some barriers like wireless, broadband coverage are well known. Moreover there is something called “image problem”. People still believe agriculture belong to grandfather generation so many people don’t want to come in that sector. Another challenge can be the question “who will be the owner of those sensor controller data? Data on soil or water could be used by biotech giants. Access to real time info about harvesting helps corporation predict property value of farmers to get idea about market. However IoT should be brought closer to primary sector by integrating with complementary tools to generate more efficient product. Electronic media can help in this regard by advertising commercials and on air campaigns about new technologies. The information from one farm can be shared with other farm in order to get aggregated output.

### CONCLUSION

Although IoT in agriculture is in nascent stage in India still the way we are embracing technologies we can be hopeful. If farmers are provided with proper training about technologies, with a smart mobile in hand they can perform many of their agricultural tasks without even reaching there. Basically it helps farmers to stay connected with their farms from anyplace anytime. It also helps in reducing human effort with increased productivity and at the same time it boosts economy of farmers. Therefore with fully equipped software and Internet of Things, agriculture industry can provide a better vision for next generation and make India better in coming days.

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