Agricultural Management Tools:
Is there information equity between agribusiness and the small farmer?

Reid Boehm: Doctoral Student, School of Information Sciences, College of Communication and Information Studies, The University of Tennessee, USA, mboehm@utk.edu

Suzie Allard, Ph.D.: Associate Professor & Associate Director, School of Information Sciences, College of Communication & Information, The University of Tennessee, USA, sallard@utk.edu

Abstract: *Agriculture is an essential part of a nation's economy. It supplies food for people, fodder for animals, and provides a livelihood for a significant portion of the population. Agricultural information management is important because it means that we can plan and prepare for changes in our food supply and our economy, we can troubleshoot problems and assess past issues. This paper is an exploratory analysis of the literature surrounding tools and services that are available to support agricultural information management. In particular, it begins to discuss why we need to assess in detail the differences between the data services for agribusiness versus those for small-scale farms.*

Keywords: agricultural information, data tools and services, agricultural production lifecycle, sense-making

Agriculture is an essential part of a nation's economy. It supplies food for people, fodder for market animals, and provides a livelihood for a significant portion of the population. Globally we have grown increasingly industrialized and one concern for sustainability and environmental awareness as well as human health is that we continue to recognize the essential link between those involved in agricultural practices and our food supply. Agricultural information management helps us prepare for changes in our food supply and our economy. Data tells the story of the farm and the farmer with potential to influence governmental agricultural policy, support the decisions of consumers and the farmer. Having these data allows for well-informed evidence based agricultural decisions (Hill, 2009). As farmers witness the significant climate differences due to global warming and other chemical disruptions, communicating about small changes to gain a widespread perspective is highly valued (Hertel & Lobell, 2013). The rise in sophisticated monitoring systems comes in response to farmers' need to exemplify compliance to new standards and sustainable practices in order to receive important incentives that are offered through government initiatives (Sorensen et. al., 2010).

We are interested in examining whether agricultural information management is meeting the information needs of the small farmer and whether there are cost-effective, easy to use information tools available for the small farmer. Agribusiness is collecting and submitting data and using information tools such as sensor controlled irrigation and web mapping services (Nash, Korduan, & Bill, 2009). Often they are connected with research institutions or funded by large corporate entities that have informatics professionals to work with the collection and submission of data as well as the acquisition and visualization of relevant data from large scale data centers (Liaghat & Balasundram, 2009; Matthews, Schwarz, Buchan, Rivington, & Miller, 2008). Small farms often do not have access these types of services (McCown, 2002; Morton, 2007), yet family-owned and operated farms are vital for feeding communities. Scholars seek answers as to why the technological adoption has been slow for farmers (Hill, 2009; Thysen, 2000). Harkin (2005) suggests that the farmers decision making processes and critical information needs were rarely considered during the design processes. Information seeking studies are noting the need for and demonstrating the effectiveness of user-focused inquiry when designing information management applications (Cope, McLafferty, & Rhodes 2011; Hill, 2009; McCown, 2002).

Defining terms: farm, farmer, farm size and status

Internationally, farms and farmers are defined in myriad ways. According to the United States Department of Agriculture's (USDA) 1999 census definition, a farm is a place where there 1000 dollars or more in agricultural outputs are produced and yearly (USDA, 2003). A farmer is both decision maker and/or manager of operational activities. The United States and the European Union have many ways of defining the different cultures of agricultural work based on various characteristics including the size, scale, production type, and philosophies of practice (Morton, 2007). Agribusiness is defined as all of the operations involved in the processing, manufacturing and distribution of farm supplies as well as the farm operations and the processing and distribution of commodities that are a result of the products (Davis & Goldberg, 1957). This definition differentiates from smaller scale agricultural endeavors that have more specialized, yet equally necessary roles in the production of food and services for consumers.

