Role Of Big Data On Digital Farming

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Abstract— This study aims to explore the potential of big data technologies for ensuring digital farming. A systematic literature method has been conducted to explore the current practices as well as aspects that can help farmer at field level for increasing production. This study reveals several technologies and practices in agriculture that are based on big data for taking right decision at right time in right way at the field level. The study reveals that use of agricultural big data technologies are still a low level and needs more investment for infrastructure establishment, related expertise, technological knowledge of farmers, attitude of adoption of technologies and awareness about the benefits of big data technologies. It also explores that application of big data technologies can help farmer to weather forecasting, crop selection, irrigation management, crop diseases and pest management, crop yield prediction, agricultural marketing, and agricultural policy decision. But farmer needs help from an expert team to implement the facilities at field level. The study argues that a commercial implementation of big data technologies requires government initiatives, private sector's involvement and a public-private partnership to supply related facilities to farmers in time.

Index Terms— Smart farming, precision agriculture, digital agriculture, sustainable agriculture, smart agriculture, digital farm, agricultural development.

1 INTRODUCTION

Big data is considered as a potential technology for assessment of farm-level decisions, policy decisions, and market-distorting actions for increasing the productivity in agriculture properly. Digital farming is a means of sustainable growth of crop, fisheries and livestock by using modern technology [1]. Modern technology provides an opportunity to transform the traditional agriculture to modern agriculture [2]. The transformation from traditional agriculture to digital agriculture requires a huge amount of data from almost all stages of crop production, fisheries and livestock production [3]. As a holistic approach, digital agriculture uses the knowledge of information science, environmental science, computer and software engineering, system science, GIS (Geographical Information System), GPS (Global Positing System), remote sensing technology, and virtual satellite imaging for better integration with soil, climate, environment with agriculture [4]. Now the world population is more than 7 billion which will be around 9.6 billion by 2050 [5]. The income level of the people to buy enough food i.e. the middle-income people will be 5 billion by 2030. But rest 4.5 billion people may suffer from food insecurity. For feeding these people, the agricultural production should be doubled within a short period of time [6]. It is a major challenge for humanity. The only way to increase the targeted food production by using modern sophisticated technology in every step of agricultural production i.e. using big data in agriculture [7]. Farmers usually take decision based on their experience on consulting with other experienced farmers or from technical expert. But this decision-making process is not accurate and scientific be causing of rapidly changing weather and climate condition. Due to technological develop, it is a great opportunity for farmer to transform traditional farming system to smart farming. It is only possible to adopt ICT enable decision support system [8]. Big data driven agriculture provides opportunity to transform traditional decision making to data-based decision making [9]. Since agriculture is a complex system which ranges from seed sowing to selling the product, it depends on various factors like agriculture inputs, intercultural operations, climatic condition, ecosystems, and consumers' behavior. Data-driven smart agriculture is based on real time data which provides information about all sphere of agriculture [10]. It requires robotics, image analysis, GPS technology, forecasting of climatic condition, and other sensor to get real time data which helps to take real time decision and action. Data-driven smart agriculture is sometimes known as precision agriculture and smart farming. Some new technologies already introduced in agriculture like bio-technology, remote sensing, Internet of Agriculture Thing (IOAT), and cloud computing which provides an opportunity to transform traditional agriculture. The introduction of these technology and ICT strengthened precision agriculture awareness, decision making and farm management.

A specific information regarding the status of soil, crop, fish, and animal and intercultural management requirements is necessary to manage farm properly. Though few scholars are in favor of the application of big data application [3] but some others are opponent to the suitability for ensuring digital agriculture [4-5]. This study focuses the specific digital technologies which will help farmers as well as related stakeholders to manage agricultural farm in a sustainable way. Therefore, this study aims to explore the potential of big data technologies for ensuring digital agriculture. The rest of this paper describes methodology in its second section, results and discussion in its third and fourth section and final section concludes the article with few recommendations.

2 METHODOLOGY

A systematic literature method has been conducted to explore the current practices as well as aspects that can help farmer at field level for increasing production. The study assessed all the available literature from 2012 to 2018. The period is selected because of the initiation of big data technologies as the big data technologies are a new phenomenon. The study is followed two inclusions criteria like availability of full article and big data technology related to farm management and also two exclusion criteria such as available literature published in English language and article focusing technological design. Similar methodology has been used by some other researchers [6,3,4]. Data has been collected by using some keywords like "big data, agriculture, digital, precision agriculture, smart, farming" in the renowned data bases such as web of science, engineering village, Springer link, and science direct website.

