Relevance of Big Data Analytics in Agriculture: *Focus on Nigeria Agricultural Sector*

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Abstract: ***Agriculture is the most significant sector in Nigeria in terms of employment and GDP. A number of the agricultural related business interest in Nigeria are constrained by a challenging business environment with defective and limited public infrastructure and overbearing government bureaucracies. Agricultural exports from Nigeria are not competitive because of phytosanitory concerns resulting from disease and pest attacks. Moreover, inefficient farming practices affects crop yield and increases waste in the production process. Dealing with these supply chain concerns can be complicated and overwhelming for industry players. As big data analytics tools are increasingly adopted for agricultural purposes and use cases in more developed countries, this study focuses on how it can be adopted in Nigeria and included in a holistic solution from a business interest perspective, to mitigate challenges and to become more competitive both locally and internationally.***

1. Introduction

This research evaluates the critical need of big data analytics for farming practices in Nigeria. The government seeks to develop the agricultural sector for increased farm yield, a more diversified economy away from the dominant energy industry, and as a major earner of foreign exchange(Agricultural Transformation Agenda).This has further increased the significance of the sector in the national economy (FMARD, 2016). Agriculture in Nigeria employs a third of the population within the working ages of 18to 60 year olds and accounts for 40% of the national GDP (National Bureau of Statistics, 2018; Kamil, et al 2017). However, it contributes less than 20% to the country's foreign exchange revenue (National Bureau of Statistics, 2018). The comparatively low output in the sector despite the significant input is due to the predominantly subsistent state of agriculture in Nigeria (Roser and Hannah, 2018). However, in more recent times there has been an upward surge in farm yield and food processing as a result of the renewed investment by the government and big businesses in the sector (FMARD, 2016). Also, the country's middle class continues to grow which has significant implication for the local food economy (OECD/FAO, 2016).

Both corporate and private interests involved in farming in the country are faced with a myriad of challenges that range from production risks that results from several factors including input supply challenges and crop failure, through supply chain and logistics risks to inadequate and unreliable public infrastructure. Bureaucratic bottlenecks of government agencies often clog transaction processes and breeds corruption which further burdens farming interest. Burdensome bureaucratic bottlenecks is the result of frequent changes in government policies. Communal clashes and security concerns in farming areas also disrupts supply chain and complicates the transaction process of trading companies.

It is vital to address these deeply rooted challenges because it has fundamental implication for the profitability of farms and their long term growth in the country. Secondly, farms are faced with international competition that poses a more competitive economies of scales. Finally, the successful implementation of a big data analytics business model will significantly reduce inefficiencies that results in financial costs and delays in transaction turnaround time in agricultural commodities.

The research comprehensively examines the ways that big data analytics can be adopted by farms and agribusinesses in Nigeria; it examines how it can be applied to address identified problems across the agricultural value chain of farms and agribusinesses (production, logistics, storage, processing).

1.1 Research Question, Aim, and Objectives

Research Question
How can big data analytics be used to support farming practices in Nigeria?

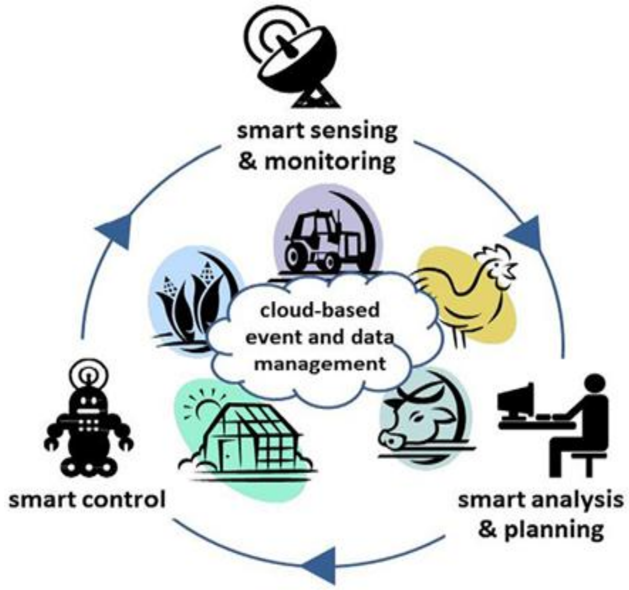
Research Aim
The aim of this research is to explore the ways big data analytics can be adopted to enhance farming practices in Nigeria for increased farm yield and reduced input cost.