The many facets involved in farming leads to the topology difficulty which is addressed in a recent study of the EU's Common Agricultural Policy (CAP). This CAP study specifically focused on measures related to the value and direction of semi-subsistence farms, which are often family owned (European Commission, 2012). Small and semi-subsistence farms are defined as having an potential sales revenue of less than 8,000 Euros and the smallest group having less than 2,000. The difference between the small and the semi-subsistence farms is the nature of the farmers' motivation to generate external profit versus providing mainly for family needs. (Davidova et al., 2013). Another standard is the USDA's Economic Research Service (ERS) classification system. It divides farms into eight distinct groups based on gross yearly sales and ownership type. Speaking about this topology of farms in the US more broadly, the National Commission on Small Farms selected the cutoff between small and large-scale farms to be gross sales of $250,000 dollars (Extension, 2013). Large-scale farms may be family owned or commercial farms that make over $250,000 a year in gross sales. Small-scale farms include both rural-residence farms whose income comes from other areas besides farming, and farming occupation farms whose income comes solely from the farm production and sales.

Creating a model

None of the literature we found addressing farming in Europe and the United States identifies the wide range of information tools and services needed for a farmer of a small farm at the various points in the agricultural life cycle. We adapted an existing agricultural production cycle model and identified key points for data collection or use in that model and then we projected what "families" of tools might be needed at each point. We begin by modifying an agricultural production cycle model. It is based on the Integrated Farm System model (ISFM) created by the USDA's Agricultural Research Service and is a simulation model that incorporates all aspects of crop, beef, and dairy production in order to assess the process combined with the use of different technologies and in conjunction with weather changes (Rotz et al., 2013). The computational system processes were derived from the synthesis of actual production cycle activities. We have simplified specific aspects of the original model which goes beyond the cycle presented here (see figure 1) by discussing chemical and financial inputs and losses.

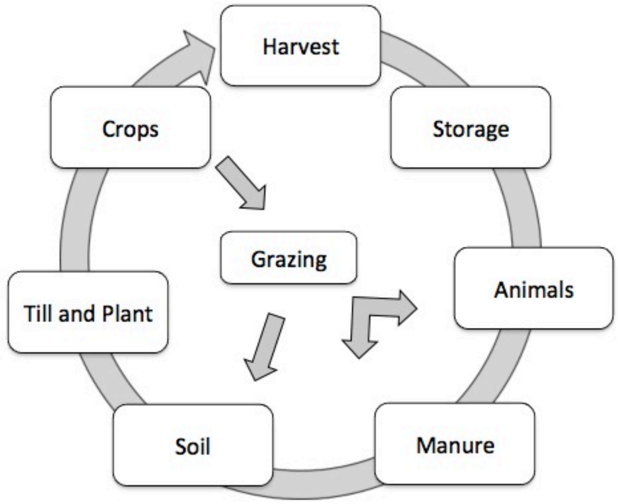

Figure 1. Integrated Agricultural Production Lifecycle Model

We are looking at the model as a way to discuss the potential data, applications and other information tools that would be involved in each phase and discuss the types of applications that are currently available. In addition to looking at data and applications we can discuss the information needs and information behavior according to these agricultural phases. Context is an important factor when discussing information needs because certain events in the process may trigger specific information seeking behavior to occur (Babu, Glendenning, Asenso-Okyere, & Govindarajan, 2012).

Data and Applications

One of the questions we are asking is what kind of data would be involved in each of the components and what kind of applications could be available. At this point, to name the myriad applications and programs available to farmers is beyond the scope of this paper, however, this construction can serve as a framework for future in-depth analysis at each phase of the model. As we look at the steps in the process we have the ability to discuss instances where data creation occurs.

In the animal phase the process of registering and tracking herds of livestock requires records of each animal and each farm. Sales of the livestock will change the registration and location of each animal. Another aspect of animal data focuses on the fertility of the mother animals, along with health and genetic characteristics of the offspring. Grazing information involves land classification data gathered by remote sensing techniques. The practice serves to define categories of grazing intensity (Liaghat & Balasundram, 2010). A major impact of manure management is the effect that chemicals can have on the environment especially in dealing with issues of water quality. In one example, Oliver et.al. (2012) studied a decision support system for identifying agricultural areas of vulnerability to pollution in the form of microbial transfers from land to water. Elements of soil data include the chemical composition such as nitrogen content and salinity as well as the moisture and temperature of the soil. Part of the tilling and planting process involves the choice of the seeds and keeping track of what went where when. An example of an application that deals with such data is a web-based system that looks at the selection of variety in field crops (Thysen, 2000). Additionally, the type and characteristics of the seeds planted are important elements to record in relationship to the crop yields (Ali & Kumar, 2011).

