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Transforming Agriculture: Exploring Precision Farming Research Needs

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Abstract

Information Technology, Information Systems, Decision Support and analytics play an increasingly important role in the practice and science of agriculture. Precision farming or precision agriculture uses tools like sensors, the global positioning system (GPS), Cloud data storage, and analytics and decision support tools to increase efficiency and effectiveness of land, labor and machines used in farming. JMWAIS publishes a wide mix of scholarship and research related to Information Systems and Information Technology. Given our origins in the Midwest United States we also encourage and publish articles especially relevant to our region. Precision farming is an important topic for Midwest US.

Keywords: Precision agriculture, information and communication technology, data analytics

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1. Overview

According to the United States Department of Agriculture (www.usda.gov), the Midwest United States produces a wide diversity of agricultural products, including corn and soybeans. The Midwest U.S. "represents one of the most intense areas of agricultural production in the world" and has a large impact on the global economy. The Midwest U.S. is the nation's and the World's breadbasket. In 2017, farmers in Midwest U.S. sold more than $76 billion in corn, soybeans, livestock, vegetables, fruits, berries, and nursery/greenhouse plants. There are over 127 million acres of fertile agricultural land in the Midwest U.S. and approximately 75% of that area is planted in corn and soybeans each year. Agriculture, the science or practice of farming and production of food and other goods, is an essential activity that supports human life. Information Technology and Information Systems (IS/T) play an increasingly important role in the practice and science of agriculture. IS/T have become essential to efficient and effective agriculture and precision farming.

The Journal of the Midwest Association for Information Systems (JMWAIS) at URL http://jmwais.org/ promotes research and scholarship about IS/IT in general and given our regional origins we especially encourage articles that meet specific regional needs. Precision agriculture and farming is a critical topic for Midwest U.S.. The application of Information Technologies, including the Internet of Things (IoT), automation and machine learning, and Artificial Intelligence (AI), is transforming agriculture and farming. More applied research on these applications can influence the future of farming.

In approximately 8000 B.C. when farming communities were initially established, the population of planet Earth was around 5 million people. On July 30, 2019, the World population was approximately 7.595 billion people, cf., www.census.gov/popclock/. To feed the growing population, more efficient and more effective farming developed to provide an expanded food supply. To meet the food needs of a global population expected to reach 10.85 billion people on July 4, 2100, more efficient and better technology-supported farming is needed. Computerized decision support and analytics using new data is central to site specific crop management and better farm management. Studying and creating new capabilities to use the technologies of precision farming will feed our growing population.

2. Defining Precision Farming

According to Covey (1999), "Precision farming is an integrated agricultural management system incorporating several technologies. The technological tools often include the global positioning system, geographical information systems, yield monitoring, variable rate technology, and remote sensing." He notes that "just having information about variability within the field doesn't solve any problems unless there is some kind of decision support system (DSS) in order to make VRT recommendations." VRT is an acronym for Variable Rate Technology.

Farms.com explains "precision agriculture, also known as precision farming, is a broad term commonly used to describe particular farm management concepts, sometimes referred to as satellite farming or site-specific crop management (SSCM). The term first came into popular use with the introduction of GPS (global positioning systems) and GNSS (global navigation satellite systems) as well as other methods of remote sensing which allowed farm operators to create precision maps of their fields that provide detailed information on their exact location while in-field…. The use of decision support systems (DSS) is often incorporated into precision agriculture as it pertains to managing the information collected through spatial and temporal practices."

The HGCA Glossary (2009) defines precision farming as "management of farming practices that uses computers, satellite positioning systems, and remote sensing devices to provide information on which enhanced decisions can be made. Sensors can determine whether crops are growing at maximum efficiency, highly specific local environmental conditions can be identified, and the nature and location of problems pinpointed. Information collected can be used to produce maps showing variation in factors such as crop yield or soil nutrient status, and provides a basis for decisions on, for example, seed rates and application of fertilizers and agrochemicals, as well for the automatic guidance of equipment." Pierce and Novak (1999) point out that precision agriculture enables farmers to do the right things, in the right places, in the right times, and with the right methods.

Wolfert, Ge, Verdouw, and Bogaardt (2017) suggests that precision farming or smart farming's future may result in a continuum of two scenarios. One option is a "closed system that the farmer is part of a highly integrated food supply chain" and the other is an open and collaborative system that "the farmer and every other stakeholder in the chain network is flexible in choosing business partners as well as the technology" for the food production side (p. 60).

