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Internet and e-Commerce Use by Agribusiness Firms: 2004

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In 2001, the dot.com bubble burst and U.S. e-commerce growth slowed. Slower e-commerce growth may signal changes in the use and perceptions of the Internet and e-commerce in agribusiness companies. Agribusiness firm managers were surveyed in 2004 to identify agribusiness use of the Internet and e-commerce and to solicit their perceptions about the Internet and e-commerce. The survey was developed from a similar survey conducted in 1999. In 2004, agribusiness firms were using e-commerce more with their suppliers than with their customers. Perceptions regarding Internet and e-commerce varied by the intensity of e-commerce use. Given the variety of opinions regarding the Internet and e-commerce, e-commerce capabilities in the agribusiness industry will remain highly diverse in the near term.

Key Words: agribusiness, e-commerce, Internet

Internet and e-commerce technologies have rapidly penetrated U.S. businesses and households.[1] Food and agricultural businesses rapidly adopted Internet and e-commerce technologies. Based on the share of e-commerce shipments, beverage and tobacco manufacturers ranked second, with e-commerce accounting for 33% of their manufactured shipments in 1999.[2] In 2001, 43% of farmers had Internet access, with 15% of these farms engaged in e-commerce activity (Hopkins and Morehart, 2001; Morehart and Hopkins, 2000). Many forecasters assumed growth in e-commerce activity would persist (Goldman Sachs Investment Service, 1999).

While the 2001 recession tempered the rapid expansion of e-commerce, the recession had mixed impacts on e-commerce growth in food and agricultural

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[1] By 2001, Internet technologies had penetrated over 50% of U.S. households in a short span of 10 years (Goldman Sachs Economic Research, 2005). In comparison, radio and television penetrated 50% of the U.S. households in a shorter time frame (nine and five years, respectively). It took longer for telephones, computers, and mobile phones to penetrate 50% of U.S. households (56, 20, and 14 years, respectively).

[2] According to E-stats (U.S. Department of Commerce), manufactured shipments are the market value of all commodities shipped from a plant, and e-commerce shipments are those that are sold online.

businesses.[3] Based on U.S. Department of Commerce E-stats data from 1999 to 2001, e-commerce shipments for the food products and beverage industry rose 17%, but only 11.2% from 2001 to 2003. In contrast, e-commerce wholesale trade sales growth for the farm-products raw materials industry rose 17% from 2001 to 2004, after declining from 1999 to 2001.

As a result, several questions arise regarding the use of e-commerce in the agribusiness industry. For example, has the recent slowdown in e-commerce growth affected Internet and e-commerce adoption by agribusiness firms? How are agribusiness firms using the Internet and e-commerce? Have the perceptions regarding the Internet and e-commerce changed in the agribusiness industry? With increased Internet and e-commerce experience and a changing web environment, the use and perception of the Internet and e-commerce by agribusiness firm managers may have changed and could potentially have profound impacts on future e-commerce use in the agribusiness industry.

This paper seeks to provide some insight into how perceptions of the Internet and e-commerce have changed in agribusiness firms that service the farm sector. Agribusiness firms include manufacturers, distributors, and dealers who sell inputs to farmers and various financial, consulting, and miscellaneous service providers to the farm sector. This paper reports findings from a new survey of agribusiness firm managers conducted in the spring of 2004. Managers were asked a series of questions regarding Internet and e-commerce use at their company, their general opinions about the Internet and e-commerce, and their perceptions of the factors that support and hinder farmers' acceptance of e-commerce. These results are compared to a 1999 survey of similar agribusiness firms to provide some insight into the historical trends surrounding the development of Internet and e-commerce capabilities and perceptions concerning Internet and e-commerce use.

Literature Review

The Internet and e-commerce have been the subject of increasing research attention.[4] Dinlersoz and Hernandez-Murillo (2005), and Forman, Goldfarb, and Greenstein (2002) analyzed the diffusion of electronic commerce and Internet use across U.S. industries and census regions. Both studies found that transaction costs are a leading driver of e-commerce adoption. Firms are using the Internet for access to their suppliers and their product catalogs to a greater extent than selling to customers (Dinlersoz and Hernandez-Murrillo, 2005). Internet use was also found to occur less in rural locations (Forman, Goldfarb, and Greenstein, 2002).

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[3] The growth in U.S. e-commerce retail sales slowed from 62.3% per year in the three years prior to the recession to 23.3% per year in the three years after the recession (E-stats, U.S. Department of Commerce).

[4] A search of EconLit for the word "e-commerce" returned 167 citations for 2004 compared to no citations for 1998 and 11 citations for 1999. Similar trends were also found in searches for the words "Internet" and "e-commerce" in electronic databases of business and newspaper publications.

In analyzing Internet adoption by small and medium-sized firms, Dholakia and Kshetri (2004) found adoption to be conducted in phases. The first phase was website adoption, with e-commerce adoption as a second phase. Prior use of technology was the primary factor associated with both website and e-commerce adoption. E-commerce adoption was heavily influenced by privacy and security issues as well as customer service.

The Pew Internet and American Life Project has produced many reports on the dot.com meltdown and Internet use. Rainie et al. (2001) documented the impact of the dot.com slowdown on changes in Internet usage. Fallows (2005) found that people were generally confident and trusting of Internet searches, despite the fact that such trust may be naïve. Confidence and trust of the Internet varied with age, with younger users being both more confident and trusting.

Researchers have also examined the development of Internet and e-commerce capabilities in the food and agricultural industries, with most of the research focused on farmer Internet use. Morehart and Hopkins (2000), and Hopkins and Morehart (2001) explored Internet and e-commerce adoption by U.S. farmers. Their results indicate that from 1997 to 2001, Internet use for business reasons by farmers grew from 13% to 43%. In 1999, 15% of U.S. farms reported using e-commerce, with price tracking, information gathering, and communication being the most prevalent uses.