Research Objectives
- To explore the ways big data analytics is currently used in farming
- To explore the ways big data analytics is currently used in agricultural value chain
- To propose recommendations on how to use big data analytics to address the challenges facing agriculture in Nigeria.

2. Literature Review

2.1 Big Data Analytics in Agriculture

Available studies on the application of big data analytics in agricultural commodities reveals different methods of adoption and use cases. Certain comprehensive reviews focus on methods that centre on crop cultivation in precision agriculture and includes the upstream input segment of the value chain that supplies farm machines, chemicals and seeds to farms. Detailed methods used in the application of big data analytics is investigated such as machines equipped with navigation systems, sensors and internet of things capability and are able to collect and transmit live data captured in crops, soil and air to centralized data centres or cloud storage solutions where they can be analysed for enhanced farm yield and crop quality (Xuan and Martin, 2018).



Source: (Wolfert et al , 2014)

Other studies are more focused on the ways the 3 V's of big data affect aspects and major themes in agriculture (Andreas et al, 2017). Certain studies have investigated how the remote application of big data enabled technology such as IoT platforms can be used to address problems in precision agriculture and the ecology (Tomo et al, 2017). They describe the use of IoT enabled nodes, camera nodes and gateways, satellite imaging and cloud servers for data acquisition, transmission, storage, preparation, prototyping, and analytics.

A Comprehensive review of the methods and use cases of big data analytics in the practice of agriculture should first identify the area of practice the application is focused on, secondly, it should describe the sources of big data in the defined agricultural area. Lastly, the techniques used to capture and analyse the data should then be reviewed as explained below.

Soil

Moisture content and salt levels are captured from soil sample using ground sensors which also detect and collect data on underground electricity charges (Meyer et al, 2004). The sensors are internet of things IoT enabled and transmit live data to remote cloud servers where they are studied and analysed using machine learning and artificial learning applications (Armstrong et al, 2007).

Crops

Sensors have diverse uses in farm practices; both underground and above the ground sensors are used to collect crop data through a process known as metabolite sensing, satellites can also be used to remotely sense and capture data in crops (Waldhoff et al, 2012). Historical datasets that document the history of land use, cropping practices, and yields are also sources of crop data. Machine learning technologies, normalized difference vegetation index NDVI which is a graphical indicator used in the analysis of remote sensing measurement data are among the technological tools used to collect and analyse crops (Urtubia et al, 2007; Sakamoto et al, 2005).

Forecasting Climatic Conditions

Data on Weather and climatic conditions are collected from sources that include historical records, and satellites (Tripathi et al, 2006). The need to know and predict upcoming climatic events have become more pressing because of climate change and the implication on earth. The application of big data management and analytics tools such as scalable machine vectors (machine learning), cloud computing solutions, geospatial analysis and modelling in handling weather and climate data is now extensively used for agricultural purposes (Wu et al, 2016; Andreas et al, 2017) and should form part of an integrated and proactive strategy underpinned by big data analytics platform of an agricultural commodity trading company. In Nigeria, variations in weather and climatic conditions tend to be limited to extreme temperature variations, floods or drought. (Fraisse et al, 2006). The ability to anticipate and be proactive with disruptive climatic phenomena like El Nino that may result in high temperatures and flooding with severe consequences for agricultural yield and supply chain is important for trading companies (Rembold et al, 2016). Cloud enabled service; climate- analytics- as- a- service is a development in the fast growing big data domain of climate science (John et al, 2017). So, trading companies do not have to invest in developing their own infrastructure in this regard but can subscribe for the service.

Livestock

The adoption of big data analytics technologies in livestock is primarily geared towards research purposes which is reviewed in the study of Patricia et al (Patricia et al, 2014). The literature reviews the application of artificial intelligence in agriculture, by comparing 190 predictive models in AI to reach the highest level of accuracy on the prediction of the individual body mass of 210 chicks within the same age period. The chicks were subjected to different durations and levels of thermal intensity and studied using a framework of databases that included 840 datasets (Patricia et al, 2014). This study validated accurate AI models that can be used to predict poultry yield under controlled and specific conditions. It can be adopted by agricultural commodities trading companies to improve yields and enable a proactive strategy with accurate projections on production output.

