Big Data Meets Small Sensors in Precision Agriculture

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ABSTRACT
In India, majority of rural residents are dependent on agriculture for their livelihood. But, the current agricultural practices are not prudentially viable neither environmentally supportable and the yields of many agricultural products in India are critically low. In the near future, it will become essential for the country to build a high yielding, competitive, and varied agricultural sector and expedite rural, non-farm entrepreneurship and employment. This paper identifies the corollaries of traditional farming practices and addresses how to increase the yield of the agricultural commodities by using present day computer technologies. Further, it also acknowledges the critical computing and diagnostic ability of Big Data in processing huge volumes of transactional data in real time situations. The objective of this paper is to present the amendments in the agricultural sector and encourages the discussions on how government can foster innovations in the big data analytics to improve the rural agricultural system.

General Terms
Electronic sensors, Big data, agriculture.

Keywords
Big Data Analytics, Rural agricultural systems, Precision Agriculture, Electronic farm records.

1. INTRODUCTION
India is an indomitable country with more than billion plus people, and also one of the world's rapidly flourishing economies. Out of the huge population, 58.4% are ingenuous agricultural assemblage. India's recent accomplishments in crop yields while being impressive, are still just 30% to 60% of the best crop yields achievable in the farms of developed as well as other developing countries [1].

Today, India ranks second worldwide in farm output. Agriculture and allied sectors accounted for 13% of the total GDP in 2014; about 50% of the total workforce .Agriculture is topographically the broadest economic sector and plays a symbolic role in the comprehensive socio-economic domicile of India. But, the existent report asserts that the agriculture sector continue to trail for India. [1]The economic augmentation of agriculture to India's GDP is indirectly declining with the country's economic growth.

Precision agriculture (PA) is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. Crop variability typically has both a spatial and temporal component which makes statistical/computational treatments quite involved. [1]
Some agriculture experts have perceived the demand for sensor data incorporation in agricultural system and actualize how to overcome the realistic propositions involving the government and its policies. The data analysts or the data examiner, agricultural professionals and others using this technology lay forward how to bring about better culmination at lower costs.

The rampant evolution of data over the past decade has initiated a unique realm in the domain of information technology and data science called Big Data. This ingenious technology is acquiring intensifying consideration as an idea to upgrade the performance of agricultural systems by combining different systems via a data and communications platform to diminish redundant crop failures, enhance and hasten agricultural governing, and permit passage to all stratum of agricultural services for a wide range of circumstances. It gathers all viable crop information generated through electronic smart devices (like moisture sensors, electromagnetic sensors, and optical sensors) for a detailed area. These smart devices will generate prodigious amounts of data, impelled by record keeping, compliance and regulatory requirements, which are considered as big data.

As per the above discussions, the e-Agriculture service data can be considered as a Big Data because of its variety of data with huge volumes flowing with high velocity. Some of the solutions to the e-Agriculture service big data include the predominant current technologies like HDFS, Map Reduce, Hadoop, STORM etc.

The following are the key points that make the performance of agricultural systems better and increase productivity:
1. Measure, store and analyze the data to improve yield quality.
2. Manage revenue costs by reducing crop failure's probability.
3. Improve preventive care and increase producer-consumer satisfaction
Adoption of big data in agriculture significantly decreases the possibility of crop failure and farmer's primary concerns and recommends the soil sensing and crop yield information to be stored in data centers.

This paper is organized as follows: in section II, we describe the existing agricultural system in India, section III discusses about big data in general, section IV focuses on the problems in the existing agricultural system, section V presents the implementation of the big data analytics in agricultural system and section VI concludes the work.

