Big Data: A tool for Agriculture as Industry 4.0

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A B S T R A C T

Keywords Big data, Agriculture, Industry 4.0, Smart Agriculture, Decision support system **Article Info** *Accepted:* 04 March 2020 *Available Online:* 10 April 2020	Big data is characterized into five dimensions called five Vs, volume, velocity, variety, veracity and value. The growth in big data is a recent phenomenon not only in area of information technology but also other sector. The agriculture sector is also experiencing the rise of Big Data which is fuelled development of multiple cheap and portable sensors. These sensors range from soil moisture, temperature and humidity sensors, RGB cameras to hyperspectral cameras. As much as collection of data is important so much is its analysis. It has shown its application in remote sensing, smart farming, Internet-of-Things (IoT), automation of supply chain and farm decision making. In this paper role big data in agriculture as an emerging tool for transforming agriculture as Industry 4.0 is reviewed, discussed and finally its challenges and limitations are listed.

Introduction

"Industry 4.0" refers to the concept of factories in which machines are augmented with wireless connectivity and sensors, connected to a system that can visualize the entire production line and make decisions on its own. There are many pillars of industry 4.0 like Big data, Data analysis, IoT's smart sensors, cyber-physical systems, 3D printing etc. With the development of cheap sensor and internet of things Big-data is becoming one of the most important components which help in gaining insights, knowledge and decision making of complex interconnected system automatically. It refers to large-scale data architectures and facilitates tools addressing new requirements in handling data volume, velocity, and variability. It is characterized by 5 V's Volume, Variety, Velocity, Veracity and Value (Kune *et al.,* 2016). Through the adoption of the Industry 4.0 matrix technology by the agricultural sector, the efficiency of production processes and the focusing on the new needs of the current consumer can be addressed (Corallo *et al.,* 2018).

Agriculture is the practice of cultivating plants and different crops in order to use products such as food, cloth, medicines and many other products for sustaining and improving human life. Among all these, cultivation of crops is the most important since they produce a wide variety of essential human consumables such as rice, wheat, sugar, etc. The demand for such products has linearly increased with the increase in global population. In time of intensive agriculture more inputs and market integration is involved which increases the risk with every unscientific management decision made in agriculture. Up until now common-sense based decision and recommended blanket application of inputs are rampant in farming system.

But with the advancement of big data collection as well as processing we are advancing toward a future of automatic algorithmic data driven decision making and smart farming. Faced with extreme climate changes and increased global population, we are having to quickly adapt farming practices and crop choice. The remedy to this is IoT,s of multiple sensors collecting big data and its automatic analysis, allowing farmers to gain insight into which crops they can grow; meanwhile, while the system keeping track crop cultivation behaviour (Tseng *et al.,* 2019).Big data is also providing thrust for transition from precision agriculture to Smart agriculture future (Rodríguez *et al.,* 2019). Novel upcoming multidisciplinary model for smart agriculture using Internet-of-Things (IoT), sensors, cloud-computing and mobile-computing are also driven by big-data (Channe *et al.,* 2015). Hence, in this paper, I have presented a discussion on the Big Data application in agriculture. I have listed out the works, analyse the workings of Big Data framework and highlight the drawbacks. My contribution basically lies in presenting clear cut information about high big data-based

solutions for agricultural productivity decision making and information processing.

Big data and its drivers in agriculture

Big Data is not just about size of data in tera bytes or peta bytes but it also includes others dimension as well. It comprises of variety of variable data collected from multiple sensors at high speed (Fig. 1a). We are going from structured data to unstructured (veracity), from batch to streaming (velocity) and from tera bytes to peta bytes (volume). This is scenario is same for agriculture as in case of industry. Agriculture farm units can derive benefits from this. Deriving value, information and knowledge discovery using it is accomplished Big-Data analysis.

Why talk about Big Data in agriculture now?
Big data has become a popular among agriculture research community recently because of the big data growth drivers. These driving factors include cheap and portable sensors, camera (RGB, multispectral, hyperspectral), drones, smart phones, cloud computing, internet connectivity and IOT's (Fig. 1b).

