A DISSERTATION ON THE CURRENT AND FUTURE IMPLICATIONS OF BIG DATA ANALYSIS ON THE FARMING INDUSTRY IN NORTH AMERICA

# ABSTRACT

The way agricultural information is gathered and disseminated across all global regions have taken a dynamic change due to the rapid growth and development of information technology as well as increase of computer-related devices. Moreover, there has been a decrease of traditional ways of accessing information such as traditional paper-related and telecommunication centers.

The availability of different information dissemination methods have resulted to overlapping, frustrating, and overwhelming information to farmers due to its contradicting or confusing aspects. Farmers ahs been relying on familiar or known information sources but ignores any new farming ideologies due to fear of putting into practice knowledge. The research study aimed at answering how the farmers can access concise, relevant, and convenient agricultural information.

In answering the research questions, a survey was developed where the participants were supposed to fill in the questionnaires using both open ended and close ended questions. The findings of the study are beneficial to other scholars, information providers, public and government

# Declaration of Authorship

I, Elad Shalom, declare that this research project titled “The current and future implications of big data analysis on the farming industry in North America” and the work presented in the paper is originally investigated, authored, and presented by me. This report is an output of the original studied towards the completion of the course.

I confirm that:

1. This report comprises an original content that I have been exploring as a candidate in this University;
2. In case, whatsoever that there is any part that have been submitted previously or published, this report has carefully and clearly cited, quoted, or state, thereof;
3. Sources in this research study are well cited or given for all direct quotes from other scholars.
4. The content in this paper has acknowledged all helpful sources
5. Lastly, I confirm that this is my original work, and none has been submitted or published in any faculty.

Signed: ………………………….

Date: ……………………………..

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# CHAPTER ONE: INTRODUCTION

## Introduction

Over several decades, there has been a wide-ranging gap between the agricultural production and the possibilities of technological advancements in the farming sector. The available information that can help farmers in moderns days can be termed as enormous, which is a sign of potential empowerment that is vital in making important decisions. As explained by Kalusopa (2005), the availability of information about farming methods or techniques is crucial as it may lead to better communication, new knowledge, and effective decision making. The ability of farmers to make decisions depends on the availability of adequate information as well as the mechanisms that conveys such important information. It means the format at which the information is conveys play a critical role on how the farmers utilize the new knowledge to improve the farming approaches through better decision-making processes.

Other scholars explored the way agricultural industry is essential for economic development and growth for individuals and the entire nations. Various countries have been striving to improve the dissemination of available information by developing information systems that are effective to farmers. Some nations such as India adopted the information frameworks dubbed as Agricultural Information Dissemination System that targeted any level of farmers across the Indian Territory. There is great demand of improving the dissemination of agricultural knowledge, especially during the current digital age where there is adoption of new practices and technologies that are dependent on different empirical factors such as demographic, economic, political, social, and technological approaches. Some researchers suggest deeper investigations for establishing the roles played on new technologies, especially on decision-making process of the farmers (Armstrong et al., 2008). As such, this project is dedicated to provide farmers in Atlantic Canada the best way to disseminate agricultural information in order to improve farming yield in the easiest methods possible.

## Background Information

The way agricultural information is gathered and disseminated across all global regions have taken a dynamic change due to the rapid growth and development of information technology as well as increase of computer-related devices. Moreover, there has been a decrease of traditional ways of accessing information such as traditional paper-related and telecommunication centers. Despite several attempts to improve agricultural sector such as green revolution, there has been little success improvement in the usage of technological solutions. The production of food has been characterized by utilization of low technologies, as well as subsistence producers. For instance, farmers receive little information on where to get improved seed varieties as well as the best farming methods or where to market their productions, thus making it hard to improve the sector.

The current status of agricultural sector that includes populated information, rapid technological improvements, governmental intervention, and influence of professionals has contributed to a dynamic way of disseminating agricultural information. Such technological breakthrough has been achieved over the recent decades in Atlantic Canada where farmers have adopted more specialized strategies to improve the agricultural sector. In this case, the specialization paradigm in the farming industry have led to more sophisticated needs for either management, marketing, or technical information as explained by Marsh and Pannell (2000). For instance, a farm manager doubles the tasks of coordinating and administrative in order to develop, implement, and evaluate agricultural programmers effectively, thus creating the needs to come up with centralized application. The current situation in many farms creates a complex scenario for managers, especially when they have modern ideas to improve their yields but lacks better platform to organize, plan, develop, and implement them effectively due to lack of capabilities. It is notable that the way agricultural information is delivered or acted upon differs with individual circumstances, production region, or enterprise mix, as there are no streamlined standards that control farming activities. it means there is a lot of differences on the way agricultural information is utilized, thus polarizing the improvement level as each entity have unique practices, as explained in the following sections.

### Public Farming versus Private farming

In Atlantic Canada, public sector is mostly supported by the State’s Agricultural Department but the norm has changed drastically. The changes have been realized as a result of privatization of most agricultural activities due to governmental underfunding. Over the last few decades, it is notable that most agricultural departments for various nations reviewed their services due to funding reductions and increase of private consultants. However, public agencies in Atlantic Canada continue to control the agricultural sector but the sector is dominated by private sector thus making it easy to implement any beneficial policies. Additionally, the research shows that state agencies have the mandate to generate and provide agricultural information by conducting their investigative programs, hence can ensure effective dissemination of any effective policy to assist farmers (Marsh & Pannell, 1998).

Most of the modern agricultural models have been conceptualized towards business orientation where the producer is separated from the marketer. Such attributes attracts investors or private entities to take up the outsourced work of marketing. It means the farmers enjoy the funding and researched information from the investors, as they are always profit-oriented entities. A major benefit of outsourcing some agricultural services is that the farmers enjoy the funds from private entities, especially in the places that were under-looked by public agencies. The current situation in research agencies where private sectors are requested to apply for research grants is a major example that shows private organizations are taking superior tasks for improving agriculture. Private organizations contribute to prioritized research and formulation of agricultural policies. As such, this research project is aimed at achieving its objectives to explore the best ways that can be implemented to improve the Atlantic Canada’s agricultural sector.

### Changes of Agricultural Sector

As noted earlier in previous section, there has been a rapid change in the services covered by the public agencies. Research and Development organizations have been taking more practical positions in adopting, facilitating, and commercialization of research outcomes. Various research organizations are determined to encourage effective connection between agricultural industry and public institutions. Unfortunately, there have been concerns about the responsibilities, accountability, and accessibility of information within private and public sectors, as they compete against each other. Various researchers found out that private sector have the tendency for not sharing crucial information that may help the society, especially when they implement intellectual property rights on their innovative ideas (Marsh & Pannel, 2000).

Another concern is the rate at which public sector are losing expertise in areas of research as well as the availing important information that is helpful to farming industry. Moreover, the implementation of governmental policies that favors and encourages private investors since it makes several agricultural activities to be commercialized. As such, this paper explores how technological enhancements can be used to improve the flow of information and networking in farming organizations and communities, as well as the overall agricultural sector. Over the last few decades, it is evident that the use of technological innovations in North America has been widely embraced and has changed the whole farming approaches. It means agricultural sector has been modernized in most regions, although the private sector has played a core role in production and transfer of beneficial information through the use of distributed technologies.