In the crop phase applications such as plant pest forecasting systems exist to aid in the monitoring of pathogens and pests and to facilitate risk assessment based on climate changes. Research recognizes a lack of field level crop data in this area (Margosian et al., 2009). A factor in such systems is the ability to share data collected in the fields to prevent the future infection and widespread invasion. One example of harvest data collection is yield mapping which uses a yield monitoring device mounted on harvesting equipment such as the combine harvester to quantify the amount collected (Steinberger, Rothmund, & Auernhammer, 2009). Another harvest phase example is monitoring the spoilage of products, and tracking the amount lost through product waste (Ali & Kumar, 2011).

Information Behavior

In information science research, a major portion of inquiry delves into the behavior of the information seeker. Throughout the literature models of information seeking have been defined that can shape how we understand the environment of information behavior within the context of the user. In the situation of the farmer in the context of specific constraints and needs, the element of sense-making plays a major role in the shaping of the whole of his or her experience. Dervin's sense-making model creates an excellent structure in which to theoretically examine the issues related to the information needs of the farmer because it addresses the idea that the mainstream models used in communication, information systems, and, formal education environments are not well suited to the users needs. These systems are based on the act of transmission and not around the understanding of metaphor (Dervin, 1999). In the original sense-making model, Dervin (1983) focuses on bridging the gaps in relation to the situation to influence the outcomes of the information interaction.

Our version of Dervin's model (see figure 2) places the information needs in the context of the farmers experience during a specific moment in the agricultural lifecycle. Due to the complexity inherent in the way information is offered from multiple sources, each phase will require illicit specific information behaviors depending on such nuances as the amount of risk involved with a decision based on information or the pressure involved in finding quick fixes such as in an emergency situation. In some cases defining the problem can in itself be a difficult task. By understanding the needs of the different areas we can begin to shape specific services and studies that are tailored to these phases.

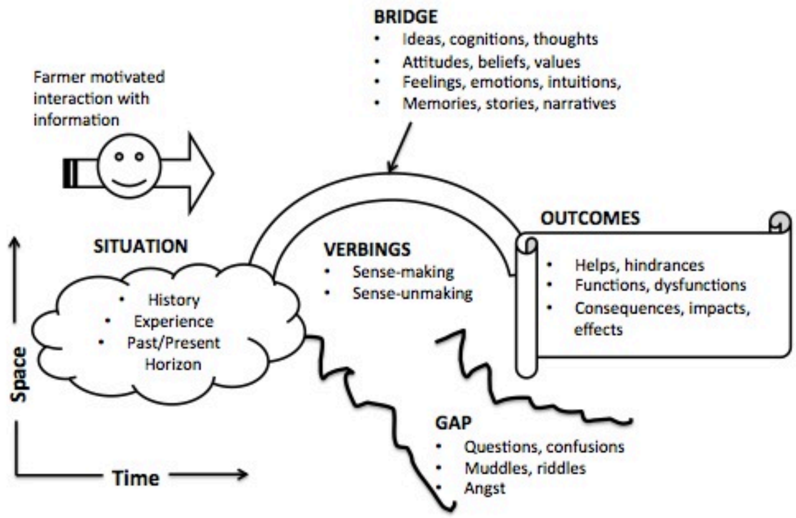

Figure 2: Agricultural Information version of Dervin's Information Sense-making Model

Farmers raising animals require information regarding diseases, access to veterinary care, and knowledge of options for antibiotics (Leckie, 1996; Verbecke, 2001). Livestock producers who want to sell their stock at auction need to be able to connect with auction houses. They also need to know about transporting the livestock for slaughter and processing. All of this requires a network of information that comes from multiple stakeholders: consumers, federal, state and local governments, processing facilities and feed companies. In manure management farmers will need information on how to handle and prevent runoff to water supply (Oliver et al., 2012) and they may seek external sources of disposal and use. In the soil phase, soil composition is often monitored using technologies such as remote sensing in precision agriculture (Liaghat & Balasundram, 2010). Farmers may be taking samples of their own soil and need information on maintaining and developing the soil fertility at the ground level (Ali & Kumar, 2011).