There has been rise of use of these technologies in food production and farm management and this trend it only rising. Government of many companies are making policies with digital and data driven based money as centre. India is moving towards digitization and doubling of farm income with these unconventional technologies. It is becoming popular all over the world as it provides competitive advantage, accurate decision making and precise input optimization.

Application of big data in agriculture

Agriculture production system is determined by a complex number of factors to account for

which we need heterogenous and large amount of dataset or in single term we can say we need - Big Data. There are number of applications in agriculture some of which are as follows-

•Crop Disease Identification Management
•Smarter Agricultural Practices
•Visualization of the environment, crop status
•Visualization of production and sales
•Optimum decisions in farming
•Commodity prices
•Crop recommendations
•Hybrids crop selection
•Pesticide recommendation
•Farming practices
•Profitability Analysis

Thus, Big Data can drive the task of monitoring, forecasting, decision making automatically in various aspect of agriculture from crop cultivation to marketing.

Crop diseases identification

Recently Plantix application installed on end user (farmers) smart devices are proving much useful to detect crop diseases and nutrient deficiencies in filed. This is possible with the leveraging of cheap imaging sensor on phones matched with Big data in cloud of occurrences of similar diseases. Also, the crowd sourced data from the farmers is used to accurately predict epidemiology of crop diseases like- blast of rice, nitrogen deficiency *etc*.

Smart agricultural practices

There is shift from precision agriculture to Smart Agriculture. The term Smart Agriculture means the data driven agriculture in which the emphasis is on addressing the velocity and veracity component of Big Data. New technologies such as a Big Data, IoT and Cloud Computing (after 2000), have been able to increase collaboration quickly, because the data is in cloud database systems

that can be shared and this real-time data that help to accelerate decisions making. The idea of connected farm that appears in Smart Farming, is the fundamental vision of collaborative systems in agriculture.

Crop selection

Applying Big Data for Intelligent Agriculture-Based Crop Selection Analysis is very suitable in scenario when climate change hitting farmers hard (Fig.).

Denoising, cleaning and intelligent processing of Big Data from heterogeneous sensors can yield information about farm environment automatically. This when combined with available knowledge of crop can help in decision making quickly in changing climatic scenario while taking into account the spatial and temporal heterogeneity. The effectiveness of this method is already proved in a study performed in Taiwan farm where cereal crop was unsuitable for this area due to high temperature but spinach was suitable.

Big data driven multidisciplinary models

The multidisciplinary model is very modular. These modules address different problems & function and are- SensorKit Module, MobileApp Module, AgroCloud Module, Big-Data Mining, Analysis and Knowledge Building Engine Module, Government & AgroBanks UI

SensorKit module is an important part of this architecture and is responsible for soil sampling at periodic intervals to get soil property values. MobileApp Module consists of mobile applications need to be installed on the end users' mobile phone.

End Users can be farmers or marketing agencies or procuring agencies which can get cultivation information, input cost and demand etc. Big data layer will act as

repository and will also help in query, analysis and forecast. Government and bank can send notification to end user about different ongoing schemes.