The farmers have also adopted a new paradigm of working as groups to achieve their objectives at ease due to complexities of ideological concepts of using modern technologies. As such, agricultural officers are seen as not only technological experts or agricultural scientists but also information facilitators in farming industry. Fortunately, the formation of farming groups have influenced farmers to participate in research and technological innovations, resulting to easy adoption of new farming methods where there is more emphasis on learning and better methods of information flow. Such emphasis helps the farmers to control the format and method of information dissemination with the help of technology. The technological understanding possessed by farmers provides a better environment for new and modern farming integration, which is a core objective of this research project.

Moreover, the group-based farming is usually recognized at regional and local level where issues are investigated, ideas are shared among members, as well as the feedback is given to researchers to improve technologies or come up with new innovations. Farming groups may include non-profit cooperatives and commercially-oriented companies that provide typological representation to farmers in local and global markets. According to Gianatti and Carmody (2007), farming groups have effective relationship with researchers, as they provide valuable connection for implementing the recommended outcomes, thus playing a pivotal role in promoting research-based innovations. In this case, group-based innovations can help the farmers with relevant information about the innovated farming technologies, which allow them to adopt it practically with other members or peers. Additionally, farming groups form a strong association that links farmers with other agricultural stakeholders such as research groups, agribusiness organizations, and the policy makers across local diversity or region.

### Changing Information Communication Technologies (ICT)

ICT are electro-based systems that are used for processing, transmitting, and retrieving information. Such benefits were realized with the advent of World Wide Wed where computers were able to communication with Servers through internet connection from any part of the world. The advent of Web platforms facilitated virtual connectivity, especially the installation of third party apps as well as integration with communication and hardware systems. For instance, the development of smart phones with inbuilt applications communicates effectively, especially in accessing of specified line of information such as forecasting weather. Such technological integration maybe be helpful in providing direct connection with other related software that have enhancements for combining information for effective decision making. Unfortunately, it is notable that the adoption of new technologies face substantial resistance among different societies who fear change but the future generation is likely to be comfortable with the modern technological integration such as smart phone apps and social media tools.

Most of the farming regions in North America are well connected with communication tools where farmers use mobile phones and internet for personal and business needs whilst connecting the rural and urban dwellers. Even though there is limited connectivity in rural areas as compared to urban centers, it has been noted that farmers use dial-up Internet as part of their farming investments. The increased growth of smart phone systems facilitated a modern and decentralized flow of information that is not immune to farming and the entire agricultural sector. The cellular or mobile technology has been used since 1990s where smart phones use operation system to allow installations and functioning of third party applications.

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The use of smart phones was highly commercialized when Apple and Nokia released iPhone and N95, respectively at around 2007. The development of Google’s Android also added advantage to smart phone users, especially by their availability and affordability. The process of using App-Store in Apple’s devices and Google-Play in Android phones allowed phone users to install or download the applications directly to the smart phones as compared to traditional process of installing apps via a PC. As such, it is a noble course to download and install apps directly as it also allows third party or purpose-built solutions for easy access and retrieval of communication and information.

The current situation in the agricultural industry across the Atlantic Canada is noted by poor usage of mobile technologies despite the increased usage of smart phones and mobile devices, as compared to other developed nations. The available mobile technologies available have been identified as a poor, which a major issue affecting the farmers in remote or rural areas. Such issue arouses this research paper to explore the best approaches to be adopted by farmers in order to improve their efficiency and production through the dissemination of available information. The adoption of the new information has been driven by the needs of the farmers and the methods to achieve such solutions. Specifically, this research projects articulates the way farmers gather and disseminate the information in a more effective and reliable channel.

### The Media Factor

The media acts as a major channel for delivering or conveying information to farmers. The media channels that are mostly used in North America include online platforms, newspapers, televisions, and radio programs. The rural area across Atlantic Canada has been served by media industry for several decades. The type of information that is provided by various media channels includes market situation, weather forecast statistics, as well as the newly researched crops. Despite such importance, the media fails to alert the farmers on any weather changes in time or advice on any demanding markets. Various agricultural experts use websites and other online platforms to provide farmers with professional information but it becomes difficult to make any practical decisions based on the online advice. Therefore, coming up with effective way to alert and provide adequate information to farmers will be a major breakthrough in agricultural sector, as it will create a strong relationship between the farmers with other stakeholders. The best solutions will be the one that conveys information services

## Statement of the Problem

It is a fact that the world's population is on the rise, and an unfortunate turn of events is the fact that the world’s resources will soon not be enough to feed the entire world. According to projections by experts, the population of the world will hit over nine billion by 1950 and to sustain that population will require food production to increase by sixty percent (Zhijun 2011, p. 296). Big data is a term that has penetrated the technological world in the recent years. It refers to the collection of relevant data from a vast number of sources and translating it into actionable information so as to insightfully solve problems at large scale and speed thereby improving business processes (Zhijun 2011, p. 296). To ensure that the populations in the future survive, there is a need to incorporate Big Data into farming. Using adequate information, agriculture will enter a new age where it maximizes food production.

The world today is in the information age where everything depends on it to run successfully. The new era of information is because of the immense competition in the business world forcing businesses to try and take never-ending precautions to ensure that they do not slip up. Thus, with technology levelling the playing field, there was a need for organizations to come up with a competitive edge. That advantage became information because the adequacy of information brought immense benefits. For instance, decision-making processes are smooth because the management will be able to make informed decisions. It is possible for companies to identify their problems and deal with them. Because information brought this many changes in the business world, in farming, the changes will be a sight. Brian Marshall is one of the few people who have seen the benefit of this idea and created a digital farm (Galt 2013, p. 343) that can be enumerated to achieve the farmers’ needs.

Despite having the innovating ideas to use farming applications, the agricultural stakeholders in Atlantic Canada have not embraced the power of technologies because the solutions have been poorly used in most private farms. The department of agricultural have been trying hard to standardize and providing modern information about farming methods but it has not embarked on any innovative ideas, as thought in this project. Therefore, this project acts as a breakthrough solution to be used in many farms to improve their yields.

## The Purpose of the Research Study

The main purpose of the project is to figure out and utilize the best method of increasing data collection and analysing it to decrease costs and increase productivity in the farming industry. Specifically, the project has an objective of analyzing the impacts of using the innovative solutions for providing, retrieving, and analyzing farming data to farmers for making viable or effective agricultural decisions. Existing solutions are not viable for small farms and will take even well financed farms months to execute the results. The ideal solution will be an output to provide tweaks to the daily activities of all farming aspects. The solution in mind will benefit the farming community in Atlantic Canada and the body of know as the algorithms, data processing techniques and research can be used to benefit any field where increasing productivity is a matter of big numbers.

In the current situation, most of the farmers in North America, specifically Atlantic Canada have the same problems when it comes to over spending and under growing. As such, proper data collection and analyzing techniques, the innovative farm application can determine the reasons and propose solutions for both decreasing costs and increasing quantity and quality of crops. It is factual that big data is one of the major tools of enhancing agricultural sector by using the concurrent information to tweak the way information is received and disseminated. The fact that a technological solution can help in cost reduction and increasing productivity will be highly focused in this study through the experimentation of an IT artifact that will be developed through an extensive exploration of big data. The focus of the test and exploration of valid information in agriculture will be addressing the underlying issues faced by farmers through the formulation of formidable solution that will end existing impediments for easy adoption of digital technologies through the usage of big data concepts. Clear analysis such as the use of error analysis technique will help in assessing the validity of information received as well as the effectiveness of the developed software.

The projects is also purposed to test major issues that may arise when developing the solution such as the problems in telecommunication infrastructure, required training, and skills capacity, among others. These issues have a potentiality of acting as impediments in adopting and developing agricultural digitization across the world, which increases the costs of farming and yielding low productivity thus creating the needs of conducting thorough research to end the agony faced by farmers. As such, the general purpose of this study is to improve the productivity of farmers in terms of their financial muscles and harvests. For instance, the technological solutions is expected to give actual information and better guidance on the best farming methods that will lead to high productivity at low expenses.