Hall et al. (2003) analyzed Internet adoption by Southeastern beef and peanut farmers. A survey of farm operators revealed that information access was a driving motivation of Internet adoption. Over 40% used the Internet for information searches related to the farm business, mostly for weather, farm product information, and farm, financial, and political news.

Smith et al. (2004) investigated computer and Internet use among Great Plains farmers based on data gleaned from a 2001 survey. They found that exposure to technology through educational, employment, and social experiences was more influential in Internet adoption than farmer age and farm size. Yet, about half of the respondents using the Internet for farm-related business reported zero benefits from Internet use. The fixed costs associated with the time needed to learn how to use the Internet were high, creating a challenge for future Internet use.

Ehmke et al. (2001) analyzed the adoption of e-commerce services by agribusiness firms in Ohio. Their survey, conducted in 2000, found extensive use of the Internet as a communications tool with increasing adoption of e-commerce services. Firm managers responded that the establishment of e-commerce was forcing them to change the way they think about their business.

Based on a 1999 survey, agricultural input firms reported having greater e-commerce engagement with their suppliers than with their customers (Henderson, Dooley, and Akridge, 2004). Survey respondents noted that information benefits associated with improved access to information, more product choices, and easier product comparisons supported e-commerce adoption by farmers. However, the lack of after-sales service, along with security and privacy concerns by farmers, was expected to limit farmer e-commerce adoption.

A limitation of the literature on Internet and e-commerce adoption in agribusiness industries is the lack of data after the dot.com shake-out. Most of the analyses on agribusiness Internet and e-commerce adoption were based on data obtained prior to 2001. Internet company closures rapidly intensified in 2001 (Rainie et al., 2001). With a changing web environment, Internet and e-commerce use by agribusiness firms may be substantially different today than in the past. Moreover, the perceptions of e-commerce by agribusiness firm managers may have changed due to additional Internet and e-commerce experience in addition to a changing web environment. Finally, while most previous research of e-commerce adoption has focused on farmers, e-commerce is a two-party business transaction. Analysis of agribusiness Internet adoption and the perceptions of agribusiness firm managers is necessary in order to understand why agribusiness firms are offering specific Internet and e-commerce capabilities. In other words, the benefits or barriers perceived by agribusiness firm managers will influence how agribusiness firms use the Internet and e-commerce to engage farmers.

Characteristics of Respondents

To analyze Internet and e-commerce use after the 2001 recession and the dot.com collapse, executives and managers in agribusiness firms were surveyed in 2004 regarding the Internet activities in their company. Agribusiness firms included manufacturers, distributors, and dealers who sell inputs to farmers, as well as various financial, consulting, and miscellaneous service providers to the farm sector. The survey questionnaire asked for information on the current features on company websites, the extent of e-commerce usage by customers and suppliers, the general opinions about the Internet and e-commerce, and perceptions about the factors supporting or limiting Internet and e-commerce adoption by farmers. The survey questionnaire was based on an earlier survey conducted in 1999 by Ivanic et al. (2001). Appendix A provides a list of questions from the questionnaire.

The questionnaire was successfully distributed to 2,388 managers, 1,620 by e-mail and 732 by fax.[5] Questionnaires were sent by e-mail when the e-mail address was provided, and by fax when e-mail distribution was not possible. A total of 199 questionnaires were returned. However, 38 respondents failed to fully complete the survey and were dropped from the final response list, leaving 161 observations for an overall 6.7% response rate. The response rate was higher for managers receiving a fax (9.7%) compared to a 5.8% response rate for managers receiving an e-mail.[6]

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[5] An additional 477 questionnaires were distributed, but unsuccessfully delivered (341 by e-mail and 136 by fax).

[6] The survey response rate was substantially lower than the 19.3% response rate for the 1999 survey reported by Ivanic et al. (2001). Several factors may have resulted in a lower response rate. One, the 2004 survey was longer than the 1999 survey. Two, the use of e-mail may have limited the survey participation as shown by the different response rates. Three, an advanced stage of Internet and e-commerce adoption may have led to lower interest in survey participation. Finally, the 1999 survey was administered by the Center for Food and Agricultural Business at Purdue University. The 2004 survey was administered by the Center for the Study of Rural America, which had a weaker connection with survey participants than the Center for Food and Agribusiness and may have contributed to a lower response rate.

A limitation of the survey is that it was based on a convenience sample. Contact information was drawn from a database of agricultural firm managers compiled by the Center for Food and Agricultural Business at Purdue University.[7] Convenience samples may not reflect the target population. A comparison of the geographic distribution of the sample and agribusiness establishments from County Business Patterns data revealed the survey may be biased toward Midwestern firms (table 1).[8] Half of the survey contacts were located in the Corn Belt compared to 28.5% of wholesale agribusiness establishments. The survey appears to under-represent firms in California, Texas, and the Southeast. However, the distribution of wholesale establishments may be an incomplete reflection of the target population for various reasons. First, County Business Patterns data do not include non-employer firms. Second, industry classifications for County Business Patterns may not necessarily reflect the distribution of agribusiness firms. For example, firms that finance farms are lumped together with other financial firms and are not able to be identified as an agricultural service firm.

A majority of the respondents were involved in the crop sector.[9] Half (50.3%) of the respondents reported involvement in only the crop industry (crop equipment, seed, chemicals, fertilizer, grain merchandising) versus a scant 7.5% of the respondents indicating involvement in solely the livestock industry (animal health, feed, livestock equipment). More than a quarter (28.6%) of the respondents were associated with both the crop and livestock industries. The remaining respondents (13.7%) were engaged in lending, consulting, or marketing functions of the agricultural industry.[10]

Respondents represented a broad cross-section of the agribusiness distribution channel and diverse ownership structures. They included manufacturers (34.2%), distributors (9.9%), and dealers (24.2%). More than 17% of the respondents indicated they serviced multiple roles in the distribution channel (manufacturer, distributor, and/or dealer).[11] Roughly 14% participated in the financial and consulting activities of the distribution channel. Respondents were employed

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[7] Questionnaires were sent to all firm managers who were not randomly selected to receive other surveys in the past 12 months.