Figure.1 a) Big-data different dimensions; b) Big-data growth driving factors in agriculture includes multiple hyperspectral satellites, drones, automatic weather stations, cheap CCD camera sensors, IoT's, big database, cloud computing and smart end user devices
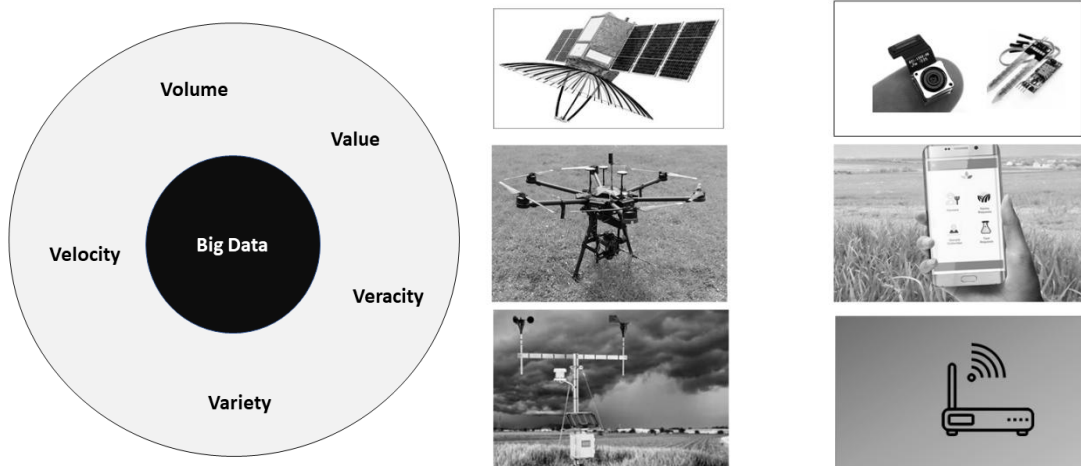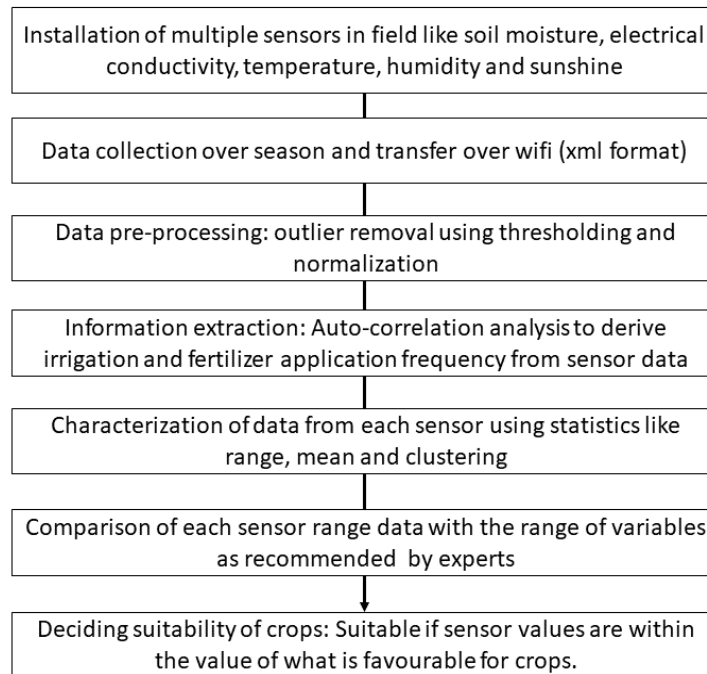

Figure.2 Flowchart showing crop selection technique using Big Data, collected by multiple sensors

Challenges with big data

Setting of such complex sensor network as well as maintain it is a challenge in itself. High initial cost of investment will be excluded small and marginal farmers if proper government support will not be made available. Also, for every problem big data is

not a solution as in case of factors which are fairly explained by variability of only few variables. Data is over network so it has potential security risks associated with it. Sensors are subjected to degradation over time in harsh farm environment unlike indoor factory settings. Level of expertise and integration of interdisciplinary knowledge required to develop such cyber-physical system based on big data requires high technical skill. So, we can conclude that challenges are big but with that said we know where lies challenges are where lies opportunities. So, more research in needed in this respect.

In conclusion, the transfer of the Industry 4.0 paradigm to the agri-food Industry will result in a consequent and natural transfer of benefits to this industry. The use of digital technologies will allow to act concretely on the factors of production, catalyzing the innovation process already introduced by the precision agriculture paradigm.

It will provide impetus to Digital agriculture characterized by data driven decisions and optimization of inputs like fertilizers, pesticide *etc*. Farmers in developing country will benefits from information derived from big data, giving them competitive edge as well as reducing risk. The opportunities of collaboration community and government level Cooperative farms are rising due to virtualization of big data in cloud. Automation, optimized resource utilization, farm management, better accessible advisory and recommendation services (data driven daily decisions and strategic decisions), risk analysis, price monitoring and supply chain in agriculture is only possible with the power of Big Data.

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