2. EXISTING AGRICULTURAL SYSTEM IN RURAL INDIA
Farming Systems in India is adapted judiciously, according to their most suited locations. That is crops are grown

according to the farm or the soil conditions present over a particular area or the land. The regions in India vary in accordance with the types of farming they use; some are based on horticulture, agro forestry, and many more. India's geographical site, cause different parts to experience distinct climates, which affects every region's agricultural productivity distinctly. India holds the second position in agricultural production in the world at the present day. In 2007, agriculture and other industry made up more than 16% of India's GDP. Despite the steady decline in agriculture's contribution to the country's GDP, India agriculture is the biggest industry in the country and plays a key role in the socioeconomic growth of the country. It is also the second biggest harvester of vegetables and fruit, representing 8.6% and 10.9% of overall production, respectively. India also has the biggest number of livestock in the world, holding 281 million [1].

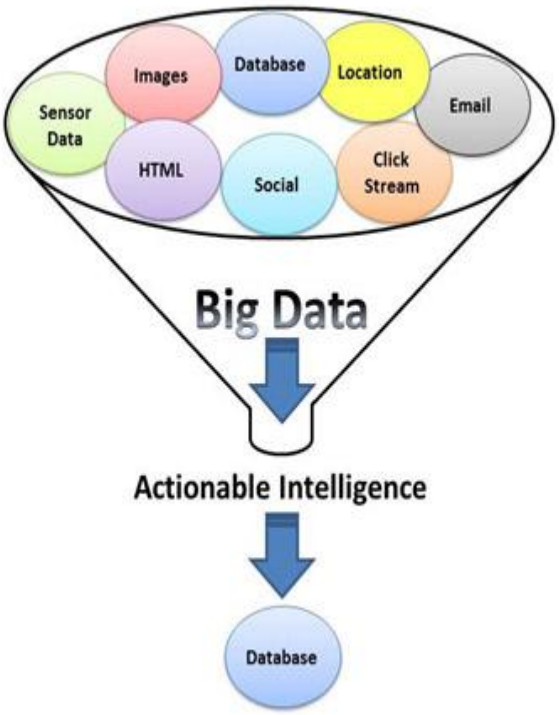
About one-sixth of the land area undergoes serious crop yielding issues such as erosion, water logging, aridity, acidity, salinity, and alkalinity. Approximately, soil conservation measures are required for as large as 80 mega hectare of cultivated area. After the irrigation practices were introduced, within a few years, the problems of salinity and water logging had aroused. Apparently 7 Mega hectare of land are affected by alkalinity and salinity.[1] According to the soil conditions of the particular farm area the crops to be cultivated are decided based on the moisture content, humidity, degree of nutrients present etc.So it is very important to keep records of all the soil quality properties (for which the big data can be used).

3. BIG DATA IN GENERAL

3.1 Definition

Big data is an evolving term that describes any voluminous amount of structured, semi-structured and unstructured data that has the potential to be mined for information [3]. Big data is a set of techniques and technologies that require new forms of integration to uncover large hidden values from large datasets that are diverse, complex, and of a massive scale [2].

The processing of such data using common database management tools or conventional data processing applications is a very strenuous task. Everything around us is contributing to the generation of Big data at every time instance. Every social media exchanges as well as digital processes involving systems, sensors, mobile devices and every other digital device present are transmitting it. To extract meaningful value from big data, you need optimal processing power, analytics capabilities and skills. Big data is creating a new culture in which business and IT leaders must join forces to realize value from all data. But for the proper understanding of this continuously growing data we need a new fundamental approach to architecture, tools as well as practices.



The vast Indian agricultural system is ought to harness agriculture's "big data" by interpreting a complex set of data, including electronic farm records and sensor data. This enables agriculturists to access and analyze agriculture's big data to ascertain quality, determine best practice, assess treatment strategies and identify crops at risk.

3.2 Characteristics of Big Data

In addition to the exponential growth of data the changing user behavior and globalization is also responsible for directing Big Data. Thus, many organizations are seeking for analyzing such models to enhance their functioning.