## Objectives of the Study

The study has the following objectives:

1. The project aims to figure out and utilize the best method of increasing data collection and analysing it to decrease costs and increase productivity in the farming industry.
2. Providing viable solutions for small and large farms for easy and cheap executions of agricultural decisions.
3. Describe and analyze agro-ecological, intra-households, and socio-cultural variables that affect the local farmers in Atlantic Canada.
4. Determine the perceptions of farmers in regards to effectiveness of technological solutions, especially in addressing the constraints faced by farmers as well as opening up opportunities.
5. Determine the impacts of implementing technological innovation in farming sector across Atlantic Canada.
6. Explore the best methods to provide the required information to farmers that improve their harvests at cheaper costs.

## Research Questions

The following research questions acted as integral frameworks that helped the research to gather the required information.

They include:

Main Research Question 1: How can technological improvements and supporting infrastructure be useful to farmers’ decision making in Atlantic Canada?

Sub-Questions:

1. What information type is needed for retrieval in Atlantic Canada?
2. What are the preferred information channels that are favourable to farmers?
3. What technological methods can be used for improving delivery of information delivery and retrieval?

# CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The Literature Review chapter provides a thorough exploration or review of the previous studies that have been conducted by other scholars about the retrieval and dissemination of information in agricultural sector. Various literal sources that are reviewed in this chapter aims at addressing the research questions outlined in previous chapter. Furthermore, the literal investigation covers theoretical and evidential aspects of the sources to demonstrate their inspirations towards achieving the technological objectives in farming sector. Consequently, the literature review focuses on various delivery mechanisms of literature through exploration of information barriers, information drivers, role of information in value chain, its dissemination within the agricultural industry.

2.2 Information Barriers

There are various studies that identify barriers to the adoption of technological artefacts for disseminating agricultural information. According to Kari (2007), the information barriers include poor technological infrastructure, political, geographic, demographics, and economic aspects. Additionally, the farm size, type of farming, human resource development, as well as poor methods of creating awareness acts as barriers to better agricultural information. Foutas et al. (2005) noted that the time for interpreting and managing retrieved information also hinders the adoption of better farming methods.

Significant communication barriers between the state agencies and agricultural officers such as researchers have been apparent. According to research studies conducted previously, agricultural expert acts as mediators between the farmers and governmental information centres in regards to dissemination of technological information (Margono & Sugimoto, 2011). The authors concluded that there is need for developing technological innovations for farmers in target locations and groups. They highlighted a number of barriers that need immediate solutions including decentralisation and tools, budget, information content, as well as the development of human resources. It is apparent that the farmers lacked updated information about the market situation such as prices and demand of agricultural products. Such information is required to be available, accessible, and reliable to agricultural experts as they play a critical role in creating a bond between the governmental agencies and the farmers. In this case, the officers need a portal where they can access bother secondary and primary information for easy data access and retrieval.

According to Foutas eta al. (2005), technological advancement and IT modernisation helped the farmers to access specified information for their agricultural sites thus easing the process of making decisions. The authors noted unfortunate findings that farmers face several challenges in managing the collected information due to insufficient time to interpret and analyse its beneficial attributes. Such notions were supported by other scholars who suggested that there is need for innovated channels for disseminating information to farmers even in areas where there is poor communication or mobility infrastructures as experienced in most African communities (Gudza, 2010). The author found out that several African nations face poor communication networks or lack of basic electricity, which influences his sentiments that reliable, affordable, and accessible information dissemination methods are required. This is to ensure there is easy sharing of knowledge and information needs.

In summary, the economic, political, information delivery methods, farmers’ personality and age impacts the way information is disseminated to or from agricultural stakeholders. Various literal sources as discussed above have explored the barriers to the delivery of agricultural information about specific crops or farmers in specific locations. As such, the information from these literal sources can be applicable for specific purpose or situations where the study took place. Fortunately, this study aims at informing the scholars and researchers that further study is needed to explore the barriers to information dissemination as well as highlighting the barriers to implementing information technology.

## 2.3 Information Dissemination Methods

The information dissemination methods in agricultural sector across Atlantic Canada take different forms or approaches. The recent trends show that the delivery of information is becoming faster but complex due to the advancements of information technologies. Nowadays, the information can be delivered virtually or electronically through mobile phone technologies, internet, audiovisual tools, radio, or even the telephone lines. Traditionally, information was delivered through prints such as newspapers, brochures, as well as letters. A face-to-face contact was also used to convey information, which means modern methods have not fully replaced the traditional ones as most of them are still being used, as noted by Woodgate & Dook (2002).

The research study conducted by Oliver et al. (2009) that explored the operational activities in production of large scale crops showed that the livestock farmers used diverse information sources as compared to those information source used by crop farmers. For instance, the researchers found that 45 percent of crop farmers used internet while 37 percent of livestock farmers also used internet as information source. Specific studies argued that there are innovative and traditional farmers in any agricultural contexts (Arstrong et al., 2008). According to these authors, the traditional farmers have the tendency of using printed information sources, have limited accessibility and skills of using the internet who prefer face to face method of distributing or getting information from agricultural experts or other farmers. On the other hand, innovative farmers collect and disseminate information through different formats using internet and other technological systems. The innovative farmers are also referred to as the learned group who are capable of using different sources of information whose behaviours of informational gathering can be influenced by variant factors such as gender, age, history, geographic, and demographic factors towards decision making process.

Licht and Martin (2006) also conducted a study that explored how various informational channels were used by farmers for their agricultural activities. The authors found out that it is important for every scholars, researchers, or policy makers to understand the methods used to gather information in order to come up with effective, efficient, and reliable dissemination methods. The study showed that internet tools play an important role for delivering information at a cheaper or effective ways, thus supporting the aims of this study for coming up with a solution that is internet-based. Similarly, Bardon et al. (2007) argued that it is beneficial to develop a specific solution for delivering information rather than using different methods that may confuse the farmers due to contradictory information.

Another literal study highlighted the roles played by governmental channels and library services in providing beneficial information to farmers (Anderson et al., 2003). The authors noted that the information services received from those sources help in alerting or preparing the farmers during their agricultural activities such as any impending drought, rain, or even disease outbreaks. The governmental information channels also provide a database of local and international data that may acts as resource servers for easy retrieval using keywords.

Another important source that was studied by Woodgate and Dook (2002) explored the usage of internet tools for supporting the information needs to farmers. The study discussed the advantages and disadvantages of using the internet as the channel of information and as the communication tool. It is apparent the usage of traditional methods of disseminating information such as seminars is not only time consuming but also costly. The authors asserted that the delivered information can be credible or effective if the farmers trust the channel or method used for dissemination.

As such, various studies have demonstrated how the internet can be beneficial in information delivery but there must be the establishment of reliable and adequate infrastructure, especially in rural areas. The development of IT infrastructure in Atlantic Canada can help the successful usage of important technological systems and devices such as satellite imaging. The development of Google Map have helped the internet users to obtain the situational images of various locations as it has enhanced satellite imaging tools for online users. Satellite imaging helps the farmers to get information for making appropriate decisions such as grazing rotation, financial management, fertiliser management, and other farming techniques.

