Big Data In The Bigger World Of Agriculture Today

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Recent decades have witnessed a dramatic growth in technological advancements, particularly since the rise of the Internet and its applications in everyday life. If we stop and look around, one could observe that technology has touched every aspect of human life, be it education, communication, food, health or lifestyle. Technology, in its diverse forms and shapes, is enabling humans to achieve more with less, and has provided an even bigger platform to innovate. This rapid explosion of technology has also resulted in a surge in big data around us.

Big data is described as both structured and unstructured data that is too "big" to be processed by traditional data processing systems. The "big" part of this term is characterized by the magnitude of its 5 Vs, which are volume, velocity, variety, veracity and value. With the steady increase in the use of the Internet of Things and mobile technology, copious volumes of data is being produced each day using these devices. A recent report by International Data Corporation (IDC) (1) forecasts that by the year 2025, nearly 41.6 billion connected IoT devices will be generating 79.4 zettabytes (ZB) of data. The pictures we take using the latest smartphone cameras, our dietary patterns that we record using health and fitness apps, our browser history in web applications, our commands to home automation and smart devices, each of our social media activity, and videos captured by surveillance units all form only a minuscule part of the projected 79 ZB of digital information that is analyzed extensively to deliver business intelligence the world over.

Big Data In The Era Of Agriculture 4.0

The Fourth Agricultural Revolution is characterized by digitisation of farms worldwide and the consequent data-driven farming as a result of increased use of modern technologies such as farm monitoring and management gadgets, soil sensors, remote sensing. The innovative application of technological tools has enabled the collection and processing of invaluable ground agri-data, allowing various stakeholders in the agri-ecosystem to arrive at highly informed decisions. This combination of technology and big data analysis has further facilitated farmers to monitor crop in real-time and achieve higher efficiency and profitability in farm and business operations with as minimum input as possible, thereby maximizing crop performance.

Although many were apprehensive of infusing technology with agriculture, the benefits and the effects of the agri-tech have clearly outweighed the uncertainty. Data analytics has marked the path for increased efficiency, strengthened productivity and better sustainability of resources. Today, the agriculture sector is in the spotlight for multi-million dollar investments by governments, development agencies and private entities, to uplift the farming community and advance agricultural production. Recent industry figures indicate that there has been an increase of over 40% in the amount of global investment in agri-food technology in 2018. (2) Considering agriculture was one of the last sectors to adopt technology, the applications of big data here are large and plentiful. Some of the widely-used ones are as follows:

Precision Farming: IoT sensors empower farmers to monitor their crops minutely and analyse how the soil, climate, water and other inputs affect its growth. These sensors reduce the amount of muddy feet required on field, and serve as eyes at a ground-level and provide farmers with vital crop intelligence that could make a significant difference to the yield and its nutritional value. GPS-enabled drones and farm machinery assess crops for areas that need attention (3) and facilitate automated application of agrochemicals exactly and only where required, thereby ensuring optimal use of agri-inputs.

Yield Prediction: Capturing plot-level pre-harvest farm data, including those of crop stresses such as changes in weather conditions, pests and diseases at different points of the crop cycle allows farmers and agribusiness to predict the yield in real-time and plan post-harvest operations accordingly to ensure minimum wastage. Furthermore, other players in the agri value chain can use this data to make calculated decisions for their business operations.

Risk Mitigation: Agribusinesses and lending institutions in particular are now able to combine remote sensing with big data analytics from a farm level to forecast the plot's performance or the chances of a crop failure in order to mitigate risks and make well-informed business or lending decisions. (4) Pre-configured rule-based alerts can enable farmers to reduce the impact of or, to an extent, even prevent crop losses due to pest attacks or crop diseases by anticipating and preparing in advance. This capability is of critical importance today in light of the negative impact of climate change on agriculture.

Loss Reduction: Big data analytics allow farmers and key players in the supply chain to track the produce and ensure efficient and quick movement along the chain to prevent losses due to spoilage. The potent use of artificial intelligence in combination with remote sensing can be witnessed in large farms, where drones are optimized to spot problem areas, or identify crop ripeness for a perfect harvest. In addition, predictive models constructed on farm data can provide the right solutions for efficient food distribution and cut down food wastage.