Data sources in livestock include animal feed, measurements in heat and weight, historical records on milk production of individual livestock, sensors, camera sensors, soils and grazing practice (Pierna et al, 2004). Neural networks and scalable vector machines in machine learning are big data technologies that are used in the practice(Kempenaar et al, 2016; McQueen et al, 1995).

Biodiversity

The use-case for big data analytics in biodiversity centres mainly on geospatial applications. Data is managed with geographic information systems GIS which is used for data handling in spatial and geographicscience. Data is also sourced from historical records. Statistical methods in big data analytics such as Bayesian belief networks are some of the tools used to process data (Marcot et al, 2001).

Land
Satellites, drones, and radar are some of the tools used to remotely capture land data in combination with other non-remote means (Barrett et al, 2014). Land data is captured to evaluate and project on the suitability of land use for the purpose of agriculture. Diverse technological tools are employed to process and analyse land data, they include big data analytics solutions such as machine learning which gives clearer insight and better understanding in land degradation (Schuster, 2017). Clarityin the qualities of land and crop phenology is gained in the use of these big data analytics tools (Gillian et al, 2008). Commodity trading companies can gain insight that is valuable in trade with insightful knowledge of farmlands and the implication on future crop yield.

Weeds
Big data analytics automates the process of weed control in agriculture through systems that integrate autonomous vehicles with advanced GPS systems, drones, and digital library to control weeds in farms. The systems are enabled by machine learning applications in neural networks and logistics regression. Other technologies employed include image processing (Gutiérrez et al, 2008).

Decision Support Systems
Big data analytics use case in this regard extends beyond field practices in agriculture and includes the agricultural value chain. Data sources are diverse and are captured from official government surveys and data reports, weather stations, sensors, satellites, news feeds, social media, etc. Internet of things IoT, cloud computing, mobile applications and big data storage are technologies used to accomplish functions (Sawant et al, 2016). Applications in the logistics, storage and processing functions of a commodity trading company are also enhanced through knowledge discovery.

Insurance/ Finance
Organisational financial records when combined with farm yield records and weather report are sources of big data that can be harnessed stored and analysed to generate intelligent insights. This can be done using technologies such as artificial intelligence, cloud computing solutions, and mobile applications (Akinboro, 2016; Syngenta Foundation for Sustainable Agriculture, 2016).

Remote Sensing
Remote sensing is prevalent in precision farming practices and it is a major means of data capture in big data analytics in agriculture. Satellites, drones, radar and sensors are tools used in remote sensing. They are supported with Internet of Things IoT solutions, cloud servers, autonomous vehicles using AI to fulfil data capture, transmission and processing tasks (Becker-Reshef et al, 2010). These all have significant relevance for agricultural commodity trading companies that will successfully demonstrate proactive business model.

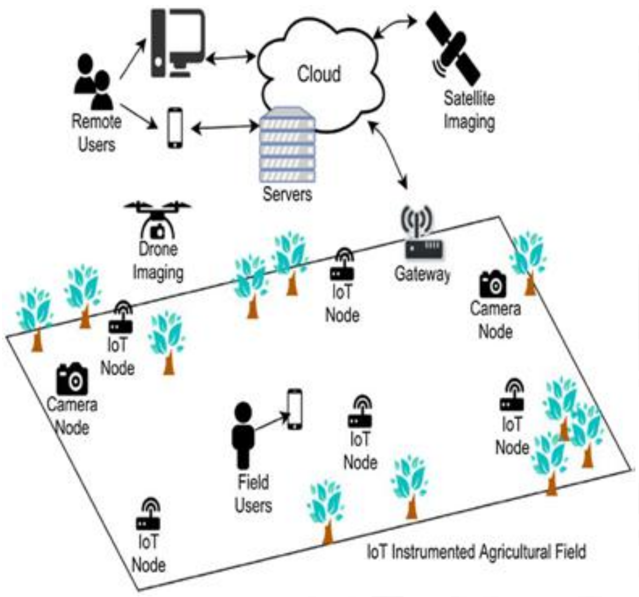
2.2 Approaches to Big Data Analytics in Agriculture

The study of big data analytics in agriculture has been reviewed by scholars using two different approaches; this distinction is made clear in the study of Sjaak et al (Sjaak et al, 2017). The first is termed smart farming and it takes a broader approach of integrating farming tasks with the entire value chain of the agricultural process (Sjaak et al, 2017). The second is referred to as precision agriculture (PA) and it entails control and resource optimization in the growing of crops and raising of livestock (Xuan et al, 2018).

