Using big data to inform agricultural decisions

Laurie Houston (laurie.houston@oregonstate.edu) OSU, Susan Capalbo OSU, and John Antle OSU

Making informed decisions at a farm or landscape scales is not easy. Critical information may be missing, or consequences may not be readily identifiable. Sometimes there is just too much information to process. The agricultural sector, like all parts of our global economy, is becoming data-rich, due to advances in remote and mobile measurement technologies, but it needs better data management and analytical capabilities. The relationship between land management decisions and desired economic, social, and environmental outcomes is complex, and management outcomes will benefit from coordination among land managers, researchers, and policy analysts.

IMPACT

Development of private-public partnerships could advance a new knowledge infrastructure for agriculture. Anonymized, spatially linked data could be analyzed to improve landscape management models and design smarter public policies. In return, individuals could receive input and yield information useful for reducing costs and improving yields.

Status of big data in agriculture. Increasingly, companies such as Monsanto and John Deere are offering services that allow the collection of detailed spatial and temporal data regarding planting densities, dates, production growth, and harvesting. In return, these companies promise to evaluate the data and provide participants with information aimed at increasing farm profits or net returns by optimizing input uses and improving yields. See Figures 1 and 2 for examples of precision agriculture software being used in the REACCH region.

Monsanto claims that its application of "data science" has the potential to create billions of dollars in increased farm revenues and lower costs by providing field-specific seeding and fertilizing "prescriptions." Monsanto's recent purchase of The Climate Corporation, a firm specializing in site-specific weather projections, has added the capability to fine-tune field-based weather predictions. These developments in software capacity are viewed by agribusiness companies as opportunities to provide services that help producers meet production challenges associated with greater variability and risk from a changing climate and changing economic conditions. Some farmers in the REACCH region are adopting precision agriculture technologies in their farming operations (Figures 1 and 2).

Next frontier for data analytics. An increase in the use of precision farming and mobile technologies and improvements in data management software offers expanding opportunities for an integrated data infrastructure linking farm management decisions to site-specific biophysical data and ultimately to the design of "climate-smart" policies. Field-specific data, combined with recommended uses of fertilizers, seeding rates, and other inputs, can be integrated with spatial landscape-scale models for fine-tuning agricultural policies. For example, better-quality data and models could enhance the targeting of incentive payments provided to farmers to improve water quality and conserve biodiversity.

So how might this work? Figure 3 provides an overview of the linkages between data and decision tools at farm and landscape scales that support science-based policy. While farm-level decision making and landscape-scale analysis have different purposes, they both benefit from the same data:

- Private data: site- and farm-specific characteristics of the land and the farm operations, and site- and farm-specific management decisions.
- Public data: weather, climate, and other physical data describing a specific location, as well as prices and other economic information.

Figure 1. *Eric Odberg, a farmer in the REACCH region, using precision agriculture software in the field. Photo by Guy Swanson.*

A key to achieving a smarter infrastructure is to recognize that new and better data are an asset to both private and public stakeholders, and can provide win-win situations for improving farm profits, the sustainability of our food and agricultural systems, and the outcomes of public policies. This requires that all participants clearly understand the mutual benefits. For example, producers should be aware that the information they and others provide will help build more effective management tools, such as prescriptive farming tools for improved yields and reduced input needs. This same information could also be used to provide the detailed data necessary for documenting organic or sustainable practices for certification, or for compliance with regulatory standards. Additionally, the spatial information will provide the data necessary to understand the relationships among management practices and outcomes for both production and conservation, as well as to document improvements in environmental quality at the landscape scale (not just on individual properties). Subsequently, this information can facilitate and enhance science-based approaches to agricultural policy.