Supply Chain Management: Multi-stakeholder platforms today have the unique potential to bring together different players in the agri-ecosystem such as food processors, retailers and distributors for a highly-collaborative functioning. This reduces dependency on individual agents, and instead promotes a more transparent and productive operations. Moreover, import/export regulations are now better monitored thanks to digital records of farm operations that indicate crop quality and nutrition value.

Farm-to-Fork Traceability: With increased awareness among consumers and their demand to know the source of their food, (5) more and more agribusiness and food brands are ensuring traceability of their products. Capturing data right from sowing to distribution allows brands to go back and track the movement of the produce or the product and identify issues if any, and it also allows concerned consumers to rest assured that the product has been ethically and sustainably sourced.
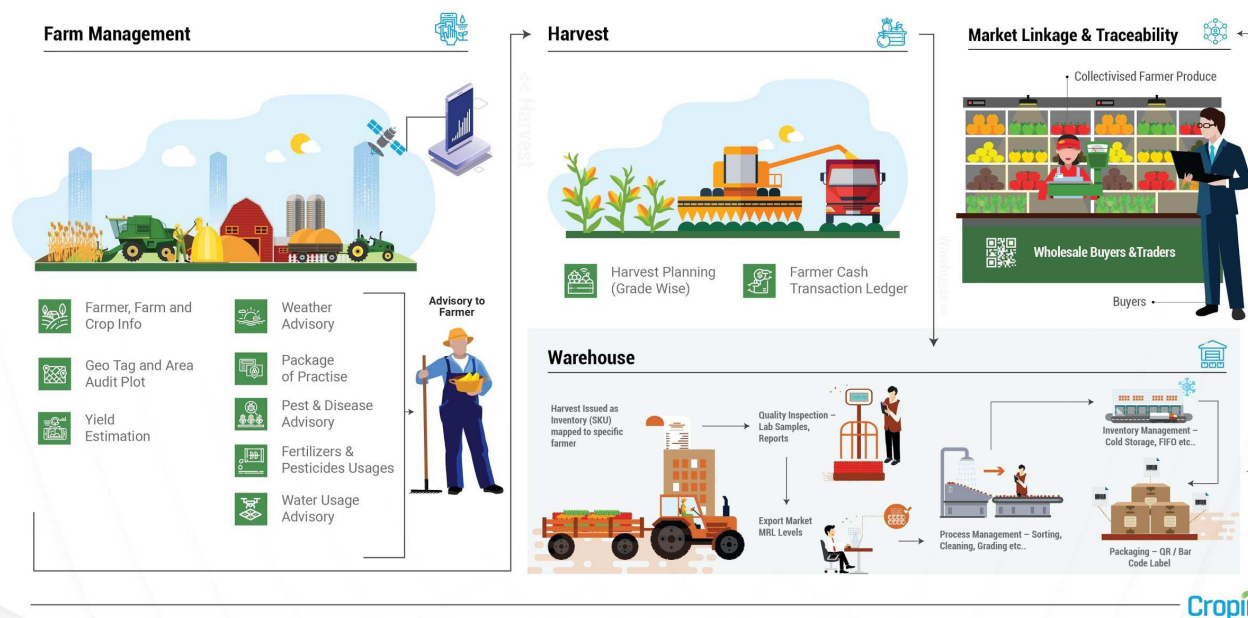
Sustainable Farming: Leading-edge technologies such as drones, remote sensors, Internet of Things, and artificial intelligence consume big data in its various forms intelligence that is progressively improving sustainability in agriculture. In a world of growing population and diminishing resources, these technologies are ensuring optimum use of land, water

and other resources to provide for global demands without taking away too much from future generations. They also provide practical and scalable solutions that aid in conserving natural resources, which in turn sustains agriculture.