2.2.1 Smart Farming
Smart farming is focused on the application of big data analytics to the business processes and across the agricultural value chain. The approach reviews the relationships that exist between variables, functions, and concepts in the ecosystem and looks to enhance their function (Sjaak et al, 2017). The breadth of the scope makes it more practical for agribusinesses that are more involved with supply inputs and post-harvest activities. The functions studied in this approach expands the application of big data analytics from farm supply inputs, through farming operations and management functions of storage, logistics and processing of agricultural produce. Studies on this approach points to the predictive value of big data analytics from a business perspective and the ways it enables proactive actions to mitigate fast changes that affect the business process (Wolfert et al, 2014). Emphasis is placed on the concepts of data chain and network management organisation. Data chain is explained as the activity sequence from data capture through decision making and data marketing, it is a depiction of the data process and includes all required activities in data management for the effective control of the farm value chain (Sjaak et al, 2017; Min et al, 2014). The depiction of the data process sheds light on the nature of data in agriculture through data capture, storage, transfer, transformation, analytics and marketing. Farms and agribusinesses can use it as a guideline in the formulation and development of optimisation strategies in their trade process (Dumbill, 2014). The concept of the network management organisation relates to the behaviour of stakeholders in the agricultural value chain and the methods used to influence variables in the completion of business process objectives. The process recognises two ways business process objectives are completed which are governance and business models. Governance refers to the administration of organisational processes that constitute part of the stakeholder network and they can be either formal or informal. Such arrangement as it relates to big data includes agreements on the availability of data, the ownership of data, who is liable for the handling of data and the security of various data sets and issues relating to privacy (Sjaak et al, 2017).

2.2.2 Precision Agriculture
Precision agriculture involves the use of big data analytics tools to maximize farm yield while minimising the use of resources (water, land, fertilizers, and chemicals) in the process (Xuan et al, 2018). This approach investigates different methods adopted to capture data on the development of crop and livestock and their environment. It is common for studies on this approach to focus on input

suppliers or the upstream input markets of the industry value chain that primarily manufacture and supply farm equipment. A number of theses supplier firms have established themselves as data holding and specialist companies. Through the integration of the internet of things IoT capabilities to farm equipment and supported by cloud servers, crop data is collected from farms and warehoused and analysed on their platforms (Xuan et al, 2018). This raises serious questions about privacy, security, and ownership rights of data collected from multiple farms. How is the data used and who profits from it are questions often asked? Some stakeholders have argued that more value can be derived from the comparative analysis of data from multiple farms than the analysis of data from an individual farm (Bunge, 2015; Manning, 2016). Farms can access these data sources through API's (application programming interface) to get better insight that can enhance crop and livestock yield.



In precision agricultural approach. Emphasis is placed on the use of technology in farming, for example, detailed description of data capture and analytics technology such as geographic positioning systems that is used to record coordinates in fields by equipping tractors with sensors and steering guidance systems. Their study also described the adoption of geomapping, precision planting, and soil fertility maps in the practice of precision agriculture to effect desired changes on crop yield (Xuan et al, 2018). A common theme in the reviewed literature *source:*(Tomo et al 2017) on PA was the need to enhance data acquisition and utilization in farms. There is consensus amongst scholars that farm data is underutilised and that there is need for further studies on the acquisition and utilization of data in farms (Tomo et al, 2017).

3. Research Methodology

3.1 Qualitative Methodology

The posited research question for this study is addressed by a systematic scrutiny of relevant literature within the last twelve years, this is as a result of the recent history of big data analytics as a significant field of study. Materials selected for the research were chosen based on two criteria; peer reviewed literature and relevance to the research question. However, articles that focused exclusively on the technicality of the technology were only used when a comprehensive definition of relevant technologies, value chain or economic concept was required.