## 2.4 Information Drivers

There are several drivers that motivate the farmers to utilize the information obtained from different sources in order to make effective decision that will increase their yields. The use of attractive and convenient messages would motivate the farmers to take relative advantage of the information to make potential and satisfactory benefits. A good example given is the adoption of modern technologies by Turkish farmers after they experienced the benefits from technological information (Sindir, 2005).

Moreover, the perceptions that the information source is reliable act as an influential factor for farmers to adopt new farming techniques. The research study conducted previously showed that the unfamiliar channels that are used to deliver agricultural information make farmers to be reluctant in experimenting new methods. However, farmers are usually ready and willing to try new farming methods when they get information from trusted channels (Bell, 2002). It means that a credible information channel is one of the major necessities towards the application of new knowledge towards the agricultural practices. The tools that influence decision making use various delivery networks such as e-mails, faxes, phone messages, word of mouth, websites, or newsletters. The provision of information related to crops and environmental conditions that are aimed at giving warning communication that makes ICT to be seen as a driver for agricultural change.

Some technological solutions aids the farmers in making decisions through documented enhancements such as GPS-related information that are capable for tracking the harvested areas or livestock, satellite imagery, and weather forecasts. In addition, the technological advancements have led to development of Smart phones, which is advantageous as they can be used for communication as well as installation of any developed technological solution for farmers and internet access. Such literal arguments suggest that the adoption of ICT in agricultural is an essential tool in information delivery but adequate infrastructure s is required for supporting any technological breakthrough in agriculture.

## 2.5 Role of Information Delivery on Value Chain

Value chain can be defined as a model that outlines series of activities that interconnects the company’s supplies with the market demand. Effective information delivery plays a critical role in value chain process that makes the today’s business society to complete globally in two aspects, either in virtual world or through physical resources (Rayport & Sviokla, 1995). It is factual that the value of any decision depends on what the participants know or belief, which means that accurate information lead to effective supply chain. Fox et al. (2000) argued that reliable and accurate information delivery helps the managers to adopt operational and tactical strategies in their companies. It means the farm managers can come up with solid decision making process if they have reliable and effective channels of information delivery.

Another literal source concluded that a value chain analysis can be used as guidance for crop farming programs such as giving agronomic information to crop breeders as a way of farming the required brand and quality of crop in the market (Hellin et al., 2010). Such notions show that adequate information plays an essential role in providing the economic and competitive position to agricultural organizations. It means information acts as a strategic asset in every farm as it has direct benefit to their financial or production results.

Various agricultural organisations face various informational related challenges including poor quality of information, information overload, poor or lack of information infrastructures or architecture, and information finding or accessibility. Such notions were supported by Schwolow and Jungfalk (2009), who argued that “that information, e.g., about customer preference and needs, brand image and employee satisfaction has become mission-critical to running and sustaining their business” (p. 4).

## 2.6 Paradigm of Agriculture Modernisation

The gap in agricultural productivity between the developed and developing regions in North America was perceived to be attributed by low usage of technological solutions. The development assistance that was attributed to agricultural sector between 1960s and 1970s led to conceptualization of addressing the issues of low productivity through direct movement of modern technologies from developed nations to developing ones. Known as the Green Revolution, the period was characterized by increased farm yields among the resource-bound farmers across the Latin America and Asia (Chambers & Ghildyal, 1985). The authors argued that the adoption of Green Revolution technologies were poorly adopted in the developing regions as the farmers had challenges in accessing agro-ecological information and lack of research centres where innovations were developed. Hence, such challenges resulted to social and distributional consequences of technological information.

There are several reasons that attributed to poor adoption of improved technologies in under-developed areas including the low education levels, fear of change of traditional practices, and poor knowledge of innovativeness. Fortunately, the shift of technological paradigm in 1970s led to the adoption of new development models in various underdeveloped regions. The increased equity, participatory development, and adoption of appropriate technological and sustainable information aroused the interests of researchers and scholars to conduct their investigative studies that benefited farmers. Such literal contribution showed that different factors contributed to technological shift in agricultural industry, where effective information is a core requirement that attracts farmers to adopt new farming methods.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This study is aimed at investigating the current and future implication of using big data analysis in agricultural industry across North America. Specifically, the project explores the best methods that would increase the collection of important farming data and analysing it to increase productivity at cheaper costs. This chapter provides extensive methodologies and other research techniques used to gather effective information for addressing the research questions outline earlier in the paper. The chapter provides a brief description of research setting including the agro-climatic, location, and socio-cultural setting of area of study. It is followed by providing the procedures used in selecting samples, collecting, and analysing data.

3.2 Research Setting

The project was conducted in Atlantic Canada where 100 farms in the region were sampled out. Atlantic Canada is a region that comprises of four provinces located along the Atlantic coast of Canada. The region is highly populated with an estimated 2,300,000 people in 2011. It means the agricultural productivity has to be increased in order to feed the increasing population and decreasing agricultural land. Atlantic Canada is the largest producer of French fries, fruits, and wild blueberries across the world. Additionally, it is the first region with largest carrot processing industry in North America. Such information means Atlantic Canada is the vibrant agricultural hub, which benefits from its strategic topography for easy transportation and exports to international market. As such, the region acts as a good setting to conduct this important study, as the location is populated with different types of farmers, agricultural experts, as well as focused governmental and intergovernmental agricultural agencies. Atlantic Canada is a home for several research and development centres with an extensive networks and specialised facilities to concentrate on advanced and innovative technologies.

3.3 Data Collection Methods

The study used the filling in questionnaire method to conduct the survey for easy gathering or primary data. The survey was conducted using the Google form, which were to be distributed to 100 farms located at Atlantic Canada. This survey will be designed to understand how farmers use technology, how they farm and what would be the easiest and most cost-effective way to collect data from their farms.

3.4 Sampling of Participants

The participants were selected using the inclusion and exclusion criteria. On the inclusion criteria, the participants had to possess the following attributes:

* The participant must be a farmer within Atlantic Canada
* He or she must be identified to have been depending on agricultural as main source of income
* Must be aged 21 years and above and considered independent in running his or her own farm

On the other hand, the exclusion criteria entailed:

* Dependent farmers such as aged below 21 and working for their family farms
* Farmers who are not residing in Atlantic Canada or perceiving agriculture as ‘other’ economic activity

3.5 Distributing Questionnaires

All the selected participants were farmers from Atlantic Canada who are established in the region. The questionnaire forms were distributed electronically using Google forms enhancements by embedding the questionnaire’s link through their email correspondence of the farmers. Using electronic means is very convenient to gather the required information as it reaches wider audience base level at cheaper costs. Unfortunately, few qualified farmers responded to the participation invites due to some unavoidable challenges such as poor technological frameworks and the researcher used other means to ensure other targeted groups participate.

Other means employed include the inclusion of extension officers, professionals, and scholars by employing other mechanisms to collect information. The mechanisms used include using agricultural seminars, workshops, and events to hand deliver the questionnaires for filling.

The hand-delivery of questionnaires was faced by various challenges including limited time for event organisers and busy schedules that inhibited them from filling in the forms. Additionally, the busy schedule also caused a challenge to event participants who could not get enough time to fill in the questionnaires, thus compromising the quality of information. It was a breakthrough when one event organiser suggested distributing the forms to specified people using postal addresses in form of letters. The method was successful and the filled forms were sent back in time after carefully filling the required information.

3.6 Informed Consent

The researcher took about one week to inform or explain more about the purpose and objectives of the study before the distribution of the questionnaires. Furthermore, an informed consent document was prepared for every farmer in order to be aware about their right to participate or withdraw from the study at any level of the research. The letter was also aimed at seeking permission to have any information sought from the farmers published if need be. In this case, only 83 out of the selected 100 participants completed the survey.