Impact

The effect of big data in agriculture is far-reaching and we are only in the nascent stages of exploring its applications in agriculture. Big data has proven to be fruitful in developed nations where adoption of technology is already at an all-time high, and it also has much to offer to rural and smallholder farmers, who have just begun their foray into smart farming. Big data coupled with other modern technologies have streamlined agriculture into a sector that is highly capable of providing much more even with the current limitations to farming.

Big data analytics provides the agri-ecosystem with in-depth insights that educate farmers about their crop and soil, and help them understand their unique relationship with the ecosystem. This knowledge facilitates them to make significant changes in the way they farm, to produce crops that are healthier, bountiful and more nutritious. The analysis of decades and centuries worth of data has allowed researchers, scientists and agronomists to forecast crop stresses and recommend practical solutions to prevent excessive crop loss. Furthermore, farmers are now able to sow and harvest their crops at a time that is favourable for a generous harvest.

Diverse applications of agri-food technology are now able to analyse records from the past and the present to advise farmers and agribusiness on the precise quantity of produce that needs to be cultivated to match consumer demands. Farmers can thus reduce food waste by producing only what is required, thereby saving time, money and resources. Technological innovations in the supply chain can further reduce food losses estimated to be worth $1.5 trillion by 2050, (6) by enhancing and optimizing processes involved in logistics, storage, and distribution.

In research stations and laboratories, the data collected from the farm during the length of the cultivation cycle is also being used to develop seed varieties that are climate-resilient, high-yielding and require minimum inputs. On the fields, agri-tech solutions are monitoring farms day and night each day with minimum human intervention. Satellite monitoring, sensors, drones, and other unmanned agricultural systems thus reduce the dependence on physical manpower on one hand, and improve accuracy and productivity on the other.

If there is one sector that affects every individual on the planet, it has to be agriculture. Big data thus has a profound impact on the lives and lifestyles of people across demographics. In such manner, data captured from farm to fork plays a critical role in realizing the Sustainable Development Goals as defined in the 2030 Agenda for Sustainable Development. Enhancing agricultural productivity results in food security (7) for all and improved livelihood for the farmers. Developing nations that can produce more can also provide better facilities to the marginalized farming communities, thus raising their standard of living. An increased yield with existing resources also helps to safeguard the ecosystem by ruling out the need for more land by clearing forests, which further aids our battle against climate change.

Modern technologies time and again have proved their ability to adapt to the needs of different sectors regardless of how traditional they are. Agri-tech, still in its nascent stages, is expanding its reach to leverage the abundance of big data in the agri-ecosystem to provide unique solutions for diverse global problems, and ensure quality food, feed and fibre for all.

CropIn Technology's (8) platform consumes agri big data from remote sensing technologies and ground data to power its AI/ML models, thus enabling an interconnected network of all stakeholders in the agriculture ecosystem to analyze and interpret data and derive real-time actionable insights on standing crop. Businesses use CropIn's agri-tech solutions to effectively drive their initiatives around Digitization, Compliance, Sustainability, Predictability and Traceability. The AI-driven insights generated in CropIn's platform through satellite imagery, ground sensors, and weather data not only provide food growers with a better understanding of the land under cultivation, it also helps in improving our understanding of cultivable land for the future. The historical and real-time data present a wealth of information that can help governments and developmental agencies make meaningful, forward-looking policy decisions.

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About the author

Kunal Prasad is the co-founder and COO at CropIn Technology. He has over 13 years of experience in technical and management arena with substantial work in sales and business development, project management, product and customer experience. Kunal's strengths lie in his strong team management skills and his tenacious attitude that has helped CropIn reach out to over 2.1 million farmers in 46 countries. He is passionate about working on improving farm productivity, climate resilience, sustainability and food security. He has extensive experience in working with government bodies, development aid agencies, co-operatives and farmer groups globally. He believes that farming should be data-driven and collaborative, and so he is on a mission to digitize 20 million farmers by 2022.