The process commenced with the use of multiple combination of two sets of keywords to search through Scopus, ScienceDirect, and web of science. The first set of keywords involved big data analytics together with all related and developing fields such as artificial learning, machine learning, cloud computing, internet of things, and the second set addressed agriculture and included related subjects of value chain, farming, precision farming, smart farming, supply chain. The decision to use the mentioned databases was because they fulfilled the first criteria of providing a deep and broad spectrum of peer reviewed literature. The processes then proceeded to collect and peruse up to 20 peer-reviewed full articles for their relevance to the research questions by focusing on the context, approach and use of the keywords.

After the screening process, 5 articles were considered as very relevant to the research and another fifteen articles as relevant in some way. The low number of relevant peer reviewed articles collected was due to the relatively new concept of big data analytics and the development of related fields. To make the depth and breadth of the literature more comprehensive, grey literature was included from industry players, consulting firms and news articles. After reading and extracting relevant information, a framework was developed to further synthesize and analyse the information.

To ascertain the most effective way big data analytics can be adopted for farming and agribusiness in Nigeria, the studies reviewed literature that focused on the problems and challenges faced in the practice of agriculture and the affected value chain in Nigeria. Four studies were selected based on their relevance and depth of review.

The key subjects and concepts were identified and classified systematically. The selected literature on the application of big data analytics in agriculture were analysed by identifying 5 main fields where big data and analytics is adopted across the agricultural value chain. The main themes and intervention areas of the respective studies were extracted and categorized under the defined field. In perusing the literature on the application of big data analytics in commodity trading, literature that showed in-depth domain knowledge of the futures and derivatives market was considered as well as a clear explanation of the adoption of big data analytics in the execution of the trade process.

4. Findings, Analysis, and Discussion

4.1 Findings

The results of the literature reviewed for this study showed that the application of big data analytics is done primarily in the United States, Europe, and Japan. Though there are indications that emerging economies such as China and Brazil are not too far behind in the process of adopting some of the practices (Sjaak et al, 2017). In Nigeria, the government has launched three space satellites for agricultural and climatic purposes, however, there is no evidence of an integrated and active use of data generated from the satellites in the practice of agriculture in the country (Aron, 2013; BBC, 2011). The research program in the country is more focused on the development of improved crop species and seedlings (Council, 2018), however, there are isolated practices of big data analytics solution relating to aquaculture and irrigation (Oladipo, 2013).

The challenges present across the agricultural value chain are the most pressing theme on the state of agriculture in Nigeria (Downie, 2017) they affect input supply, farming practice, storage, processing and logistics (Pirrong, 2014). Infrastructural failure and excessive government bureaucracies were identified as the most pressing challenges facing the sector (PWC, 2017).