3.7 Data Collection

The study used two data collection methods including employing qualitative and quantitative evaluations such as the use of questionnaire to gather information about what data is needed by farmers and the effective ways to retrieve or access that information. The techniques used to collect the farming information are described in the sections below.

### 3.7.1 Survey/ Filling in Questionnaires Research (Gathering Quantitative Data)

Conducting surveys is a major quantitative method that is used to gather information in most academic and industrial settings, especially where the study is focused on different people’s beliefs and opinions as explained by Schmuck (2006). Using the online questionnaires helped the researchers to reach a large group of intended participants conveniently. Additionally, the distribution of questionnaires is usually dependent on the resources and tools used where it is easy to generalise the results, especially when a large sample group is used.

3.7.2 The Farmers Survey

The survey to the farmers and other selected stakeholders was conducted as a way of gaining a clear understanding on what information needed by the farmers including the access methodologies, retrieval, as well as the best distribution channels within the agricultural sector in the whole region of Atlantic Canada. Prior to the actual research study, a pilot survey was conducted after obtaining a project approval from the University. The pilot project was conducted to guide the actual study about the information needed by farmers as well as the sources to the beneficial data. Similar to the actual project, the questionnaires in the pilot project were distributed electronically using Google form through direct emails of 20 participants who were sampled randomly. Only 15 out of 20 of the selected participants filled in the questionnaires. Some small corrections were done on the questionnaire such as deleting irrelevant research question that was perceived as a repetition by the participants. Additionally, the survey included both open and close-ended questions in order to provide an opportunity of giving all information that might not be captured when closed-ended questions are used only.

The questionnaire used in the research project had two different sections that were designated to be simple, concise, and clear. The first section required demographic data such as gender, age, location of the farm, and education level of the participants. The second section asked for information needs, as well as the delivery methods that can be available to them in heist of accessing or retrieving information. Inclusively, the questionnaire also asked for attitude, expectations, and the type of information towards the delivery mechanisms that are available, as well as the preferred methods.

The type of questions asked in the questionnaire varied as there were open-ended, close-ended, and multiple questions. Open-ended questions allowed the farmers to provide descriptions about their farms and agricultural activities, property details, as well as the way information delivery can be improved. Closed-ended questions outlines possible answers where participant may give Yes or No answer or evens select the most appropriate answer. On the other hand, the multiple-choice questions included Yes or No answer or even selecting the most fit choices from the given answers.

3.8 Data Analysis

After conducting surveys, all the data collected were entered in online software known as Qualtrics Survey for a “manual” data analysis process that helped with building the algorithm for analysing farming data. This algorithm had a “goal” given out from the survey and a “starting point” which was a constant variable upon the data that was fed to the software. The data stored in Qualtrics Survey was later encoded into the SPSS, statistical analysis software. Similar responses for each question were examined first and grouped together based on the concepts of the study. Some statistical algorithms such as mean, percentages, as well as standard deviations were used to forecast the expected patterns, followed by tabulation methods such as ANOVA in order to explain the findings of the study.

3.8.1 Quantitative Analysis

Quantitative analysis, also known as statistical analysis was used in this study to examine the collected data’s dependent variables. For instance, it focused on investigating whether the posed answers sheds the light on what was asked or helps to predict the expectations.

Initial Assumptions

The literature review gave the assumptions that there is a great relationship between the research results and other predominating characteristics such as farmer’s age, gender, size and location of the farm, as well as farming activities. One of the major assumption was that some demographic information can affect the way data collection technique are used on the farmers as well as the type of farming data required. For instance, the gender information acted as a common variable since it impacts the way users use ICT. Age also matters since several literal studies claimed that younger generations are much comfortable in using modern technologies, as compared to older generation. Location and farm size information was gathered to investigate the ICT infrastructure and communication coverage to the underlying issues. The assumptions were that the side of farm or type of farming can determine the way information techniques or type of data needed.

3.8.2 Measuring Methods Used

In research, there are four types of measurements including nominal, interval, ordinal, and ratio measurements. This research study used nominal, ordinal measurements, and interval. Nominal measurements were used in the study to investigate the obtained results based on demographic data given. On the other hand, ordinal measurement was used to rank and investigate the specific information channels favourable to farmers, as well as perceptions on their access and retrieval of information. The interval measurement was used to measure how the perceptions of farmers towards information delivery changed over a given period.

3.8.3 Data Collation and Cleaning

The data collected was collated using Excel and SPSS software. The Excel was used to clean and check the research questions for validity using:

* Clustered questions
* Structured data in every question
* Removal of data anomalies or outliers

CHAPTER FOUR: RESULTS

## 4.1 Introduction

After conducting the surveys in Atlantic Canada, only 83 out of 100 respondents provided the information that can be used in the study. Out of the 83 respondents, four of them were disqualified through exclusion criteria leaving only 79 surveys for considerations. The excluded surveys were either not a farmer, insufficient information, and duplicated results. Eight more surveys were disqualified for not answering one question that required the participants to provide information about agricultural behaviors 10 years prior to the survey. The question had possibilities for being irrelevant to participants who were not in farming industry those days, thus could not comprehend any information. As such, the eight surveys were included in response analysis for each question but were excluded from post-hoc data analysis.

## 4.2 Demographic Variables

### 4.2.1 Age, Gender, and Education of Participants

Age

The participant’s age was important in the study as it determined any connection with the usage of ICT tools. The age bracket for the participants was above 21 years since it was perceived that the median age of farmers is always higher as compared to age brackets of other sectors. The following graph showed the participants’ ages.

The chart above shows that a large percentage of participants were aged between 26 to 30 years followed by 46-50 years.

Gender

Out of the considered 79 participants, 62 of them were males while 17 were females, which show that the largest numbers of farmers were males. Many literals studies confirm that farming industry is usually dominated by males (Elizabeth & ZIRA, 2009). The gender phenomenon was used in this study to examine the connection between the agricultural information to the farmers’ gender, which affirmed the results that agricultural industry is male dominated sector.

Education

The study recorded the participant’s educational level to investigate the connection between the use of computing tools and the educational level. It is factual that the delivery of information through ICT can be very challenging when workers are unskilled or illiterate. The following chart demonstrates the percentage of different levels of education possessed by the farmers.

The statistical results showed that the most of the farmers had post-secondary education although the ones with secondary education had substantial percentage.

### 4.2.2 Farm Attributes: Size, Location and Type

Various literal studies evidenced that the size of the farm plays a crucial role in creating a strong connection with the usage of internet in seeking beneficial information for management purposes (ABS, 2009). As such, this project requested the participants to provide their farm sizes as a way of affirming the relationship between the ICT, size of the farm, and other common variables in relation to the needs of farming information and its retrieval.

Geographic Location

The study focused on farmers who have the farms in Atlantic Canada only. The region comprises of four provinces that are located along the Atlantic Coast, with exclusion of Quebec. The provinces included Maritime Provinces such as Nova Scotia, Prince Edward Island, New Brunswick as well as Newfoundland and Labrador, which is the eastern province. The location of the farms was crucial since the project aims at addressing the issues faced by farmers in the area to increase productivity and reduce cost of product through delivery of effective agricultural information.