For planting, farmers will be seeking information on crop rotation, planning placement of paddocks and fields, and what to plant based on the current climate and long-term weather forecasts. Information from multiple sources will inform specific behaviors that can make or break the crop yield. In examples of needs for crop production, farmers may need to make important decisions related to adoption of new technologies such as the choice of different irrigation systems (Hill, 2009). Another area of information includes the application of pesticides and herbicides as well as the continued nutrition of the crops throughout their growing season. One major information need in the process of harvesting is in minimization of post harvest loss (Ali & Kumar, 2011). They may also require market prices for each product, outlets for sale, and finding the most cost efficient and quality means to store the products before and during the process of transportation of goods to the market. These information needs are just the tip of the iceberg.

Discussion

Filtering out the information that is needed and finding the most trustworthy and salient nugget is near to impossible without the help of expert training such as extension agents. Technology expertise is needed to be able to participate in this information arena and to have one's needs met in the same way as those involved in large scale production (Grainger-Jones, 2013; Steinburger et al., 2009). Due to this issue of information overload, what is the best possible way to begin looking for gaps? In developing nations everyone is in the small scale category and information tools and services can address the specific needs of that category, but in the developed world, it is easy for the small scale, the family owned and the subsistence farmers to get lost. Future research needs to take into account the eccentricities of the farmer as both a creator and a seeker of data and information.

Conclusion

Viewing the phases of an agricultural production lifecycle in relationship to the types of data created, the potential applications available and the information behaviors and needs that arise at each point, provides new depth to understanding the complexity of the information environment surrounding agricultural production as a whole. This is a position paper drawing conclusions for future research that delves into the phases of the agricultural production lifecycle in order to look at the information needs and seeking behaviors in conjunction with the available tools and services.

In particular, we can begin to assess the differences between the data services for agribusiness versus those for small scale farms. It also examines how this may be different in North America and the European Union. By beginning this dialogue about information tool use among farming businesses large and small, we can begin to see gaps within the technological support system. One example is the field of GIScience, which acknowledges the role that geospatial technology plays in advancing the information tools that farmers use to track vital information, as well as the importance of volunteered geographical information and citizen science to understanding the relationship between climate change and agriculture (Goodchild, 2007). Seeing what has worked with such projects may help to address disparities in countries where large scale agribusiness is well developed compared with struggling small scale farming endeavors. These small communities have specific cultural knowledge that gets lost under the tools and services for agricultural information management at the large scale.

Including such knowledge in the design of information tools and services that address the gaps that are discovered is important because while agribusiness is often studied and can afford machinery and experts to utilize the most technologically advanced systems and information tools, there are many more small scale, family-owned farms in Europe and North America that feed the population. The quality, health, and sustainability of these small farms will affect the availability of food for the millions of people of these developed nations. In the face of a changing climate, environmental research is showing that sustainability at the small scale level will be increasingly difficult (Grainger-Jones, 2013). Practices will need to be continually monitored and new sustainable practices defined. The more information and data that can be shared between all peoples, the more we can change with the environment and provide the best possible support as new issues arise.

References

Ali, J., and Kumar,S. (2011) "Information and Communication Technologies (ICTs) and Farmers Decision-Making across the Agricultural Supply Chain." International Journal of Information Management 31 (pp.149–159).

Babu, S., Glendenning, C., Asenso-Okyere, K., and Govindarajan, S. (2012). Farmers' Information Needs and Search Behaviors. *IFPRI Discussion Paper* 01165.

Cope, M., McLafferty, S., and Rhoads, B. (2011) Farmer Attitudes Toward Production of Perennial Energy Grasses in East Central Illinois: Implications for Community-Based Decision Making, *Annals of the Association of American Geographers*, *101*(4), 852-862. DOI: 10.1080/00045608.2011.575320

Davidova, S., Bailey, A., Dwyer, J., Erjavec, E., Gorton, M., and Thomson, K., (2013) Semi-Subsistence farming: value and directions of development. European Parliament's Committee on Agirculture and Rural Development.