3. Decision Support for Farming

The goal of analytics and decision support is to help a decision maker choose an action associated with a decision situation that will change the identified state or process in a way that makes it more favorable. Farming remains risky and subject to many uncontrollable factors. Given the increasing complexity of farming, more and better decision support and information can help make farming more profitable and more sustainable.

Russo and Dantinne (1997) suggested five steps for creating precision farming decision support:

1. Identify environmental and biological states and processes in the field that can be monitored and manipulated to improve crop production.
2. Choose sensors and supporting equipment to record data on these states and processes.
3. Collect, store, and communicate the field-recorded data.
4. Process and manipulate the data into useful information and knowledge.
5. Present the information and knowledge in a form that can be interpreted to make decisions.

Lowenberg-DeBoer (1996) argued that "Long run profitability of precision farming technology depends on the development of management systems that link inputs applied with yields harvested on specific sites. These management systems will be some combination of computerized decision support systems and the accumulated wisdom of experienced managers. Decision support systems require databases. Wisdom comes with long experience. These management systems will be site specific. Generic decision support systems will be developed, but their performance on your farm will be enhanced by data from your farm." Precision agriculture is no longer the "infant technology" discussed by Lowenberg-DeBoer, but the need to improve decision support and collect and share data remains and has become more urgent.

In 1998, Davis, Casady and Massey explained "As important as the devices are, it only takes a little reflection to realize that information is the key ingredient for precise farming. Managers who effectively use information earn higher returns than those who don't." GPS (Global Positioning System) and sensor technologies make precision farming possible, but databases of historical information, analytics, and decision support enable farmers to effectively use the data gathered from using the technology tools.

Pierpaloli, Carli, Pigantti, and Canavari (2013) state that “precision agriculture is a fairly new concept of farm management developed in mid-1980s” (p. 62). In their article, they focus on precision agriculture (PA) technology adoption from the lens of ex-post research technology adoption and then focus on technology acceptance for PA. Their adoption model focusses on factors classified into three drivers of adoption which they classify as competitive and contingent factors, socio-demographic factors, and financial resources.

In general, the goal of Information Technology, analytics, and decision support is to help farmers manage their farms better. Precision farming decision support applications include advising about 1) what to plant where, 2) when and where to apply chemicals and in what amounts, and 3) when to harvest. There is also a role for decision automation in precision farming. Real-time decision automation can control the application of chemicals in the field based on GPS data, soil data, crop and decision rules. Software creates an integrated, precision farming system from disparate hardware components and historical and real-time data.

Research investigating precision agriculture, precision farming, and agriculture decision support and analytics is appropriate for submission to JMWAIS. We encourage more research in this important topic area.

The Journal of the Midwest Association for Information Systems (JMWAIS) remains a double-blind, peer-reviewed, quality focused, and open-access online journal. JMWAIS strives to ensure that original Information Systems research broadly defined from scholars linked to the Midwest United States is widely shared and disseminated. Articles that are published in JMWAIS are available from the AIS eLibrary and at http://jmwais.org/. DOI registration complements our purpose.

4. Overview of the contents of this issue

This issue of the journal includes a tutorial and two traditional research articles:

Jacob Young and Kristie Young in their tutorial for the use of Amazon's Mechanical Turk provide a timely set of guidelines and best practices for researchers on how to use this platform to safeguard the quality of the collected data. They further recommend that more attention needs to be paid by reviewers and editors on how data is collected for research purposes.

Sharma and Biros in their article suggest that a major barrier to the adoption of healthcare related wearable devices is the lack of trust by potential users of these kinds of devices. Hence, they have conceptualized a user's trust model for adopting these devices.

Bansal and Redfearn examine the role corporate social responsibility initiatives play in the weakening in trust and its restoration in cases where a data breach has occurred and the CEO of the affected corporation issues an apology. The study considers four scenarios and concludes that the corporate social responsibility initiatives may play a role in privacy concerns.

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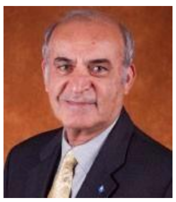

Rassule Hadidi is Dean of the College of Management, Metropolitan State University, Minneapolis, Minnesota. His current research areas of interest include online and blended teaching and learning pedagogy and its comparison with face-to-face teaching; MIS curriculum development and quality assessment; cloud computing and its applications for small and medium-sized enterprise; and quality of online information. He is the First Hanson Professional Services Faculty Scholar; served as the President as well as the At-Large Director of the Midwest Association for Information Systems and is the founding Managing Editor of the Journal of the Midwest Association for Information Systems. He is a member of Board of Directors of the Society for Advancement of Management.