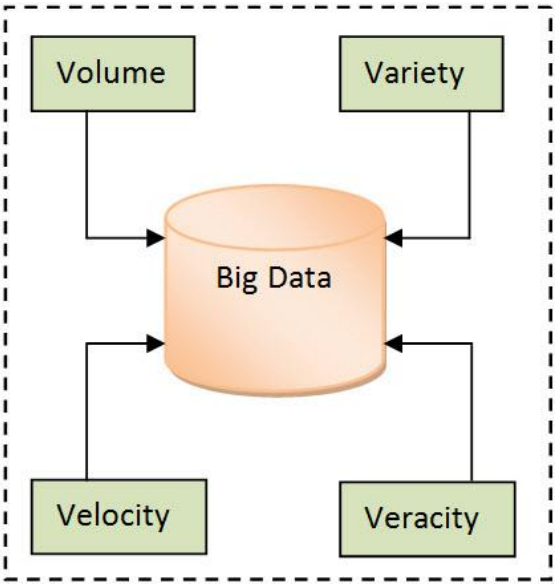
The typical characteristics of the big data are:

Volume: The quantity of data generated as Big Data ranges from Terabytes to Exabytes and Zettabytes of data. The volume has been increasing exponentially: up to 2.5 Exabyte of data is already generated and stored every day. This is expected to double by the end of 2015[4].

Velocity: Big data is growing rapidly, generating a bizarre of quantities needed to be stored, transmitted, and processed quickly. It refers to the speed of generation of data or how fast the data is generated and processed to meet the demands and the challenges which lie ahead in the path of growth and development [2].

Variety: This refers to the inconsistency which can be shown by the data at times. In Big data, the variety and heterogeneity of data sources and storage has increased, fuelled by the use of cloud, web & online computing [4].

Veracity: Big Data Veracity refers to the biases, noise and abnormality in data. Accuracy of analysis depends on the veracity of the source data. In comparison to Big Data's volume and velocity, veracity is the most challenging characteristic in data analysis.



4. PROBLEMS EXISTING IN PRESENT AGRICULTURAL SYSTEM IN INDIA

Over 68% of India's total population resides at the rural area, and about three-fourth of the residents of rural areas are dependent on agriculture for their livelihood.[1]

Mr. Gopal Naik, a professor in the area of economics and social sciences and Chairperson for the Center for Public Policy at Indian Institute of Management, Bangalore, in one of his interview has pointed out some critical issues. Currently, the issues that afflict the Indian agriculture are the deficiency of proper knowledge and infrastructure in the rural areas. Problems related to irrigation, market infrastructure and transport infrastructure add significant cost to farmers' operations. Another issue is lack of delivery mechanisms. There are a number of schemes aimed towards developing agriculture. We don't have effective delivery mechanisms that can translate those into effective facilitation at the ground level, in terms of increasing productivity or decreasing cost or increasing price realization. Inadequate government support exacerbates these issues.

Government failure is a major concern in agriculture because the high risks involved make help and facilitation necessary. Like any other business enterprise, agriculture is subjected to high risks because of the volatile nature of the factors involved. For instance, weather is often a problem - you have droughts in one year and heavy rains in the next. In both cases, farmers lose out; hence they have to look for a normal period to make money. Government, therefore, has to play a major role in providing support to farmers. This is true all over the world and there is hardly any country where government intervention is not present. There may of course be variations in the extent of intervention; but if you check the situation in most countries or regions, including developed ones like the US, Canada and the European Union, you see substantial intervention by the government. Thus government facilitation is essential for sound agricultural development. [1]

5. IMPLEMENTATION OF BIG DATA ANALYTICS IN AGRICULTURAL SYSTEMS

We have entered into the age of big data. Big data provides a ground for collecting, storing and analyzing data to unveil the information not previously known. By wisely using the ever-increasing amount of data available, we could develop new vision by reconsideration of the data or merging it with other available information. In agriculture this means not just mining crop records, precipitation maps, diagnostic reports etc., for insights, diagnoses and decision support device, but also continuous analysis of the data streams(fully fledged records) produced for and by the specified area at every time instant.