Davis, J. and Goldberg, R. (1957). *A concept of agribusiness*. Division of Research, Graduate S chool of Business Administration, Harvard University.

Dervin, B. (1999). On studying information seeking methodologically: the implications of connecting metatheory to method. *Information Processing & Management*, *35*(6), (pp.727- 750).

Dervin, B. (1983). An overview of Sense-Making research: concepts, methods, and results to date. In: *International Communication Association annual meeting*, Chicago, May.

Extension, (2013). *USDA Small Farm Definitions*. Accessible from: http://www.extension.org/pages/13823/usda- smallfarm-definitions - .Ui- FMryxZFq.

European Commission. (2013). A*griculture: A partnership between Europe and farmers*. Luxembourg: Publications Office of the European Union.

Grainger-Jones, E. (2013) Strengthening Resilience. International Innovation, Environment Issue 118, (pp. 76-79).

Goodchild, M. (2007). Citizens as sensors: the world of volunteered geography. *GeoJournal*, *69*(4), (pp. 211-221).

Harkin M. (2005): ICT Adoption as an Agricultural Information Dissemination Tool – An historical perspective, http://departments.agri.huji.ac.il/economics/gelb-harkin-3.pdf (2005.12.20.)

Hertel, T., and Lobell, D. (2013). *Agricultural Adaptation to Climate Change in Rich and Poor Countries: Current Modeling Practice and Potential for Empirical Contributions* (No.

4030). Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University.

Hill, M. (2009). Using farmer's information seeking behaviour to inform the design of extension. *Extension Farming Systems Journal*, *5*(2), (p. 121).

Leckie, G. (1996) Female farmers and the social construction of access to agricultural information. *Library & information science research*, *18*(4), (pp. 297-321).

Liaghat, S., and Balasundram, S. (2010). A review: The role of remote sensing in precision agriculture. *American Journal of Agricultural and Biological Sciences*, *5*(1), (p.50).

Matthews, K., Schwarz, G., Buchan, K., Rivington, M., and Miller, D. (2008). Wither agricultural DSS?. *Computers and Electronics in Agriculture*, *61*(2), (pp.149-159).

Margosian, M., Garrett, K., and Hutchinson, J. (2009). Connectivity of the American agricultural landscape: assessing the national risk of crop pest and disease spread. *BioScience*, *59*(2), (pp.141-151).

McCown, R. (2002). Changing systems for supporting farmers' decisions: problems, paradigms, and prospects. *Agricultural Systems*, *74*(1), (pp. 179-220).

Morton, J. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences*, *104*(50), (pp. 19680-19685).

Nash, E., Korduan, P., and Bill, R. (2009). Applications of open geospatial web services in precision agriculture: a review. *Precision agriculture*, *10*(6), (pp. 546-560).

Öhlmér, B., Olson, K., & Brehmer, B. (1998). Understanding farmers' decision making processes and improving managerial assistance. *Agricultural Economics*, *18*(3), (pp. 273-290).

Oliver, D., Fish, R., Winter, M., Hodgson, C., Heathwaite, A., and Chadwick, D., (2012). Valuing local knowledge as a source of expert data: farmer engagement and the design of decision support systems. *Environmental Modelling & Software*, *36*, (pp. 76-85).

Rotz, C., Corson, M., Chianese, D., Montes, F., Hafner, S., and Coiner, C. (2013) The Integrated Farm System Model Reference Manual. Version 4.0. Pasture Systems and Watershed Management Research Unit, Agricultural Research Service, USDA, (pp. 1-213).

Sørensen, C., Fountas, S., Nash, E., Pesonen, L., Bochtis, D., Pedersen, S., Basso, B., and Blackmore, S. (2010). Conceptual model of a future farm management information system. *Computers and Electronics in Agriculture*, *72*(1), (pp. 37-47).

Steinberger, G., Rothmund, M., and Auernhammer, H. (2009). Mobile farm equipment as a data source in an agricultural service architecture. *Computers and electronics in agriculture*, *65*(2), (pp. 238-246).

Thysen, I. (2000). Agriculture in the information society. *Journal of agricultural engineering research*, *76*(3), (pp. 297-303.)