[8] The comparison was limited to wholesale industries that appear to directly do business with farmers, because questions asked about the business's farm customers. Moreover, agricultural support establishments (NAICS 115) were excluded from the analysis because they are often described as farms, ranches, dairies, greenhouses, nurseries, orchards, or hatcheries.

[9] For a comparison of the characteristics of respondents from the 1999 and 2004 surveys, refer to appendix B. The Mantel-Haenszel chi-square test for stratified tables was used to compare the 1999 and 2004 results (Cody and Smith, 1997).

[10] In the County Business Patterns data, farm product raw material wholesale establishments were segregated into grain and field bean, livestock, and other categories. The "other" category included establishments engaged in both the grain and livestock sectors. Based on these data, 65% of farm product raw material establishments were classified as grain and field bean establishments, 20% were livestock establishments, and 15% were classified as other.

[11] As observed from appendix B, the channel positions of the 2004 respondents were significantly different from the channel positions of the 1999 respondents at the 0.05 level. Dealers and financial and consulting participants accounted for significantly more of the 2004 respondents than the 1999 respondents, while manufacturers accounted for significantly less of the 2004 respondents than the 1999 respondents.

Table 1. Geographic Distribution of Survey Sample and U.S. Agribusiness Establishments by Region (percent)

Description	U.S. Region [a]			
	Corn Belt	Delta	Northern Plains	South-east
2004 Survey (% of contacts):	49.8	9.5	8.8	7.0
Wholesale Agribusiness Establishments (% of U.S. establishments): [b]				
< Farm Product Raw Material Wholesale (NAICS 4245)[c]	37.0	9.6	12.9	10.7
< Farm Supplies Wholesale (NAICS 42291)[c]	24.6	9.3	7.4	14.7
< Farm & Garden Machinery & Equipment Wholesale (NAICS 42182)[c]	23.2	9.7	9.1	14.0
Total:	28.5	9.5	10.0	13.1

[a] Regions are defined as reported in the *2002 U.S. Census of Agriculture*: Corn Belt includes OH, IN, IL, IA, NE, and KS; Delta includes MS, LA, AR, MO, and OK; Northern Plains includes MN, SD, ND, and MT; Northeast includes WV, MD, DE, NJ, PA, RI, CT, NY, MA, VT, NH, and ME; Northwest includes ID, OR, and WA; Mountain includes CO, UT, WY, and NV.

[b] Calculations are based on 2002 County Business Patterns data from the U.S. Census Bureau. Data do not include non-employer firms.

[c] NAICS is North American Industrial Classification System.

by cooperatives (23.6%), private firms (50.9%), and by publicly held firms (20.5%).[12]

Respondents were widely distributed across firm size. Almost 22% of the respondents reported firm sales over $1 billion dollars, with another 19% of firms reporting sales between $100 and $999 million. At the other extreme, roughly 30% of the respondents reported annual firm sales less than $10 million, and another 17.2% with firm sales between $10 and $49 million.[13]

The respondents reported a broad geographic scope for the distribution of products or services. Roughly a third of the respondents indicated their firm operated in international markets.[14] Over 40% noted the firm operated in a national or multi-state market. Finally, more than a quarter of the respondents reported that the firm operated in state or local markets.

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[12] The ownership structures of the 2004 respondents were significantly different from the 1999 respondents at the 0.10 level. Cooperatives accounted for significantly more of the 2004 respondents than the 1999 respondents, while publicly held companies accounted for significantly less of the 2004 respondents.

[13] Respondents of the 2004 survey were more likely to be from smaller firms than the 1999 respondents. The statistical difference was significant at the 0.05 level.

[14] Respondents of the 2004 survey were more likely to distribute products or services in a local market and less likely to operate in an international market than respondents to the 1999 survey. The statistical difference was significant at the 0.01 level.

Table 1. Extended

U.S. Region[a]							
Northeast	WI and MI	Northwest	TX and NM	CA and AZ	Florida	HI and AK	Mountain
5.9	5.7	5.3	3.3	2.3	0.9	0.8	0.7
6.0	3.6	4.6	7.4	4.3	1.6	0.1	2.2
10.4	4.8	5.7	7.0	9.1	4.1	0.4	2.5
10.0	6.8	4.7	7.8	8.1	3.6	0.2	3.0
8.7	5.1	4.9	7.4	7.0	3.0	0.2	2.6

Internet and e-Commerce Use

According to the survey respondents, a large and increasing majority of agribusiness firms reported having a company website (table 2). Website features in 2004 were not dramatically different from the features available in 1999, with information features remaining the most popular. The incorporation of e-commerce capabilities for customers on agribusiness firm websites did not appear to have significantly increased in the past five years. However, the intensity of e-commerce use with suppliers increased substantially.

In 2004, 87% of the agribusiness firms reported having a company website, compared to 78% in 1999. Exactly half of the 2004 respondents without a company website reported that they expected to develop a website in the future.

A wide variety of features were offered on company websites. The most popular features provided information, either about the company or its products (table 2). While the distribution of features did not change much in the past five years, three broad categories showed significant evolution. First, firms were more likely to have links to external sources of information and trade associations. Second, websites were more sophisticated as advanced features, such as password protection, customized content, and online communities, were in greater use in 2004. Finally, the number of firms using their website to provide pricing information nearly doubled from 1999 (17.4%) to 2004 (29.3%).