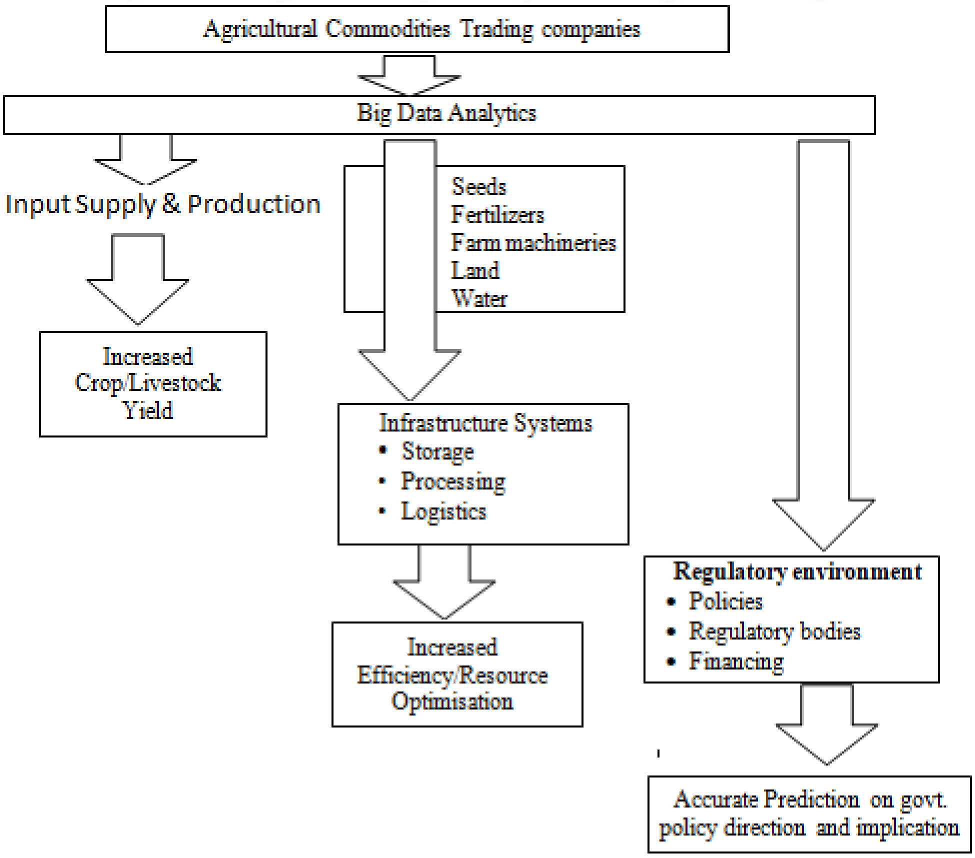
4.2 Analysis

4.2.1 Agricultural Value Chain

The framework proposed for this analysis focuses on the successful adoption of big data analytics toimprove farming practices and the agricultural value chain in Nigeria.

(Downie, 2017) Identified key pressing challenges that inhibit successful practice of agriculture in Nigeria as; uncompetitive agribusiness environment, poor inputs supply, poor market access, limited access to credit, lukewarm political commitment, and a neglected agricultural research system. These identified challenges all impose a difficult environment for the practice of agriculture in Nigeria(PWC, 2017).

In proposing an analytical framework for farming and the agricultural value chain, the identified challenges are grouped in three categories which are: Input Supply and production, Infrastructure Systems, and Regulatory environment. The input supply and production category affects the challenges that inhibit the optimization of farm practice for increased crop and livestock yield. The infrastructural category pertains to challenges that stems from supply chain constraints and business process of the trading companies. Lastly, the regulatory category deals with challenges emanating from government policies and the behaviour of regulatory bodies. The systemic application of big data analytics solutions to deal with these challenges are reviewed from the selected literature and used for the analysis.



Addressing the identified fields of problems using a big data analytics platform entails key focus on knowledge in developing a decision support system, a knowledge focused orientation involves the entire data process from the point of capture to the place of decision-making. It entails the transformation process of data to information and finally to knowledge (Leopoldi, 2002). The data process is shown in fig 3.0 and is applied to each of the problem categories defined for the framework.

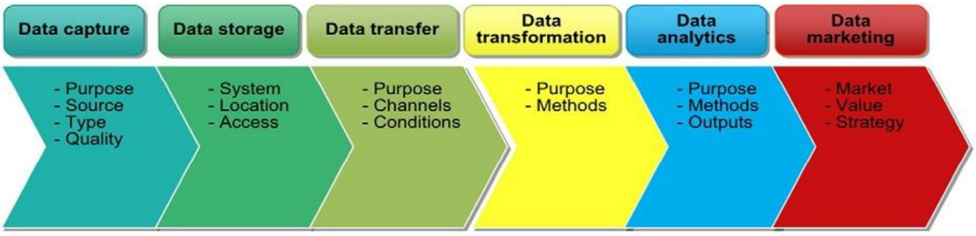


Figure 3: Source: (Chen et al, 2014)

Input supply and Production Challenges

In this study, the input supply category concerns the challenges that disrupt the availability of materials that are required to effectively practice farming activities. These input materials include a range of materials such as high yield seeds, mechanised farming equipment, land, water, livestock feeds, fertilizers, etc. The development of input markets has significant implication for agricultural stakeholders. In Production, it concerns the challenges encountered in the cultivation of crops and the raring of livestock.

Infrastructure Systems Challenges

Infrastructure in this study refers to the factors that affects agricultural produce after harvest. This relates to the transformation activities of agribusinesses in the industry value chain (Pirrong C. , 2014). The term “Infrastructure Systems” is used to illustrate the extensive effect of a broken infrastructural system on the entire agricultural value chain in Nigeria.It involves the challenges that result from storage facilities and methods in the preservation of agricultural produce which has implications for business strategy and profit maximisation. Secondly, it deals with the challenges that affect the processing of agricultural produce to enhance value and increase profits. Lastly, it concerns logistical challenges encountered in the movement and distribution of commodities across the value chain (Pirrong, 2014).

