Chapter 4.7

Information Technology Management

Stan Daberkow, Mitchell Morehart, and William McBride

Information technology (IT) is affecting the way farmers produce and market their output and how rural residents receive services and communicate. While computers and the Internet are the most common IT tools in use today, IT also encompasses software and associated services, such as telecommunications, required to fully use these technologies.

Introduction

Information technology (IT) enables U.S. farmers to access real-time market information and buy and sell through e-commerce sites; manage their cropland at ever smaller scales (to meet both economic and environmental objectives) through precision agriculture; and use modern accounting, recordkeeping, and tax management through computer and Internet resources.[1] Telecommunication infrastructure in rural areas is crucial if farmers and rural residents are to adopt and utilize IT. Many government agencies, including those servicing farmers, are offering clients the ability to receive information and program benefits via the Internet.

Information Technologies for Farm Management Decisions

IT adoption by U.S. farms has exhibited significant growth over the last several years; as of 2003, about half of all farms had computer and/or Internet access (fig. 4.7.1). However, only about 30 percent of the farms reported using a computer for the farm business. Internet access grew from less than 15 percent of all farms in 1997 to 48 percent in 2003, and 5 percent of all producers reported using the Internet to contact a USDA website.

Farm IT Users and Uses

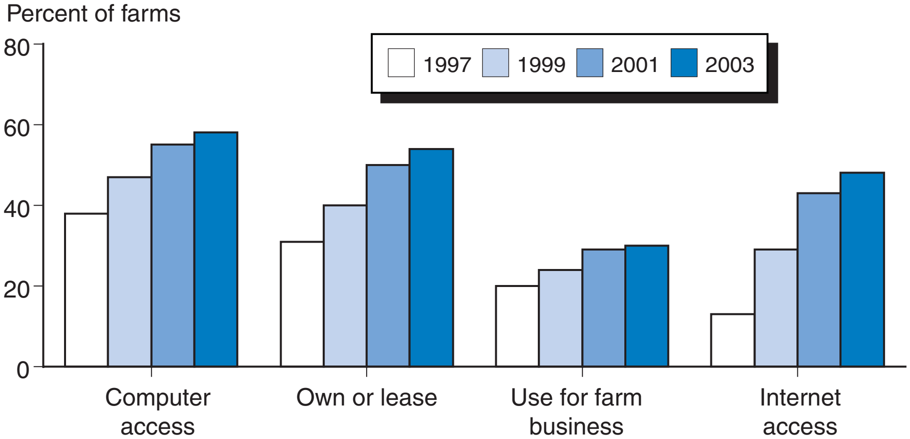
Periodically, information on computer and Internet use is collected in the Agricultural Resource Management Survey (ARMS). The 1999 ARMS measured the extent of farmers' Internet use and online purchases/sales of farm products. Many agricultural e-commerce ventures were just getting started in 1999, so this was a first look at how farm businesses were using IT. Farms that bought or sold online in 1999 were more likely to be run by younger, more educated operators than the national average. Almost three-quarters of active e-commerce users were between 35 and 54 years old, and just over a third had completed college or graduate school. Higher rates of adoption among these groups are to be expected, since the willingness to

Contents

[1] Information technology is broadly defined as those technologies that allow individuals to create, seek, and manipulate information (Vanderheiden and Zimmermann, 2002).

Figure 4.7.1

U.S. farms using computers, 1997-2003



Source: USDA, National Agricultural Statistics Service
http://usda.mannlib.cornell.edu/reports/nassr/other/computer/fmpc0703.pdf

adopt new technologies is often related to both age and education. Over 42 percent of farmers' online market activity in 1999 involved purchasing crop inputs (e.g., seed, fertilizers, and pesticides), and online buying was related to farm size. In contrast, farm size showed no relation to online purchasing of livestock inputs (e.g., feed and feeders) and selling of livestock (58 percent of farmers' online market activity).

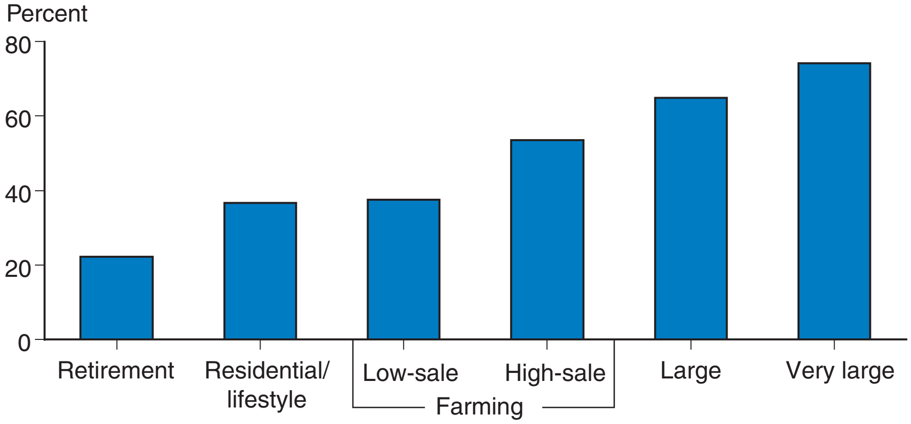
The 2000 ARMS was extended to examine the types of activities that were conducted online. During 2000, producers reported $665 million in online buying and selling. Online purchases totaled $378 million, covering machinery and equipment, farm supplies, crop inputs, livestock inputs, and office and computer equipment. Purchases of crop and livestock inputs together were 35 percent of total online purchases, and each was smaller than machinery and equipment purchases and general farm supply purchases. Online sales by farmers totaled $287 million—$191 million in livestock sales and $96 million in crop sales.