Type of Farm

During the study, the participants were asked to provide their farm types in order to examine their impacts on the farmers’ behavioral access or retrieval of information. The farm types were also compared to their specific locations to determine if they are favorable or not in terms of climatic or environmental conditions. The type of farm was also comparable to the telecommunication coverage in the Atlantic Canada thus helping in understanding the farmers’ preference of ICT drive retrieval or delivery. Even though the surveyed number of farmers is small, it provides an opportunity for comparing the size of the farm with the existing information about the location. The survey showed that a large farm has possibility not to supplement the income due to involvement of other farm types such as livestock.

## 4.3 Farming Information Resources

Farmers and related stakeholders in Atlantic Canada can access, find, receive, or retrieve the agricultural information from various information sources available in the region. Some of the resources include printed materials, agricultural workshops, seminars, online resources, radios, help lines, and the use of mobile phones. Other sources of information included local libraries, farming organisations, private consultants, and farmers’ groups or associations.

### 4.3.1 Information Channels used by Farmers

The questionnaire posed a question on which information channels used by farmers and the results were much positive. Various information resources were outlined but most of the participants showed that the farmers’ groups are the major sources of information to the stakeholders across Atlantic Canada. The following table demonstrates the percentages on how different resources were ranked by the farmers as the source of their farming information.

|  |  |
| --- | --- |
| Information Resource | Percentage of Usage |
| Farmer group | 88.6 % |
| Website/ Internet | 84.8 % |
| Printed Resources | 81 % |
| Neighbours or other Farmers | 75.9 % |
| Radio | 49.4 % |
| Mobile Phone | 50.6 % |
| Personal Knowledge | 55 % |
| TV | 26 % |
| Local Library | 1.4 % |
| Others (Education or Research, advisor or Consultants) | 16 % |

### 4.3.2 Most Accurate Information Source

In the survey, the farmers were requested to provide accurate information sources where the participants were required to use Likert Scale to rank each sources. The following table summarizes the ranking of those who said strongly agree or Agree on each information source.

|  |  |  |
| --- | --- | --- |
| Information Source | Strongly Agree | Agree |
| Other Farmers | 25.6% | 56.4% |
| Farmer Groups | 55% | 43% |
| Private Consultants/ Companies | 15% | 49% |
| Extension Workers | 18% | 61% |
| Government Agencies | 12% | 61% |
| Web/ Internet | 16% | 65% |
| Mobile Phone | 8% | 45% |
| Radio | 5.5% | 50% |
| TV | 1.4% | 29% |
| Local Library | 1.45 | 12% |

## 4.4 Type of Information Needed by Farmers

The questionnaire asked about the type of information required by the farmers as a way of improving their productivity and agricultural sales. The following table provides detailed results that were given from the multiple choices.

|  |  |
| --- | --- |
| Type of Information Needed | Percentage |
| Weather forecast | 95% |
| Varieties or Crop types | 90% |
| Managing fertilizers | 89% |
| Market prices | 80% |
| Pest and Disease Controls | 77% |
| Sustainable Farming | 77% |
| Financial Advisory | 64% |
| Health or education information | 55% |

# CHAPTER FIVE: DISCUSSION

## 5.1 Introduction

This chapter provides an extensive discussion of the results given in Chapter 4 in order to illustrate the study’s relevance to the research questions. The research questions helped in formulating specific framework to get the actual information needed to achieve the objectives of this study.

## 5.2 Research Questions

As outlined earlier, the research questions include:

Main Research Question 1: How can technological improvements and supporting infrastructure be useful to farmers’ decision making in Atlantic Canada?

Sub-Questions:

1. What information type is needed for retrieval in Atlantic Canada?
2. What are the preferred information channels that are favourable to farmers?
3. What technological methods can be used for improving delivery of information delivery and retrieval?

## 5.3 Informational Retrieval for Agricultural Sector in Atlantic Canada

This section summarizes the results that were found for the research questions outlined above. On the types of information needed or retrieved for Atlantic Canada farmers, it was apparent that most of the farmers always require the information that is relevant or familiar to them and the one that addresses the issues affecting them in their farms or local areas. The study reveals that farmers have a tendency of seeking information every time they are faced with agricultural challenges. The information sought includes the one relevant to their originating geographic or local environment rather than looking for information that is implemented in other regions or localities.

The survey showed that the most frequent information that is needed by several farmers is related to fertilizer management, weather forecasting, cropping, marketing prices of products, sustainable farming, pest and disease controls. According to Hill, the behavioral pattern noted from farmers when seeking agricultural information creates a major influence in decision making process. It was apparent that the farmers were frustrated by the increased amount of farming data availed to them through electronic or other means since they have limited time to read and understand any new concept. Farmers were overwhelmed by large amount of information that is available, thus making it hard to retrieve, select, or follow up the innovative ideas that are suitable for improving their farming methods. This study confirms that most of the farmers do not get time for concentrating thus looking for information that can address the current issues affecting their farms as the information that do not help them instantly makes farmers inhibits their chances for innovations or new technologies.

According to the study conducted by Elsey & Sirichoti (2003), the attitudinal change of the farmers towards the ICT usage and other technological tools happens after they realize the relative advantages to their farming efforts. The authors found out that the farmers have already learnt the benefits of using information technology but the generalization of available information. Therefore, they lessen their perceptional efforts of implementing the information, as they only have determination of retrieving relevant information that is specific to the issues at hand. As such, the solutions to the farming challenges in Atlantic Canada require the technological experts to develop or design farming-specific tools that require less time and lower costs to retrieve, access, and implement the information given for effective farming processes.

## 5.4 Preferred Information Channels

According to the current findings, it is apparent that the farmers in Atlantic Canada prefer getting information from the sources or channels that are familiar or known to them. Such findings are consistent to the ones given by Elsey & Sirichoti (2003), which showed that innovational is dependent on informational sources that are familiar and important to the adoption of new farming knowledge. According to the study, the participants ranked farmer groups and other farmers as important channels or sources for information retrieval. Farmer groups are usually community-based that are established as a results of regional or local issues in heist of agricultural production.

The technological advancements have played a major role in influencing the way deliver channels are preferred by farmers when accessing or retrieving information. As evidenced in this study, internet has been rated as third most delivery channel used in Atlantic Canada due to the increased availability to tech-savvy devices such as mobile phones, laptops, and similar gadgets. According to Dey et al. (2008), the computers, mobile phone technology, and internet connectivity have capabilities of delivering information conveniently and to a large audience. Unfortunately, poor understanding of information technologies among the farmers hinders the adoption and distribution of technological knowledge in farming industry. Lack of proper IT infrastructure in some regions across Atlantic Canada has caused difficulties in adopting ICTs for farmers. From the survey, it was apparent that several farmers know the benefits of ICT and have the potential of using it in their farms but there is no favorable or adequate connectivity and infrastructure for supporting information delivery.

# CHAPTER SIX: CONCLUSION

## 6.1 Introduction

This section summarises what has been learnt from the research study. It starts by highlighting the implications of the study and suggestions, as well as the needs for future research.

## 6.2 Implications of Big Data on Agricultural sector in Atlantic Canada

The development and establishment of information communication technologies is found to be driving both social and economic changes among the farmers and other agricultural stakeholders. Technological communication and digital media such as smart phones and internet have been taking a leading position in the information retrieval and delivery.

## 6.3 Using Bottom Up Approach to Build ICT

The use of effective technological application for agricultural information delivery needs to start with clear identification and development strategy for the target subject, i.e. farmers. Bottom up concept is much favorable to the farmers in Atlantic Canada, as suggested by the results of this study. This is especially in improving the information delivery and design processes. Bottom up approach allows the farmers to develop technological knowledge and developmental design at lower progressive rate to address their needs. It means the farmers are the one who generates the need of information systems instead of information providers. Some revolving factors described in this study such as age, gender, educational level, and inadequate technological infrastructure, as well as large data sets can be considered more in bottom up approach.