Regulatory Environment Challenges

This category refers to the challenges that result as a consequence of government policies and the behaviour of regulatory bodies. The propagation of the economic theory of regulation by (Stigler, 1971) marked the beginning of the maturation of the concept of regulation. This was followed by more studies such as the work of (Majone, 1996) which delved into the subjects of consumer, risk, and environmental regulations (Christel and Martin, 2017). Scholars have advanced varying definition of regulation; however, the definition of Baldwin et al is most suitable for this studies because it addresses the core of the regulatory concerns that affects the focus of this research. He defines regulation in three main conceptions, firstly, as “the promulgation of authoritative set of rules, along with the mechanism to ensure monitoring and compliance”. Secondly, as the work of state agencies to direct the economy. Lastly, as all the mechanism of social control in a state, which can also be carried out by non-state processes.

4.3 Discussion and Recommendation

Input Supply and Production

Access to quality and mechanized inputs is a major challenge that has affected yield, profitability and the development of the agricultural sector. (PWC, 2017)In their study on the development of the agricultural sector in Nigeria, identified reasons for the lack of access to input supply as high cost and limited specifications of agrochemicals, difficulty in acquiring land, climatic variations such as high temperature and irregular rainfall, and poor accessibility to improved seedlings. (Downie, 2017) Identified the same problems in addition to the lack of access to mechanized farm equipment. Whereas these problems go far beyond the lack of adoption and application of big data analytics in farming practices, it is important to recognize the significant impact big data analytics solutions can contribute in addressing these fundamental challenges. For example, generic fertilizers with fixed ratios of constituents make up to 70% of the fertilizers used in Nigeria despite a diverse range of nutritional composition in soils across the country (Downie, 2017). Using solutions in geomapping and remote data capture in soil conditions and analysis will inform on the composition of the fertilizers that should be applied on local soils for much better results on increased crop yield. Furthermore, the adoption of big data analytics tools such as scalable machine vectors and geospatial analysis can enable more accurate localised prediction on rainfall, temperature and flooding (Wu et al, 2016). Mechanized farm equipment fitted with sensors, and GPS are able to provide real-time data that is important for research in the development of high quality and adaptable seeds in the region.

A high percentage of the agricultural produce from Nigeria are not internationally competitive because they do not meet phytosanitory standards (Downie, 2017). This is due to frequent pest and disease attacks, low use of mechanised equipment, and poor irrigation practice. Precision farming techniques that use statistical models when adopted, are able to detect and predict pest and disease attacks and decisions can be made to isolate and mitigate them with preventive steps(Garrett, 2013; Sjaak et al, 2017). The use of machine learning analytics service like IBM’s Deep Thunder which combines forecasts from weather stations, satellite data and information from commercialised weather networks to generate highly localised weather forecast and information on soil temperature and moisture content through remote connection to ground sensors can be tapped and integrated into irrigation systems to optimise the use of water and other input resources (CBR Staff Writer, 2016).

In summary, a combined use of fertilizers with the correct chemical composition and nutrients for specific soil types, with improved seedlings and good insights in climatic conditions will increase quality and farm yield with increased efficiency and reduced cost.

Infrastructural Systems

Limited storage facilities, high cost of processing equipment and power generation are some of the core challenges that face the transformation phase of the agricultural value chain in Nigeria (PWC, 2017). The infrastructural failure that affects Nigeria's social-economic environment is most damaging for the agricultural value chain and drives up operational cost in agricultural related ventures (Downie, 2017). Overcrowded ports and poor road network results in delays of up to a week before trucks can drop off cargo in sea ports for export. Though this is an infrastructural problem, big data analytics can be co-opted into holistic solutions that address these problems and optimise logistical resources. Having insights on port congestion level and road traffic congestion can enable better planning, automation and optimization of logistical resources (Ray, 2016).

Post-harvest losses for fruits and vegetables in Nigeria are estimated to be between 35%-50% and between 15%-25% for grains (PWC, 2017). For example, Nigeria produces an estimated 1.5 million tons of tomatoes and almost half of that is lost post-harvest (Downie, 2017). In formulating solutions that can resolve this waste, big data solution can be adopted for key functions for the optimization of storage facilities. Big data analytics enabled platform can integrate and automate storage, warehouses, and fleet management in a unified planning and scheduling system that optimizes resources, increases efficiency and reduce post-harvest loss (Sjaak et al, 2017; Oracle White Paper, 2015).