Farmers reported using the Internet for various management activities. The most common use was price tracking, reported by 82 percent of Internet users. Information gathering from government and other sources was also relatively common. Communication with other farmers and advisory services was reported by about 30 percent of Internet users. The least often reported Internet activity was the management of business finances such as online banking, paying bills, and obtaining loans.

In 2002, ARMS investigated the intensity of business/personal use of the Internet by U.S. farmers. (Internet use was conditioned on the operator's reporting computer use.) Internet use was positively related with farm size. The share of farms using the Internet in their business ranged from 16 percent of limited-resource farms to nearly 75 percent of very large farms (fig. 4.7.2). Time spent on the Internet for farm business purposes also increased with farm size. Only 20 percent of operators over age 65 reported Internet use, versus over half of operators between age 35 and 44. Farms that specialized in crops were more likely to use the Internet than were live-

Figure 4.7.2

Internet use for farm business by farm type, 2002



Source: USDA, ERS, (http://www.ers.usda.gov/Briefing/ARMS/)

stock operations. Half of the farmers reporting Internet use reported that they spent 6 hours or less per week online. Fewer than 10 percent of Internet users spent 20 hours or more per week online.

Information Technologies for Crop Production

Recent advances in the computer, aerospace, and communications industries allow farmers to monitor and manage soils and crops on small areas of individual fields. Precision agriculture or site-specific crop management are the terms often applied to the suite of information technologies used for sensing subfield spatial and temporal variability and customizing applications across the field. A number of spatially oriented information technologies are commercially available for most crops to help with fertilizer, pesticide, seed, irrigation, and tillage decisions. Rather than treat fields uniformly, producers can use these technologies to manage soil, pest, landscape, or microclimate variability by adjusting input use within a field to enhance returns and to reduce potential environmental risks. Such technologies include yield monitors; the Global Positioning System (GPS); Geographic Information Systems (GIS); guidance systems; satellite, aerial, and on-the-go sensors; and variable-rate applicators

Adoption Trends

Based on annual USDA-ARMS surveys of corn, soybean, wheat, and cotton producers, the adoption of precision agriculture (PA) technologies varied widely across these major crops between 1996 and 2003 (table 4.7.1). Yield monitors are the most widely used PA technology, reaching over 35 percent of all corn acres (2001) and nearly 30 percent of all soybean acres (2002). This technology became commercially available to grain producers in the early 1990s, but did not become available to cotton growers until the late 1990s. Only about a third of the corn and soybean acres on which yield monitors were used were connected to the GPS and generated a yield map—an indication that

Table 4.7.1
Share of U.S. corn, soybean, wheat, and cotton acres on which yield monitors and yield maps were used, 1996-2003[1]

Technology/year	Corn	Soybeans	Wheat	Cotton
		Percent of planted acres		
Yield monitor				
1996	15.6	13.3	5.9	NA
2000	34.2	25.4	9.1	1.3
2001	36.5	NA	NA	NA
2002	NA	28.7	NA	NA
2003	NA	NA	NA	2.6
Yield map				
1996	NA	8.1	*	NA
2000	13.8	7.8	*	*
2001	13.7	NA	NA	NA
2002	NA	10.7	NA	NA
2003	NA	NA	NA	1.7

NA = survey not conducted. * = less than 1 percent.
[1]These estimates are revised from previous published estimates based on updated weights from the ARMS.

Source: For more information, see ARMS Briefing Room on the ERS website.

producers have been cautious about using this technology for changing production practices.

Remote sensing, variable-rate applicators, and guidance systems are among the most recent, as well as most rapidly evolving, precision agriculture technologies. Geo-referenced soil data, such as pH or nitrate levels and soil type, can also help producers intensely manage their crops. Recent ARMS data indicate that the adoption of these technologies, like yield monitors and mapping, differs by crop. Remote sensing, either by airplane or satellite, was reportedly used on less than 10 percent of planted acreage in recent years. While remote sensing can detect variation in vegetative reflection, the cause of that variation may still require confirmation on the ground. Also, cost, timeliness, and image resolution issues may be inhibiting the spread of this technology.

Machine guidance systems, which are connected to GPS, were introduced in the late 1990s and producers reported using these systems on 6-7 percent of corn and soybean acres during 2001-02, and on over 10 percent of cotton, barley and sorghum acres during 2003. Such systems can reduce costs associated with equipment skips and overlap; permit operation in dust, fog, and darkness; help manage soil compaction; and reduce driver fatigue. Variable-rate technologies (VRT) allow the application of inputs at different rates based on agronomic (or economic) factors that vary within a field. Variable rate application of fertilizer on corn and soybeans was the most widely reported use of this technology (table 4.7.2). Producers reported using VRT to apply inputs on less than 5 percent of planted wheat and cotton acres.