Related Readings

Big Data in Smart Farming – A review: Smart Farming is a development that emphasizes the use of information and communication technology in the cyber-physical farm management cycle. New technologies such as the Internet of Things and Cloud Computing are expected to leverage this development and introduce more robots and artificial intelligence in farming. This is encompassed by the phenomenon of Big Data, massive volumes of data with a wide variety that can be captured, analysed and used for decision-making. This review aims to gain insight into the state-of-the-art of Big Data applications in Smart Farming and identify the related socio-economic challenges to be addressed. Following a structured approach, a conceptual framework for analysis was developed that can also be used for future studies on this topic. The review shows that the scope of Big Data applications in Smart Farming goes beyond primary production; it is influencing the entire food supply chain. Big data are being used to provide predictive insights in farming operations, drive real-time operational decisions, and redesign business processes for game-changing business models. Several authors therefore suggest that Big Data will cause major shifts in roles and power relations among different players in current food supply chain networks. The landscape of stakeholders exhibits an interesting game between powerful tech companies, venture capitalists and often small start-ups and new entrants. At the same time there are several public institutions that publish open data, under the condition that the privacy of persons must be guaranteed. The future of Smart Farming may unravel in a continuum of two extreme scenarios: 1) closed, proprietary systems in which the farmer is part of a highly integrated food supply chain or 2) open, collaborative systems in which the farmer and every other stakeholder in the chain network is flexible in choosing business partners as well for the technology as for the food production side. The further development of data and application infrastructures (platforms and standards) and their institutional embedment will play a crucial role in the battle between these scenarios. From a socio-economic perspective, the authors propose to give research priority to organizational issues concerning governance issues and suitable business models for data sharing in different supply chain scenarios. Full Review Paper at http://bit.ly/2ktoVAp

Data Science in the Indian Agriculture Industry: Agriculture is the backbone of the Indian economy, but the industry currently needs more support than any other. India is a country of over a billion people in population, out of which, over 70% of the population lives in the rural areas. With 40% of the country's workforce, agriculture is a major industry and an influencer of the Indian economy. Despite this, its contribution to the $2.3 trillion economy is just a meager 16% of the entire GDP. Agriculture in India lacks institutional attention, support from banks in terms of loans and farmer welfare schemes, and suffer from a myriad of disasters like depleting groundwater levels in rural areas, climate change, unpredictable monsoon or lack of it, droughts, floods, unfair price fixing policies of produce, migration of farmers towards the cities in search of better paying jobs, and more. Agriculture is one sector responsible for feeding every individual, but the people involved in it are the last to be taken care of. After failing institutions, time has indeed come for technology to take over the change. With newer problems cropping up every day in the most inevitable indigenous sectors, it is high time we resort to emerging technologies for solutions. Full Post at http://bit.ly/2m15EGS

Big Data and Climate Smart Agriculture - Status and Implications for Agricultural Research and Innovation in India: Climate change will increase the vulnerability of agricultural production systems, unless scientists and farmers reorient their present approaches toward making them climate smart or climate resilient. The integration of recent developments in big data analytics and climate change science with agriculture can greatly accelerate agricultural research and innovation for climate smart agriculture (CSA). CSA refers to an integrated set of technologies and practices that simultaneously improve farm productivity and incomes, increase adaptive capacity to climate change effects, and reduce green house gas emissions from farming. It is a multi-stage, multi-objective, data-driven, and knowledge based approach to agriculture, with the farm as the most fundamental unit for both strategic and tactical decisions. This paper explores how big data analytics can accelerate research and innovation for CSA. Three levels at which big data can enhance farmer field level insights and actionable knowledge for the practice of CSA are identified: (i) developing a predictive capability to factor climate change effects to scales relevant to farming practice, (ii) speeding up plant breeding for higher productivity and climate resilience, and (iii) delivery of customized and prescriptive real-time farm knowledge for higher productivity, climate change adaptation and mitigation. The state-of-art on big data based approaches at each of the three levels is assessed. The paper also identifies the research and institutional challenges, and the way forward for leveraging big data in research and innovation aimed at climate smart agriculture in India. Full paper at http://bit.ly/2m1iHbi