The farmers’ opinions should to be considered as they expressed the need of having relevant, concise, and timely information for their agricultural breakthrough. It is recommended that farmers the information providers need to consult the farmers when making decision regarding the best information system to use, as well as time needed and format favourable to them.

## 6.4 Supporting Mobile Technology through ICT Infrastructure

The research results indicated that there are several factors that need considerations for improving the dissemination of agricultural information across the Atlantic Canada region. Poor IT infrastructure became a major problematic issue that was coined by farmers, as it hinders their efforts to gather, retrieve, and interpret information. Apparently, this study showed that the farmers are overwhelmed or frustrated by the increased and conflicting information available on the internet. Additionally, the changing technological devices such as smart phones, tablets, and specific farm technologies have changed the traditional computing systems such as personal computers, thus creating the need to modernize the technological infrastructure such as internet frameworks.

## 6.5 Establish and Support Farmer Groups

There were suggestions that farmer groups should be funded in terms of financial assistance or employment of staff with high qualifications. It was suggested that agricultural information should be relayed through various internet networks such as the fast-growing social media including Whatsapp, Facebook, or Twitter.

## 6.7 Conclusion and Suggestions of Future Research

In summary, the technological applications and devices, as well as supported infrastructure need to developed in the effort of supporting the farmers across the Atlantic Canada. Some technological solutions such as GPS-related precision farming are a good example that helps growers to make their farming decisions. Precision farming is much concerned with photo-sensitivity, as well as precise location technology such as sensory weed control technology.

The answers to survey questions illustrated that farmers are more in need of agricultural information that is delivered electronically due to its convenience but the efforts were hindered by poor connectivity and inadequate technological infrastructure. One of the advantage of using electronic channels for retrieving, accessing, and delivering information is the mobility such as the usage of portable and smart phones that allow them to receive or send field data at their convenience time. It seems inappropriate to have several telecommunication devices or new information channels or apps while the farmers are having difficulties in accessing their information networks, thus an urgent solution is needed for future assistance. Therefore, there is need to design and develop the electronic farm application that will derive Atlantic Canada’s farmers from challenges of accessing agricultural information.

### 6.7.1 Farmers’ Trusted Channels and information sources

This research study found out that farmers always look for the required agricultural information when they experience any problem in their farmers or when they are seeking solution from their colleagues. In other words, farmer always use or seek information delivery mechanism that is familiar or known to them. As such, farmers need considerable persuasion when initiating change of farming methods as they only accept innovated ideas from trusted channels. They are always willing to copy what other farmers are doing in practice but fears to initiate change for themselves because they rely on what has successfully been practiced. The internet provides a wide range of information but farmers are always selective in applying the online data. In this case, the information providers should improve their associations and interactions with farmers through the dissemination of agricultural data via channels and formats that are known to farmers.

Additionally, farmers need to be involved in any process of delivering agricultural information through a bottom up approach where farmers are the only entity that requests information rather than providers giving out. It means that information providers will only be focused in giving out what farmers need through channels that are familiar in the field such as though Apps on their smart phones, tablets, or even PCs for making farming-related decisions.

In conclusion, this research project has achieved its objectives of investigating the current and future implications of big data including the usage of available tools for disseminating or retrieving farming data in Atlantic Canada. The real issues found to be challenging farmer include poor technological infrastructure, huge data sets, and legitimacy of information found, received, or retrieved. Some of the preferred methods of information delivery includes electronic, face-to-face contact, printed materials, and through specialized agricultural officers.

### 6.7.2 Recommendation

The dynamic implications for the big data can be addressed through electronic means where viable application can be developed and implemented using the available technological breakthrough. The proposed application, as described in the Appendix D will provide convenient information through simple dissemination of agricultural information. The proposed application will provide effective access, retrieval, and reporting of any agricultural condition that guides farmers when making important decisions on their farmers.

Even though the study has achieved its objectives, it accomplished them by using the guidance of research results that were generalized to farmers from different agricultural specializations. It is suggested that future study need to be conducted that focuses on each agricultural sector where crop production farmers can be separated from livestock farmers.

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**APPENDICES**

## APPENDIX A: RECRUITMENT LETTER

Dear Research Participant,

I am a candidate at University of Liverpool pursuing MSc in Software Engineering and would to invite you in due respect and honor in participation of my research study to investigate the current and future implication of big data in North America, specifically Atlantic Canada.

Participation in this study involves:

* *Completing a Research Survey*

**All the information given will be treated as confidential.**

The study is aimed at improving the dissemination and retrieval of farming information for sustainable agriculture in relation to decision making in Atlantic Canada through exploration of information delivery mechanisms and establishing the methods that are preferable to farmers and other agricultural stakeholders.

The survey will take approximately 20 minutes.

The Informed Consent Agreement, Information Letter, and the Questionnaire are hereby attached.

Thank you for your generous support.

Regards,

**Elad Shalom**

MSc in Software Engineering Candidate

University of Liverpool

**elad.shalom@online.liverpool.ac.uk**

## APPENDIX B: INFORMED CONSENT AGREEMENT

***Investigating the implications of Big Data for agriculture in Atlantic Canada***

As per my understanding, it is apparent that participating in this project involves the following activities:

* Completing a Research Survey

The approximate time estimated for this research survey is around 20 minutes.

I also understand that the information will be kept confidential and private and will be purposely be used for the study. It includes not being identified as an individual in the research report using the provided information. I agree that I can remove all or part of information, or withdraw from the study at any time and at my own pleasure without any penalty or explanation.

Therefore, I agree to be participant of this research project.

Name: ………………………………………………….....

Signature: ………………………………………………..

Date: ………………………………………………………

## APPENDIX C: INFORMATION LETTER

Dear Research Participant,

I am a candidate at University of Liverpool pursuing MSc in Software Engineering and would to invite you in due respect and honor in participation of my research study to investigate the current and future implication of big data in North America, specifically Atlantic Canada.

Participation in this study involves:

* *Completing a Research Survey*

**All the information given will be treated as confidential.**

The study is aimed at improving the dissemination and retrieval of farming information for sustainable agriculture in relation to decision making in Atlantic Canada through exploration of information delivery mechanisms and establishing the methods that are preferable to farmers and other agricultural stakeholders.

The project has been approved by the University Panel including the ethics committee. The provided information will be used for this study only without the identification of individuals, organizations, place, and time in order to ensure anonymity and confidentiality. The filled in questionnaires to be used in surveys will be secured at the faculty where no third party will be allowed to access the information, whatsoever.

Therefore, any information collected from your will be confidential and private.

As a participant, you have all the rights to withdraw from the study at any stage of research process and at any time. Additionally, you have the right to remove all or part of information provided as you wish.

Thank you for your assistance.

Regards,

**Elad Shalom**

MSc in Software Engineering Candidate

University of Liverpool

**elad.shalom@online.liverpool.ac.uk**

## APPENDIX C: QUESTIONNAIRE

***(Please mark × in the textbox * that is before every choice made)**

**PART I: DEMOGRAPHIC INFORMATION**

1. What is your gender

Male **Female

1. Which age-group do you belong?

**18-2021-25 26-30  61 and above

**31-35 36-40 41-45

**46-5051-55 56-60

1. Educational level

Primary school Certificate Bachelor Degree

High School Undergraduate Diploma Masters Degree or higher

1. What is your location’s post code?



1. Your Occupation………………………………………..
2. What is your farm size if you are a farmer? .......................................................
3. What type of agricultural activity do you practice (You may select more than one choice)

Crop growing (Please specify)……………………………………

Livestock (Please specify)……………………………………

Others (Please specify)……………………………………

PART II: BIG DATA RESOURCES

1. Which information channels do your use currently for accessing agricultural information (You can select more than once choice)

Television Mobile Phone Local Libraries

Internet & Related Radio Printed sources

Personal Knowledge Other farmers

 Other (Please be Specific) ………………………………………………..