Figure 2. *An example of precision agriculture software used in the field. The Trimble FmX controller (screen on right) can independently control the application rate of up to four products. Raven Envizio Pro (smaller screen on left) carries out auto-steering and provides guidance. Photo by Guy Swanson.*

A public-private partnership would reduce the "respondent burdens" associated with the present system of multiple mail-based and personal interview surveys used to collect data periodically from growers and landowners (such as the National Resources Inventory and the Census of Agriculture). Under an integrated system, much of the baseline information could be acquired and stored once, as a part of a farm operation's ongoing management system, rather than being collected multiple times for multiple purposes. This information could be updated in a more cost-effective way, through mobile or web-based technologies. Such partnerships would minimize the duplication of data collection efforts and costs, making science-based policies and precision agriculture more economically feasible.

Concerns to address. To make these proposed partnerships attractive to participants, key operational considerations need to be addressed. These include designing an efficient and secure data system, maintaining data confidentiality, addressing privacy concerns, and identifying reciprocal benefits.

In summary, an agricultural knowledge infrastructure would be an asset for supporting productivity gains and policy improvements. It would depend upon strong partnerships with public and private entities to ensure privacy and confidentiality, reliability, sustainability, and usefulness for onsite management as well as science-based policies. The rapid pace of advancements in tools, technologies, and data initiatives, coupled with the increasing demand for better data, provides an ideal environment for the development of partnerships to build a viable and sustained knowledge infrastructure. As big data drives ever more demands for better policies and better management, the new tools and innovations that result will shape the sustainable management of agricultural ecosystems in a very positive way.

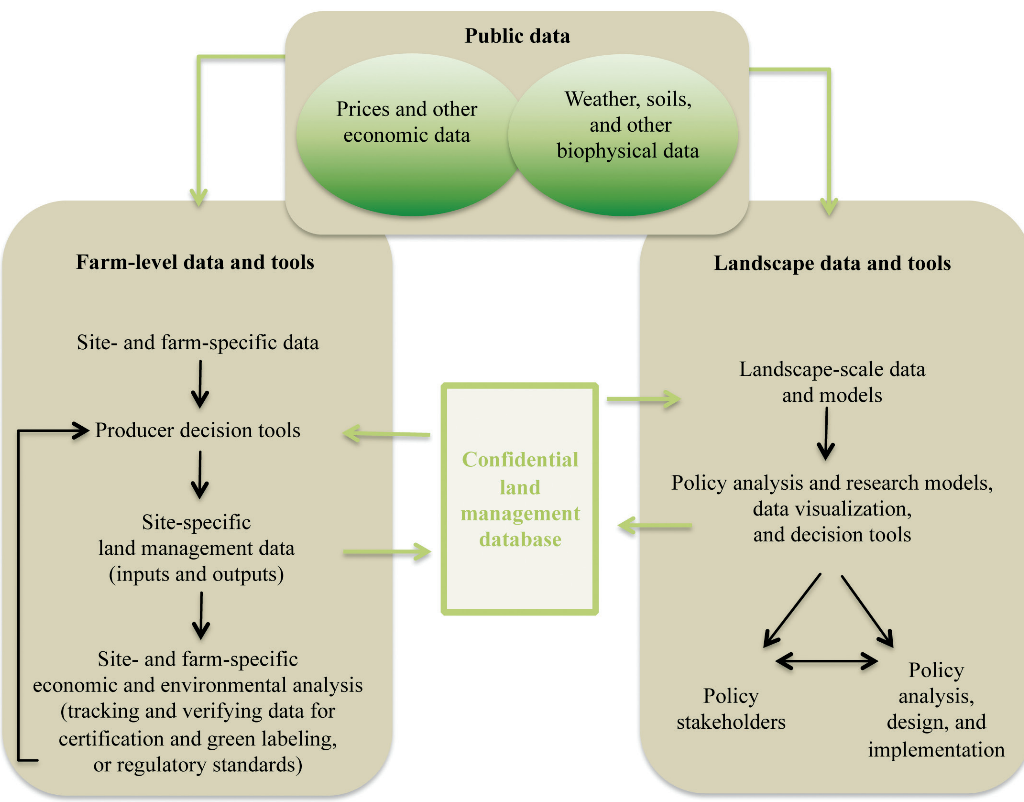

Figure 3. *Linkages between data and decision tools at farm and landscape scales.*