The objective of this paper is to provide high quality Farming techniques and also aims to ensure increased productivity of the crops to rural people and overcome the problems in the agricultural systems like use of harmful pesticides, excessive use of fertilizers, providing proper irrigation facilities and fraud management in the agricultural system. The proposed concept enables agriculturists, big-data analysts and staff to have role-based access to information on electronic farm records.

In detail, the Big data in agriculture refers to the Electronic Farm Records (EFR) which includes soil temperatures maps and data, precipitation maps and data, electrical conductivity maps and data, moisture content data, air permeability maps and data, nutrient contents and pH level data, past cultivation records, insurance and yield related information and social media posts including tweets, blogs, new feeds and articles in agriculture journal. The job of the big data scientist is to mine the big data and discover the associations, understand patterns and trends to improve the agricultural systems, increase crop productivity and lower costs involved by proper diagnosing the various factors.

Most of the analytics of the agricultural data are executed by yearly data recreation in relational databases that produce pre-processed reports. The analysis of the data is ought to be done on the spot. Also, data vivification needs to be done in real-time not once in a month or in a year.

A variety of sensors can be used to control variable rate application equipment in real-time or in conjunction with a Global Positioning System (GPS) to generate field maps of particular soil properties. To offer better services to the people, the agricultural system needs to evolve and innovate continuously.

The information acquired by the big data analysis can be comprehensively used for precision agriculture. Some of them are listed as:

- The data absorbed from the various systems (or sensors) can be evaluated in real-time for signalling the vital values that play an important role in production decision-making.
- The geographical maps thus generated are of very high resolution identifying the variation of soil moisture. It would direct to the decisive use of irrigation.
- The rigorous targeting of controls will also be made possible with the help of intricate images of pest damage in the field.

These applications of big data can be tested, polished and enhanced rapidly and economically and will entirely change delivery and research in the agricultural sector. Though, the big data analytics in agriculture plays a crucial role to provide better agricultural services, it provide analysis on the historical data to uncover hidden information. The big data analytics has challenges like heterogeneity and incompleteness of data, scale, timeliness, privacy and human collaboration [7].The future research is all about to get through

the obstacles and use big data analytics in agriculture for unveiling the proficiency from the raw unstructured data.

6. CONCLUSION

The evolution of big data analytics in the agricultural sector, is leading to the insight of new improving outcomes from these large data sets. Now, the soil and crop sensing has transformed the agricultural system to become much more efficient, less expensive and achieve better quality than before. Meanwhile, many startups are developing both terrestrial and satellite-based sensors which are speeding up the transition to 'connected' agriculture.[8] The spread of smart sensors with the effective analysis of big data will lead us a step forward towards freeing farmers from the constraints of uncertain weather. The use and adoption of Big Data, within governmental processes, is beneficial and allows efficiencies in terms of cost, productivity and innovation. But this data analysis often requires multiple parts of government (central and local) to work in collaboration and create new and innovative processes to deliver the desired outcome [2]. Through the implementation of this paper using Hadoop HDFS and Map Reduce we could uncover the information lying in the big agriculture data sets.

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8. REFERENCES

[1] http://en.wikipedia.org/wiki/Agriculture_in_India

[2] http://en.wikipedia.org/wiki/Big_data

[3] http://www.ibm.com/big-data/us/en/

[4] Tekiner, F.; Keane, J.A., "Big Data Framework," Systems, Man, and Cybernetics (SMC), 2013 IEEE International Conference on , vol., no., pp.1494, 1499, 13-16 Oct. 2013

[5] http://www.pinaldave.com/bimg/bigdataimage.jpg

[6] http://www.scaledb.com/wp-content/uploads/2014/05/big_data.jpg

[7] Venkatareddy Konasani, Mukul Biswas and Praveen Krishnan Koleth, "Fraud Management using Big Data Analytics", A Whitepaper by Trendwise Analytics.

[8] http://www.atelier.net/en/trends/articles/farmers-starting-capitalize-big-data-technology_424444