Producers of high-value crops (i.e., sugarbeets and potatoes) tend to use precision agriculture—particularly variable rate fertilizer application—on a higher share of crop acreage than field crop producers (table 4.7.3). Sugarbeet producers, especially in the Red River Valley, reported relatively high

Table 4.7.2

Share of U.S. corn, soybean, wheat, and cotton acres on which variable rate technologies were used to apply major inputs, 1998-2003

Year	Corn			Soybeans		
	Fertilizer	Seed	Pesticides	Fertilizer	Seed	Pesticides
	Percent of planted acres					
1998	12.3	4.1	2.4	6.7	*	*
1999	17.5	4.2	1.1	8.3	2.0	1.7
2000	14.5	4.5	3.8	5.8	2.5	1.0
2001	9.8	2.4	3.8	NA	NA	NA
2002	NA	NA	NA	5.0	*	1.3
	Wheat			Cotton		
1998	2.6	1.5	1.7	2.0	1.3	1.5
1999	NA	NA	NA	1.0	1.8	2.0
2000	3.1	*	*	3.8	2.4	2.7
2003	NA	NA	NA	3.9	*	1.9

* = less than 1 percent. NA = survey not conducted.

Source: For more information, see ARMS Briefing room on the ERS website.

Table 4.7.3

Share of U.S. acreage on which precision agriculture technology was used, select crops and years[1]

Technology	Sunflower 1999	Potatoes 1999	Sugarbeets 2000	Rice 2000	Barley 2003[2,3]	Sorghum 2003[2,3]
Yield monitor	17.1	10.4	1.0	17.6	17.0	14.4
Yield map	3.8	10.2	*	5.1	4.6	2.0
Geo-referenced soil map	3.8	18.7	28.6	9.5	7.3	7.3
Remote sensing	4.4	20.5	35.2	4.7	2.8	4.4
VRT used for:						
Fertilizer/lime	2.8	13.1	11.9	1.6	12.9	4.7
Seed	*	1.5	2.2	1.2	8.0	3.5
Pesticides	*	3.6	1.3	2.6	10.4	2.7
Guidance	NA	NA	NA	NA	14.7	10.4

* = less than 1 percent. NA = survey not conducted. VRT = variable-rate technology.

[1]These estimates are revised from previous published estimates based on updated weights from the ARMS.

[2]Prior to 2002, respondents were asked if the soil characteristics of the field had ever been geo-referenced. Beginning in 2002, respondents were asked about geo-referencing in the current and previous year.

[3]The question was reworded in 2002 to better define the term "remotely sensed."

Source: For more information, see ARMS Briefing room on the ERS website.

use of geo-referenced soil maps and remote sensing in 2000; this is related to the importance of nitrogen management in sugarbeet profitability (Daberkow et al., 2003).

Factors Influencing Adoption

A number of factors—such as profitability, farm and farm operator characteristics, university research and extension activities, and government agency use of IT—will likely affect adoption trends in precision agriculture (PA). Most studies of PA technologies have shown positive economic benefits from the adoption. For example, Lambert and Lowenberg-DeBoer

(2000) reviewed 108 PA studies and found 63 percent of the studies indicated positive net returns for a given PA technology, 11 percent reported negative returns, and 26 percent indicated mixed results. Much of the current research indicates that larger farms, located in the Corn Belt and operated by producers familiar with computers, have a higher probability of adopting precision agriculture technologies than farms without such characteristics (Daberkow and McBride, 2000).

Numerous land-grant universities have established PA research and extension programs geared toward adapting IT for crop and livestock production and reducing agriculture's impact on the environment. Universities in Arizona, Mississippi, and Utah are participating in NASA's Space Grant Extension Specialist in Geospatial Technology pilot program to explore how to meet the needs of farmers, ranchers, planners, and others involved in agriculture, natural resource management, and rural development. Similar in scope is the Upper Midwest Aerospace Consortium (UMAC), consisting of participants from North and South Dakota, Montana, Wyoming, and Idaho. USDA's Natural Resources Conservation Service and Farm Service Agency are beginning to offer geo-referenced, field-level data specifying soil types and field boundaries, some of which can be accessed over the Internet. Many farmers can also obtain commodity and conservation program information via the Internet.

Federal IT Policies for Agriculture and Rural Areas

Several Federal policies may facilitate the development and adoption of PA technologies and IT-related services. For example, the Conservation Security Program is a voluntary program that provides incentive payments to farmers to implement or maintain conservation practices on working lands (see Chapter 5.4, "Working-Land Conservation Programs"). Such practices include the use of yield monitors, a stewardship practice that addresses water quality concerns (*Federal Register*, 2005). As communication and information service becomes increasingly important, rural or farm communities lacking such services may be economically disadvantaged. Federal programs addressing these issues are discussed in the "Rural Telecommunication" briefing room on the ERS website.

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