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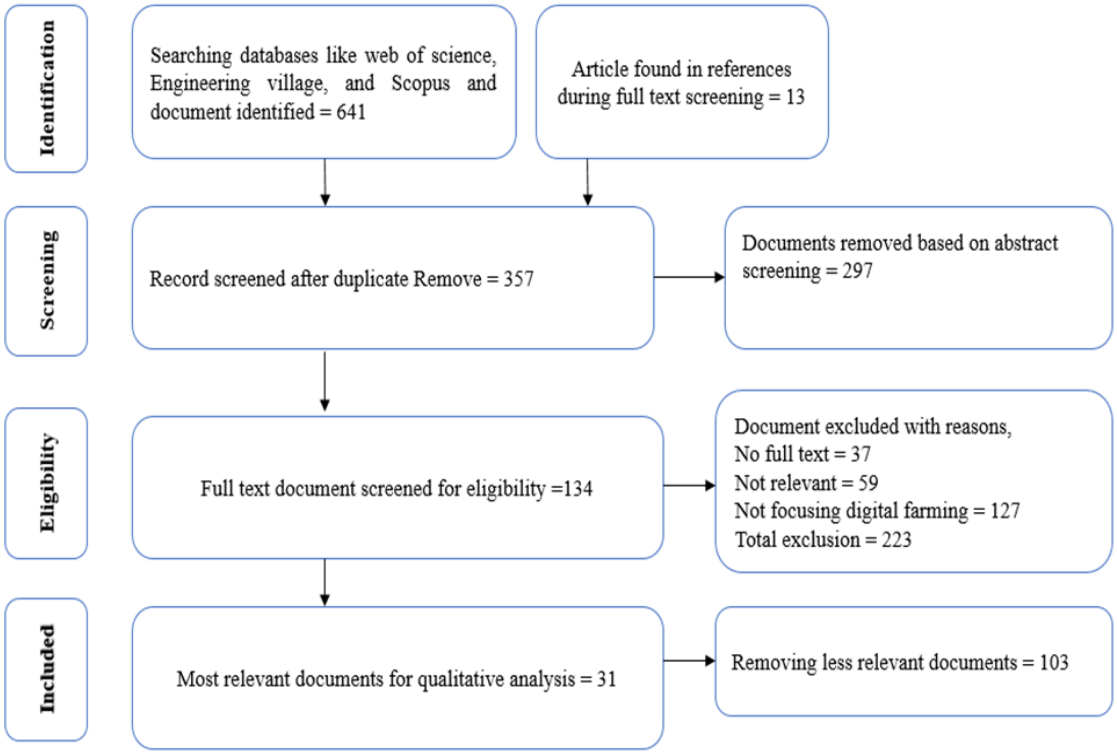

Figure 1. PRISMA flow diagram of documents selection

3 Result of The Study

Finally, 31 documents have been identified for qualitative analysis. This qualitative document selection has been done by following the checklist of the Reporting of Observational Studies in Epidemiology (STROBE) [12]. Other related documents such as journal articles, working papers, book chapter, magazine article, and books have been reviewed to explore the suitability of the application of big data in agriculture.

4 Discussion

4.1 Agricultural Big Data

There is a long debate on the data which is generated from farm. Some researchers do not consider it as big data because of its characteristics. They pointed that agricultural farm data doesn't fit properly with the existing characteristics of big data. But other researchers consider it as big data and pointed that it will be big data when all data from all farmers of a community are pooled together [13]. Considering the both views, this study tries to explain the characteristics of agricultural farm data as follows.

4.1.1 Volume

Generally agricultural data are generated from various equipment from planting, intercultural operations, harvesting and marketing. It is usually stored in office computer, cloud services and using other means [14]. Statistics shows that huge data are generated by multilayer cropping pattern and recorded according to specific year. So, the volume of data is so big and even sometimes difficult to move to other devices.

4.1.2 Velocity

Velocity means the rapidly changing characteristics of data. Generally, 5.5 MB of data are recorded for one acre of land by telematics considering location, cultivar, geo-spatial factor and speed from planters. The size of data is much more at every day during the planting season [15]. Generally, two or three agricultural seasons in a year but some crops are grown around the year. So, the data size is increasing at the pick season but continues even in an off season. Similarly, the duration or life time of crop is varying from one another. So, some crops have short life time but some others have long life time [16]. The agricultural data for crop is vary from each other.

4.1.3 Variety

Variety means a range of data sources. Agricultural farm data should be categorized according to its nature like crop wise, crop growth stage wise, and collecting procedure wise. It will help to understand and use the data properly [17]. Sometimes, data are varying from equipment to equipment, automated sensor to manual method. So, data should be managed properly according to its collection, types, and procedures [18]. Manual data should be transferred properly to computer and integrated with machine-based sensors and telematics. The manually collected data should be analyzed by an appropriate laboratory and transform into structured format for future use.

4.1.4 Veracity

Generally, farm data are unstructured in nature. Agricultural data are more unstructured than other data which generated from laboratory. There is also a problem about the data quality. Usually manually collected data are messier than machine-based sensor data [19]. For example, the yield of a new variety in the laboratory field is higher than the yield at farmer's field. It also varies in different stages of crop cultivation or similar cases in livestock, fisheries and marketing sectors [20]. Agricultural data are greatly influenced by sensor factor and human factors. It can be minimized by taking proper

records of manually applied inputs and installing automated sensors with monitoring carefully.