While information features were more prevalent on agribusiness firm websites, the prevalence of e-commerce capabilities with customers was not significantly different from 1999 to 2004 (table 2). In 2004, approximately 28% of the companies with a website allowed for online ordering. Roughly 20% allowed for online ordering with traditional payment, while 9% also allowed for online ordering and

Table 2. Web Page Features for Firms with a Website, 1999 and 2004 Surveys

Feature Found on Company Web Page	Percent of Firms[a] 1999 (N = 546)	2004 (N = 142)
< Provided background information about the company	94.9	95.7
< Provided technical information about products sold	81.3	84.3
< Provided links to other data/information sources (e.g., USDA, etc.)	47.3	70.7***
< Provided links to industry trade associations	48.4	60.0**
< Provided a dealer directory (information where products are sold)	41.4	51.3
< Included password protected areas, only accessible to registered members	26.6	49.3***
< Included areas with content customized to different audiences or individuals	35.2	37.1**
< Provided pricing information about products sold	17.4	29.3***
< Included online communities (e.g., chat rooms, bulletin boards, etc.)	16.5	18.6
< Allowed for online ordering, but using traditional means of payment	16.3	19.3
< Allowed for online ordering and payment	7.9	9.3

Notes: Double and triple asterisks (*) denote distributions significantly different at the 0.05 and 0.01 levels, respectively. A chi-square test was used to test for differences across the 1999 and 2004 data.

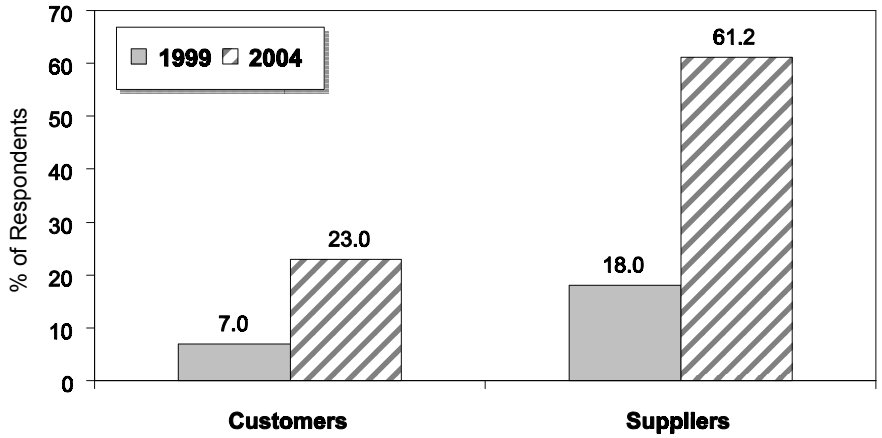
[a] Percent based only on those firms with a website.

payment.[15] Larger firms were more likely to have e-commerce capabilities on their website than smaller firms. In 2004, over 40% of firms with online ordering features on their website were firms with more than $500 million in sales, and 21% were firms with less than $50 million in sales.

Although agribusiness firms in 2004 did not appear to have increased the availability of online ordering and payment on their firms' web pages, the intensity of e-commerce use appeared to be greater, especially with suppliers. In 2004, 23% of the respondents indicated that more than 5% of their customers placed orders over the Internet, up from 7% in 1999.[16] This growth appears strong, yet it was not as strong as the growth in supplier orders. In 2004, 61.2 % of the respondents indicated their firms placed orders with more than 5% of their suppliers over the Internet, up from 18% in 1999 (figure 1). Moreover, the percentage of respondents who reported placing no online orders with suppliers dropped from 48% in 1999 to 21% in 2004.

[15] The percentages total to more than those engaged in online activities because some firms allowed for both traditional and online payment.

[16] The difference between the number of firms with e-commerce capabilities on their website (23.1%) and those receiving orders over the Internet from their customers (26.1%) could be due to the use of closed Electronic Data Interchange systems with their customers.



Notes: "Customers" denotes percent of respondents reporting that 5% or more of their customers place orders over the Internet. "Suppliers" denotes percent of respondents reporting that their company places orders with 5% or more of their suppliers over the Internet.

Figure 1. Agribusiness e-commerce use with customers and suppliers

Responses reveal that fewer firms are starting Internet/e-commerce initiatives, but those who already have an Internet/e-commerce presence are expanding the sophistication/intensity of the activity. The percentage of agribusiness firms with e-commerce capabilities was not statistically different in 2004 compared to 1999. However, e-commerce appeared to have deeper penetration since the share of customers and suppliers who are using e-commerce to engage with agribusiness firms has increased. These findings suggest that the agribusiness industry may have entered a new phase of e-commerce use, moving from a phase of rapid growth associated with adoption across many new firms to a slower growth phase associated with firms expanding their own Internet and e-commerce use.

Given the diversity of Internet and e-commerce use, all agribusiness firms were segmented into three categories based on the Internet and e-commerce capabilities available on their website. First, "e-Commerce" firms were defined as firms reporting online ordering and/or payment features on their website. Accounting for 18.9% of the respondents, e-Commerce firms tended to be larger in terms of sales, engaged in international markets, and were manufacturing or multi-channel firms (figure 2).[17] A larger share of the 2004 respondents were identified as e-Commerce firms than in the 1999 survey, reflecting the greater use of e-commerce. The firm characteristics of the e-Commerce firms were not significantly different between 2004 and 1999.

Almost 70% of the respondents were classified as "Internet" firms—firms that reported having a company website, but did not have online orders and/or payment

[17] Multi-channel firms are those indicating they performed multiple functions in the agricultural input distribution channel. For example, a firm identifying itself as a manufacturer and a distributor was classified as multi-channel.