As previously abandoned government storage centres are revamped and developed in the electronic warehouse receipt scheme (Downie, 2017). Strategic information on produce in storage can be accessed and analysed to make projection on future market supply. Leveraging storage information can provide vital information for availability of storage for farm produce. Social media and newsfeed can also be analysed for market discovery and strategic planning. Decision support is enhanced for agribusinesses with big data enabled platforms, decision to sell locally or to export markets are easily made. Risks are analysed better and outcomes are made clearer.

It is pertinent to state that not all problems require big data analytics in the agricultural value chain in Nigeria, however, when used as an enabling function in a broader solution that addresses infrastructural problems, better results will be achieved and resources will be optimized. Conclusively, most of the big data analytics solutions are available as a service and trading companies do not need to invest heavily in developing their own solutions.

Regulation

Government policies and regulations in Nigeria agricultural sector are frequent and erratic. The main regulatory bodies which are the Federal Ministry of Agriculture and Rural Development (FMARD), Standard Organisation of Nigeria (SON), and National Agency for Food and Drug Administration (NAFDAC) often go back and forth on policy issues that sometimes undermine the business process of the sector. These institutions are underfunded and are not able to effectively execute oversight functions. Agribusinesses that are not equipped with the right facilities are vulnerable in purchasing substandard produce from independent suppliers that cannot meet international standards (Downie, 2017).

Secondly, agribusinesses can scan social media and news feed to get a sense of policy direction of regulators, and using big data analytics tools, can analyse and predict the implications of new regulatory policies for trading companies and be proactive to take full advantage of it.

Application of Big Data Analytics to Agricultural value chain challenges in Nigeria

Category	Focus	Data Capture	Data transformation	Data Analytics	Expected Outcomes
Input Supply & Production	Seeds Fertilizers Land Farm Machinery Water Crops Livestock breed Energy Feeds Plant protection	Remote sensing, sensors, UAV's, Biometric sensing, Genotype Information, Geomapping, GPS,	Geospatial analysis, machine learning algorithms, Cloud platforms	Yield models, Benchmarking, Decision Ontology, Artificial Intelligence, Visualization, planting instruction	Increased yield per hectare, Resource Optimization, Enhanced productivity, Precise and accurate farm information, Decision support
Infrastructure Systems	Storage Processing Logistics	Global positioning systems, Mobile data capture, Voice systems, wireless networks, Radio frequency identification, label compliance	Machine Learning Algorithms, Artificial Intelligence, GPS, satellite Imaging, automated processing,	Statistical analytics, Decision Ontology, AI, Machine learning Algorithms, Cloud Platforms	Better transaction turnaround time, reduced post-harvest wastage, Improved profit margins, Improved market discovery and access
Regulatory Environment	Government Policies Regulatory Bodies Financing	Social media analysis, newsfeeds,	Machine learning modelling,	Predictive analytics	More accurate prediction and response to government policies, Better and quicker understanding of the implication of policies

5. Conclusion

The adoption of big data analytics in farming practices such as precision agriculture and smart farming will enable farmers and agribusinesses to overcome the prevalent challenges of low yield and high input costs. The application of big data analytics solution will optimise farming and raring conditions and improve crop and livestock yield while reducing input cost. This will result in a cut in waste and a more efficient business process. Also, storage and logistical challenges can be assuaged with big data analytics tools as they can be incorporated in an integrated solution that optimises storage and logistical schedule to reduce cost and increase efficiency (Sjaak et al, 2017).

5.1 Limitation of the Study

There are limitation in this study:

The findings of the study is based primarily on articles from academic journals, industry players, consultancy organisations and news sources. While aspects of the various concepts reviewed in the study have been successfully tested in industries, and peer-reviewed journals, however, no empirical study was done to test the analysis and recommendations in the study.

5.2 Further Research

The challenges that affect the development of agriculture in Nigeria are pressing; there are a number of studies that have investigated these challenges. The application of big data analytics in the development of the agricultural input supply sector is an identified area for further studies.

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