1. The main providers of agricultural information. (Please rank from the main important to least. NB. The most important provider is 1 while the least is 11)

Local Library

Printed Materials

Farmer group

Other farmers

Private Companies

Internet/ Related

Extension workers

Government agencies

Mobile Phone

Personal Knowledge

Other (Please specify)…………………………………

1. Information type: What type of information do need for farming (You can choose more than one choice)

* Disease and pest control

Financial advice

 Market prices

* Cropping or varieties
* Fertilizer management

 Weather forecast

 Education/health information

 Farm sustainability (e.g. salinity)

 Other (please specify) ………………………………………………

1. What would you suggest to be used in future for effective information delivery?

……………………………………………………………………………………………………………………………………………………………………………………………………………

1. What are some of the challenges do you encounter when retrieving or accessing the information required for farming? ………………………………………………………………………………………………………………………………………………………………………………………………………………
2. In your own opinion or suggestion, what do you think is required for improving agricultural information dissemination or delivery methods for decision making purposes?............................................................................................................................ ………………………………………………………………………………………………………………………………………………………………………………………………………………

The End.

Thank you for participating.

APPENDIC D: FARM APP

Version *<1.0>*

Introduction

### Purpose

The purpose of this design and specification file if to track and document the required data for effective design and architecture of the application. It guides the app development team on the matters concerned in architectural design of the proposed system. The information of this document was articulated during the project’s planning stage that is intended to give articulate information to the entire project team including developers. This design and specification document is prepared using the user-centric perspective, which includes identification of management strategies of farmers as well as the system boundaries. The document outlines the information flow and actors of the proposed app that will be based on Service Oriented architectural designs. Such architectural design s characterized by its capabilities of developing components that are integrated with common or local vocabularies.

### General Overview

The Future Farm App is proposed to come up with better farming synergies that integrates the ways things are done for diversified market situation of farming approaches. It is purposed to provide sustainable agricultural standards with the implementation of elaborated system management strategies. The app is developed in respect to ecological situations, demands from both the rural and urban locations. Strategies used must be having simplistic approach that is flexible enough for easy adaptation to environmental and economic changes. The increased demand for viable markets of farm produce as well as looking for prerequisite value-added chains will be solved using the proposed app that aims to provide timely and sufficient information. Such information will be helpful to farmers in making appropriate decisions and giving out documentary evidence in their agricultural activities. The app also have strategic objectives of using high-tech approaches of information and communication including the use of sensors for collecting geographical data. Such geo-referenced data collection approaches includes online sensors, remote sensing, and use of public databases to allow farmers have easy access of quality and accurate data for appropriate decision-making process. Having automatic data handling and acquisition will ensure successful farm management process for the farmers to adapt to the rapidly increasing demands in agricultural sector across European nations and the rest of the world. In other words, the farming app balances the technological breakthrough with the combination of socioeconomic and environmental needs with the role of information management. Intensive usage of appropriate knowledge and information ensures substantial activities that are beneficial to all commercials farms across the world.

### Standards

The benefits of using the integrated systems in farm management have been highly beneficial to some agricultural entities. Unfortunately, the approach of precise farming is yet to be adopted in mainstream agricultural sector. The technological changes have great impact on complexity of the systems as it becomes as an inhibitor for adopting the system for implementation thus creating uncertainty to either financial or economic benefits.

As such, the current collaborative FarmApp project formulates relevant objects and strives to achieve them. The objectives includes:

1. Developing a future application in perspectives of both developers and other stakeholders through the identification of key drivers and the potential impacts in crop management
2. Conducting thorough analysis of both informal and formal management approaches in farming in order to identify the required mechanism of practical management that constitutes standardization and compliance
3. Specify the required methods, information, and knowledge for adopting the system, which includes requirements for highly-valued markets, communication and recognition of cultural or ecological diversities, as well as sharing better farming methods.
4. Developing technological tools and integrated techniques for efficient and effective compliance with farming standards
5. Creating assessments that looks at technological, environmental, and socio-economic understanding to utilize the opportunities whilst avoiding the usual problems

### Architecture Design

The FarmApp’s architectural design will consist of distributed web-service tools that offer appropriate functionality. Implementing each of the web service solution varies as it depends with the flow of the required information that is clearly elaborated. The application requires well articulated, defined, and agreed vocabularies that communicate with each other for easy service deliverability. The service functionalities that create this software architecture includes agronomic, financial, modeling, and optimization, among others. It means the architecture of the system is dependent on individual case, as it is determined by the knowledge and availability of exploiting the produced information in different apps. As such, the architecture of FarmApp can’t be specified as it comprises the collection of different services that are networked together.

Each service is interconnected to the other using a STEM interface that is flexible and harmonized to enable different choices in the system thus, business models and structures are highly proposed.

The system includes the process, information, and actors that are integral part of key activities in farm management processes. The actors include markets, farming advisory, legislation, weather services, databases, decision maker and external services. The interface comprises of task controllers, tractive units, sensors, implementation controllers, and technological providers, among others.

### Hardware Architecture

Data handling and acquisition that is collected through automated tools such as online sensors requires facilities that are integrated to store and ensure easy exchangeable of information. This program requires relational database with structural design for storing the acquired information. Other XML tools will ensure the sharing of semantic mapping, either public or locally for easy export and import of sensed data.

The data collected is either imported in terms of CSV, Binary, JPEG, TIFF, XML, XLS, or XLSX file formats. The application stores the information into the database while on the other hand the client can access the information using the interactive interface depending with the requests sent.

### Software Architecture

State of the art techniques were formulated to ensure prototypic implementations are achieved for ensuring modern and flexible management of the farms. The Service-Oriented conceptual architecture that includes various parties such as consumers, brokers, and providers, as illustrated below.

Publish

Service Contracts

Find Interact

All the prototype services of the application uses REST interface, which is appropriate for making the programmers to easily integrate several services with the client app. As such, .Net-Frameworks needs to be developed for easy integration and access to the app services in Ms Windows platforms.

The clients will be required to create their personal accounts when accessing the system for easy encryption and improved security mechanisms.

### Software Components

The proposed application will have several components and actors that will ensure its performance and interactivity. The components include:

* Catalogue-it is a request controls that provides metadata for repositories and standards
* Repository/ server- delivers or stores the requires data based on the standards set
* Rules- assesses the compliance and definition of data based on the clients’ requests of the system itself
* Management Information system- the clients’ application that can send queries for repositories of catalogues depending on the parameters set

The actors include:

* the catalogue providers-catalogues helps in searching for repositories or standards
* Management information system- the application itself that is either integrated in web-based or desktop platforms
* Farmer- can either be the direct farmer or advisor of farm produce who needs the information to manage or sell the harvest
* Publisher of standards- the entity that formulates professional content or implements controls

### Use-Cases

Various cases are identified for easy usage in the proposed application. They include:

* Catalogue usage for locating appropriate metadata on the available repositories
* Server usage for retrieving metadata
* Configuring the information system as per the selected standards and view the information of those specific standards
* Server usage for rules retrieval in relevance to specific contexts