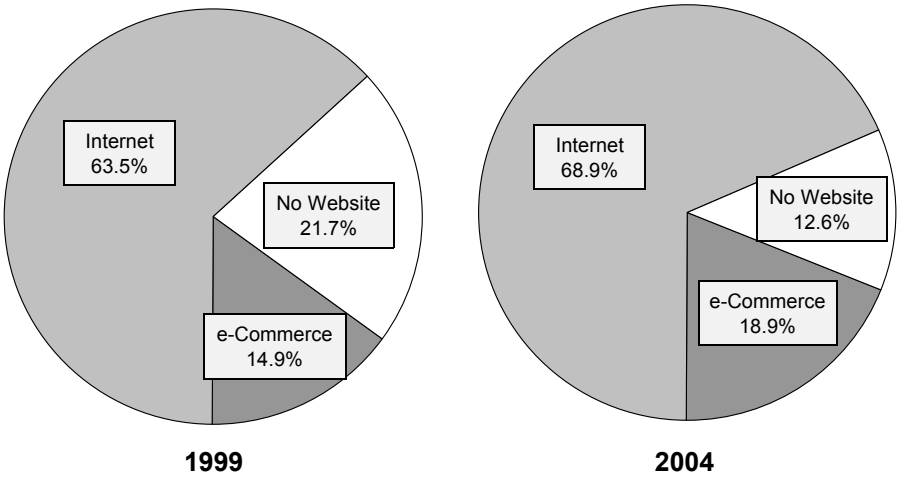


Figure 2. Respondents by Internet and e-commerce capabilities on company website

features. Internet firms were similar to e-Commerce firms because they tended to be larger manufacturing firms that engaged in international markets. However, medium-sized firms and some dealers accounted for a significant share of the Internet firms. The firm characteristics of the Internet firms were not significantly different between 2004 and 1999.

The remaining 12% of firms were classified as "No Website" because they did not report having a company website in 2004. No Website firms tended to be single-establishment dealers that operated in local markets. These firms had smaller sales on an annual basis. A smaller share of the 2004 respondents were identified as No Website firms than in the 1999 survey. Firm characteristics of No Website firms were not significantly different between 2004 and 1999.

Internet and e-Commerce Perceptions

The introduction of new technology always brings a new wave of learning as users experience success and failure. The perceptions of agribusiness firm managers could evolve as they gained experience with Internet and e-commerce use. Agribusiness firm managers were asked a series of five-point Likert scale questions regarding various perceptions of the Internet and e-commerce. Mean values were used to calculate the general level of agreement and are presented in table 3.[18] The Mantel-Haenszel chi-square test for stratified tables was used to compare the 2004 and 1999

[18] In the Likert scale, 1 = strongly agree, 2 = somewhat agree, 3 = neutral, 4 = somewhat disagree, and 5 = strongly disagree. Mean values less than 3 indicate a level of agreement with the statement, while mean values greater than 3 indicate a level of disagreement with the statement.

Table 3. Likert Scale Values for Perceptions of Agribusiness Firm Managers About the Internet and e-Commerce, 1999 and 2004 Surveys

	Mean / (Std. Deviation)	
Description	1999 (N = 682)	2004 (N = 161)
Perceptions About e-Commerce:		
< E-commerce will fundamentally change the way we do business in our industry in the next three years.	2.17*** (1.06)	2.42*** (1.09)
< The emergence of e-commerce will greatly reduce the role for local dealers in our industry in the next three years.	3.37*** (1.15)	3.65*** (1.17)
< E-commerce will improve my company's ability to manage inventory levels in the next three years.	2.67*** (1.06)	2.58*** (1.15)
Perceptions About the Internet:		
< Information about increasingly complex products is difficult to provide over the Internet.	3.12 (1.23)	3.10 (1.11)
< Farmers are unwilling to buy products on the Internet.	3.39*** (1.04)	3.15 (0.99)
< Personal relationships with customers are difficult to develop over the Internet.	2.04*** (1.09)	1.95*** (1.14)
< Distribution (logistics) issues will limit sale of my industry's products over the Internet.	2.81*** (1.21)	2.59*** (1.23)
< The Internet allows our company to expand into additional markets.	N/A	2.47*** (1.02)
< The Internet is useful for education and training.	N/A	1.52*** (0.63)
< The Internet is a critical tool for research in my business.	N/A	1.84*** (0.93)

Notes: Triple asterisks (*) denote significantly different from neutral at the 0.01 level. For the five-point Likert scale, 1 = strongly agree, 2 = somewhat agree, 3 = neutral, 4 = somewhat disagree, and 5 = strongly disagree. Mean values less than 3 indicate a level of agreement with the statement, while mean values greater than 3 indicate a level of disagreement with the statement.

results (Cody and Smith, 1997). Unless otherwise noted, only comparisons of statistical significance are described in the text.

In 2004, agribusiness firm managers continued to perceive that e-commerce would fundamentally change the way business would be conducted in the next three years (table 3). However, the level of agreement was weaker in 2004 and significantly different from the 1999 results. These results suggest the impacts of e-commerce on the agribusiness industry will be less intense in the future, as the expected changes in the industry may have already occurred. Moreover, e-Commerce firm managers specifically indicated that the impacts could be less intense; only 15.8% of these managers in 2004 strongly agreed e-commerce would change the way their company did business, compared to 31% in 1999. These findings provide additional support for the notion that e-commerce may be entering a more mature part of its growth phase.

E-commerce was also expected to challenge the traditional agribusiness distribution channel (Chambers et al., 2001; Ehmke et al., 2001; Henderson, Dooley, and Akridge, 2004; Mueller, 2000). With e-commerce capabilities, upstream manufacturers could sell directly to final customers, by-passing downstream distributors and retailers to the point where "the traditional end-user supplier becomes a glorified delivery company or goes out of business altogether" (Kenney, 2000). As a result, e-commerce was thought to present a tremendous challenge to agribusiness dealers. Agribusiness firm managers, however, did not feel e-commerce would greatly reduce the role of dealers in the industry in the next three years (table 3).[19] A general consensus among agribusiness firm managers was that dealers are expected to play a key role in the agribusiness channel in the near future; i.e., the level of disagreement did not vary by e-Commerce, Internet, or No Website firms.