4.1.5 Value

Generally, agricultural data bears a high volume of information which is generated by every stage of agricultural practice. Off course, it has great potential and value for making future decision [21]. The data sources are usually from planting, intercultural operations, harvesting, post-harvesting and marketing and ranges from crop to fisheries, livestock, agricultural economic factors, and environmental factors [22]. It possesses great value in different stages in plant, animal and fish cultivation like soil pH, soil nutrient content, moisture content, humidity, irrigation requirement, diseases and pest attack and other related management [23]. The above statements clearly explain that agricultural data is really big data in all aspects of big data characteristics. The potential of agricultural big data is actually depended on its use by agriculturist, farmers, researchers, academicians, and policy makers.

4.2 Sources of Agricultural Big Data

Agricultural sector produces a huge amount of data which is usually used in agricultural research but in a limited scale. Big data technology provides an opportunity to use the data following scientific procedure and making right decision at right time. Some large companies like Deere, Dow and Monsanto are using big data analytics for development of modern technology and tools. Agricultural big data can be used by a holistic approach comprising various related technology and related sector's data. No single source's data are not enough to make a proper decision.

4.3 Application of Big Data for Digital Farming

Some potential technologies have been revealed in this study based on big data technologies and very useful for farmers to utilize at field level.

4.3.1 Forecasting of Weather

Soil and environmental factor has a great contribution on crop farming, fish and livestock farming [24]. It is necessary for the farmer to learn about useful temperature and humidity because of the requirement of crop plant and it can be easily known by using big data analytics [25]. Big data technology gives an opportunity for farmers to adopt better crop management practices by analyzing different stages of crop cultivation such as cropping pattern, planting time, intercultural operation, fertilization, pesticide management harvesting, and crop intensity [26].

4.3.2 Prediction of Crop Yield

Using big data approach, farmers can get idea about the probable harvesting time and yield of the crops by analyzing algorithm [27]. Farmers can easily avoid yield harvest lost and manage the post-harvest activities By using this useful information [10]. Big data approach can help the farmer to achieve more yield by following planting, inter-cultural operation and harvesting time which also helps to avoid any adverse climatic conditions [29].

4.3.3 Selection of Crop

Big data approach helps the farmer to select proper crop through using algorithm analysis of input and output variables of a crop [30]. Some popular techniques of big data approach which are used frequently for crop selection such as K-nearest neighbor, decision tree and artificial neural network [10]. Big data technology usually analyzes natural calamities, climate, famine, soil and other inputs for finding out an appropriate crop for a specific area. Gacar et al. [11] argues that the application of big data can provide a better yield for corn and soybean through using edaphic factors.

4.3.4 Crop Diseases and Pest Management

In crop production, disease and pest infestation of the crop is a normal phenomenon but it reduces the quality and yield of the crop [10]. If a farmer can control the disease and pest infestation, it will help to increase yield. Big data provides this opportunity to detect any disease infestation on the crop for which farmers can easily take measure to control the disease and the safe the crop [16]. Big data technology can predict the pest attack in advance. Rumpf et al. [12] reveals that support vector machine is useful for crop disease infestation.

4.3.5. Agricultural Marketing

Market information is necessary for getting profit from agricultural products [13]. A farmer may incur a loss on their product due to ignorance about the market information. Various kinds of market data such as input cost, wages, price trends, cultivation cost, demand and supply, marketing and transportation cost can be used for market analysis [14]. Farmers can take decision easily from the result of big data analytics of these market information. The public and private agencies can use the big data technology for market analysis and do proper monitoring on market [15].

5 Conclusion

Technological integration in agriculture is considered as a key tool for maximization of agricultural production and supplying food for fastest growing world population in the future. Big data technologies provide an opportunity for digitalization of agriculture sector. In spite of the huge benefits of big data application in agriculture, there is still a long debate on its applicability to agriculture. The study focuses on the suitability of the big data technologies in the agriculture sector. Big data is a potential tool for transformation of traditional agriculture to modern digital agriculture from farm to fork at the time of technological development. It addresses all the complexities related to farming systems analyzing farmer's need, consumers need, financial efficiency, marketing efficiency and other stakeholder perspectives. This study explores several technologies and practices of agricultural big data which can help farmer in a holistic way to take right decision and right time. It also reveals that use of agricultural big data technologies are still a low level which requires more investment for establishment of infrastructure, training related person, enhancing technological knowledge of farmers, awareness about the benefits of big data technologies and attitude of adoption of technologies. It also argues that application of big data technologies can help farmer to weather forecasting, crop selection, irrigation management, crop diseases and pest management, crop yield prediction, agricultural marketing, and agricultural policy decision. But farmer needs help from an expert team to implement the facilities at field level. The study recommends that government initiatives, private sector's involvement and a public-private partnership are necessary for large scale commercial

implementation of big data technologies at farmer's level. Besides, a strong initiative is necessary to solve the related challenges like privacy of data, data availability, quality and openness, lack of expertise and context specific technology.

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