One reason for the continued importance of dealers is the perceived difficulties in developing personal relationships over the Internet. Agribusiness firm managers expressed strong agreement that personal relationships with customers were difficult to develop over the Internet (table 3).[20]

Transaction costs associated with accessing vendors and customers have been identified as a primary driver for e-commerce adoption (Dinlersoz and Hernandez-Murillo, 2005). Consequently, logistic issues were expected to play a key role in the use of Internet and e-commerce technology in the future. In 2004, agribusiness firm managers agreed e-commerce would improve inventory management, with a mean Likert scale value of 2.58 (table 3).[21] Respondents also agreed the Internet allowed their company to expand into additional markets.[22] Yet, with a Likert scale value of 2.59, agribusiness firm managers acknowledged that distribution issues would limit the sale of products over the Internet. From the 2004 survey results, distribution issues emerged as a bigger limitation than in the past.[23]

However, the results did vary according to the e-commerce capabilities of the agribusiness firm (figure 3). Compared to No Website firms, respondents from e-Commerce and Internet firms expressed significantly stronger agreement with the statement that e-commerce will improve the company's ability to manage inventory levels. Respondents in e-Commerce and Internet firms also expressed significantly stronger disagreement with the statement that distribution issues would limit the sale of the industry's products over the Internet.

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[19] The mean Likert scale value associated with the statement that the emergence of e-commerce will greatly reduce the role for local dealers was 3.65 in 2004, and significantly different from neutral. In addition, the level of disagreement in 2004 was statistically stronger than in the 1999 survey. The level of disagreement was not significantly different across e-Commerce, Internet, and No Website firms.

[20] The mean Likert value for this perception was 1.95 and significantly different from neutral. The 2004 results were not significantly different from the 1999 results. The results were not significantly different across e-Commerce, Internet, and No Website firms.

[21] The 2004 results were not significantly different from the 1999 results.

[22] The mean Likert scale value was 2.47 and significantly different from neutral. The market access question was not included in the 1999 survey.

[23] The stronger level of agreement in 2004 was statistically different from the 1999 results.

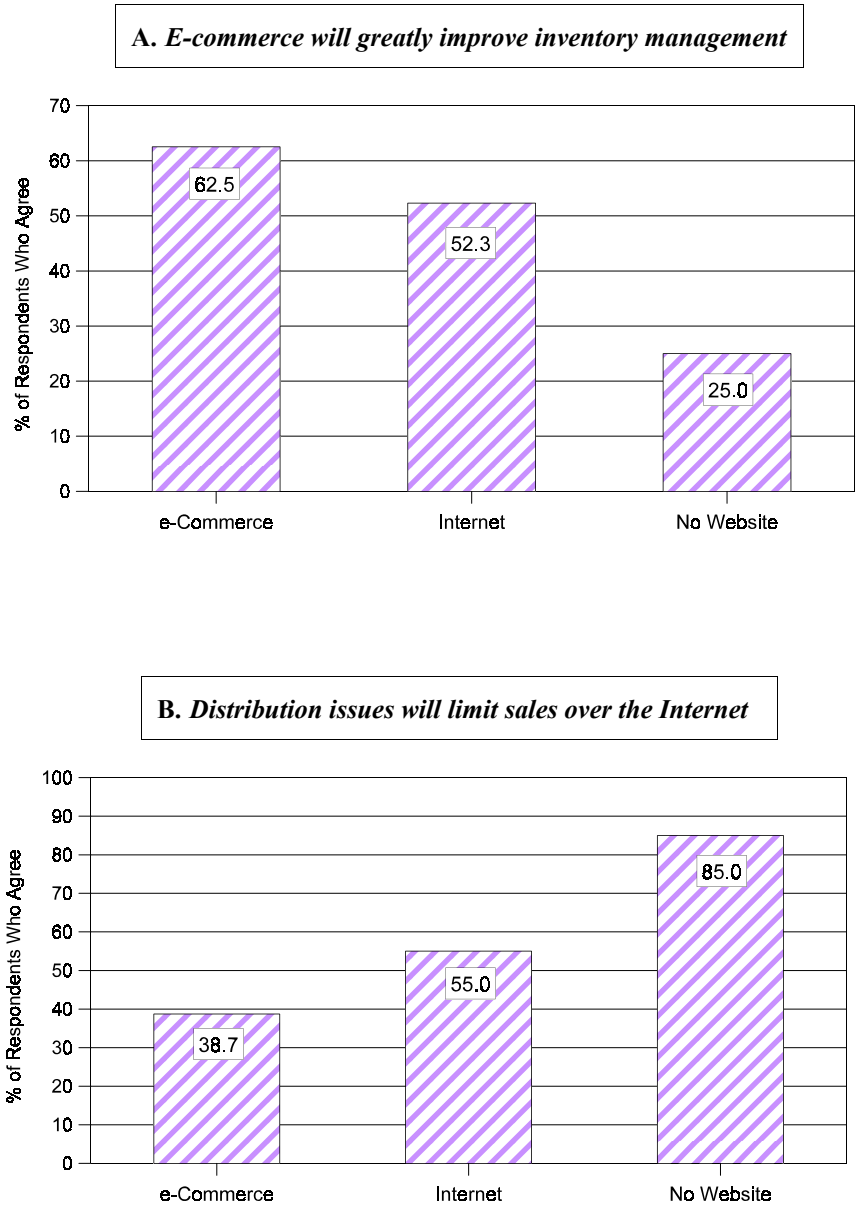

Figure 3. Opinions regarding logistics issues in 2004

Coupled with the distribution challenges, agribusiness firm managers perceived greater challenges with farmers' willingness to buy products over the Internet. To be sure, managers were neutral regarding the statement that farmers are unwilling to buy products on the Internet, as the mean Likert value was not significantly different from neutral (table 3). In 1999, however, agribusiness firms disagreed with the statement that farmers were unwilling to buy products over the Internet.[24]

Agribusiness Firm Perceptions on Farmer Internet Adoption

Security, privacy, and trust issues might be the reasons more managers perceived farmers to be more unwilling to buy over the Internet than in the past. Agribusiness firm managers were asked several questions about the factors influencing farmer Internet adoption. Responses were recorded using a five-point Likert scale.[25] Results are presented in table 4.

Confidence and trust have been identified as key issues in Internet searches (Fallows, 2005). Agricultural input managers indicated they perceive security, privacy, and trust issues to be barriers to farmer e-commerce adoption, with mean Likert scale values of 3.48, 3.46, and 3.20, respectively. All three issues—security, privacy, and trust—were identified as significantly greater barriers in 2004 than in 1999. The No Website firms were more likely to indicate that farmers' lack of trust in making Internet purchases would be a barrier to adoption.[26]

Access to the Internet, especially high-speed service, has been a major concern in many corners of rural America (Staihr, 2000). Thus, managers' perceptions about the ability of farmers to access the Internet could influence farmer e-commerce adoption. However, respondents reported that the lack of Internet access would not be a barrier to farmer adoption (table 4). The responses were not significantly different across e-Commerce, Internet, and No Website firms. In terms of ability to use the Internet, respondents stated that the inability to find desired information conveniently on the Internet would not be a barrier to farmer e-commerce adoption. Again, responses were not significantly different across e-Commerce, Internet, and No Website firms.

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[24] Respondents also confirmed a critical role of the Internet in terms of education and training and research. Agribusiness firms tended to strongly agree that the Internet was useful for education and training, with a mean Likert value of 1.52 (table 3). In fact, only one No Website firm disagreed with the statement. Respondents also identified the Internet as a critical tool for research in the company, with a mean Likert value of 1.84. Respondents in e-Commerce and Internet firms tended to have statistically stronger agreement with the statement concerning the Internet's critical role in research. Over 45% of the e-Commerce and Internet firms agreed the Internet was a critical tool in the company's research compared to 25% of No Website firms. The statements regarding education and training and research were not included in the 1999 survey.

[25] Regarding potential barriers, respondents were asked to identify barriers on a five-point Likert scale where 1 = "not a barrier" and 5 = "a major barrier." Concerning factors supporting farming adoption, respondents were asked to identify factors on a five-point Likert scale where 1 = "not a factor" and 5 = "a major factor."

[26] Trust responses were significantly different across e-Commerce, Internet, and No Website firms in 2004. In contrast, security and privacy responses were not significantly different across e-Commerce, Internet, or Website firms.

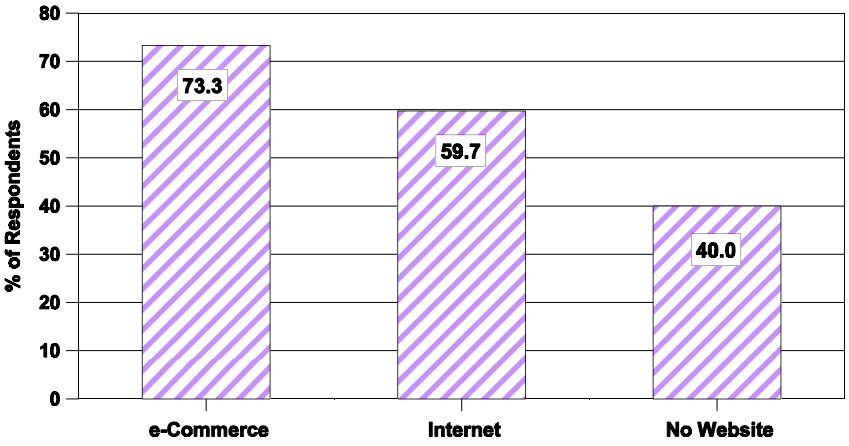
Table 4. Likert Scale Values for Barriers to and Supporting Factors for Farmer e-Commerce Adoption, 1999 and 2004 Surveys

	Mean / (Std. Deviation)	
Description	1999 (N = 682)	2004 (N = 161)
Barriers to Farmer e-Commerce Adoption:		
< Farmers do not have Internet access.	2.33*** (1.13)	2.52*** (1.23)
< Farmers lack the required trust to make Internet purchases.	3.05 (1.10)	3.20*** (1.13)
< The Internet offers limited ability to provide product recommendations to farmers.	2.92 (1.23)	2.95 (1.26)
< The Internet offers limited ability to provide after-sales service to farmers.	3.64*** (1.23)	3.66*** (1.24)
< Farmers are unable to find desired information conveniently on the Internet.	2.70*** (1.04)	2.62*** (1.00)
< Farmers question the security of e-commerce.	3.29*** (1.05)	3.48*** (1.04)
< Farmers question the privacy of e-commerce.	3.30*** (1.08)	3.46*** (1.08)
Factors Supporting Farmer e-Commerce Adoption:		
< Prices for products will be lower if purchased over the Internet.	3.55*** (1.21)	3.58*** (1.14)
< Information can be obtained more easily over the Internet.	3.56*** (1.01)	3.56*** (0.98)
< More product choices will be available over the Internet.	3.23*** (1.18)	3.15 (1.14)
< Buying over the Internet is more convenient than traditional channels.	3.11*** (1.15)	2.93 (1.13)
< It is easier to make product comparisons over the Internet.	3.20*** (1.15)	3.28*** (1.09)

Notes: Triple asterisks (*) denote significantly different from 3.0 at the 0.01 level. For the five-point Likert scale, 1 = "not a barrier" and 5 = "major barrier," *or* 1 = "not a factor" and 5 = "a major factor."

Information is often cited as a critical factor in farmer e-commerce adoption (Morehart and Hopkins, 2000; Hopkins and Morehart, 2001) and was found to be an important issue to agribusiness firm managers. The ease of obtaining information over the Internet was perceived as supporting e-commerce adoption. Seventy-three percent of e-Commerce firm managers stated that the ease of obtaining information over the Internet would be a factor influencing e-commerce adoption, compared to only 40% of No Website firm managers (figure 4).

Respondents perceive that sales, service, and product marketing issues would impact the adoption of e-commerce by farmers. In general, the limited ability to provide after-sales service to farmers was perceived as a barrier to farmer e-commerce adoption, with a mean Likert value of 3.66 (table 4). Easier product comparisons



Note: Percent of respondents denotes respondents who chose a value of 4 or 5 on the five-point Likert scale, where 5 = a "major factor."

Figure 4. Factor supporting farmer e-commerce adoption: "Information can be obtained more easily over the Internet."

over the Internet were also perceived to support e-commerce adoption (a mean Likert value of 3.28). Responses were more neutral concerning the limited ability to provide product recommendations and more product choices available over the Internet.[27] However, the responses related to product marketing issues were significantly different across e-Commerce, Internet, and No Website firms. E-Commerce firms were more likely than Internet or No Website firms to indicate that more product choices and more product comparisons on the Internet will be a factor in farmer e-commerce adoption (figure 5). Moreover, e-Commerce firms were less likely to report that the limited ability to provide product recommendations over the Internet would be a barrier to farmer e-commerce adoption than Internet and No Website firms.

Agribusiness firm managers reported price would be a factor supporting farmer e-commerce adoption, but there was some disagreement regarding the impact of buying convenience on farmer e-commerce adoption. According to respondents, farmers' perception that prices for products would be lower if purchased over the Internet would support farmer e-commerce adoption (mean Likert value of 3.58, table 4). The responses did not vary from the 1999 survey or across e-Commerce, Internet, and No Website firms. In contrast, buying convenience was not identified as a factor influencing farmer e-commerce adoption in the aggregate, but the responses differed significantly across e-Commerce, Internet, and No Website firms.[28] Half of the managers of e-Commerce firms felt buying convenience was a

[27] The 2004 responses regarding after-sales service, product comparisons, and product recommendations were not significantly different from the 1999 responses.

[28] The 2004 responses were not significantly different from the 1999 responses.

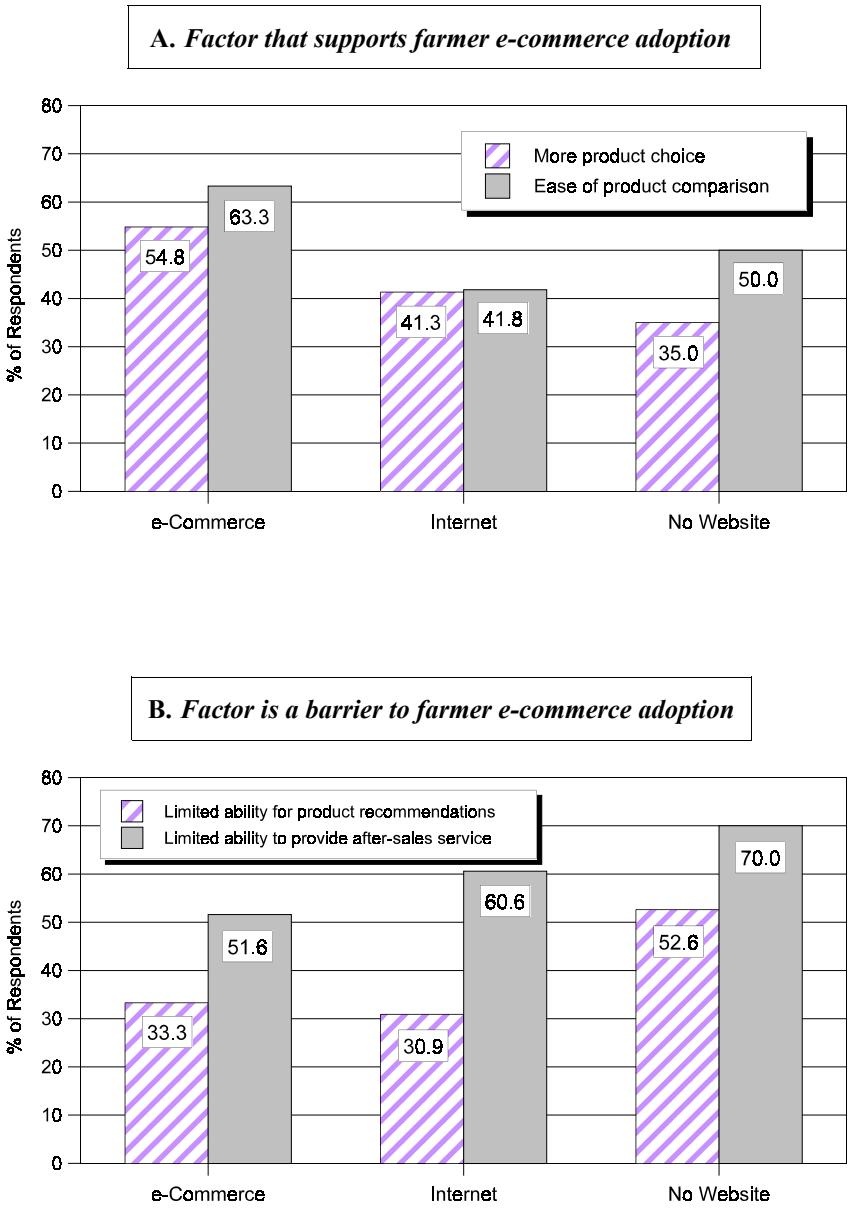


Figure 5. Perceptions of product and service offerings on farmer e-commerce adoption

factor supporting farmer e-commerce adoption, while less than a third of Internet firms and less than a quarter of No Website firms were in agreement.

Conclusions

In the last decade of the 21st century, e-commerce emerged as a highly important channel for U.S. business. Agriculture was no exception. Consistent with other industries, agribusiness firms were clearly using e-commerce more with their suppliers than with their customers. There was general agreement among agribusiness firm managers that farmers' desire for personal relationships and customer service may continue to be a barrier between agribusinesses and increased Internet and e-commerce activity with farmers.

While a majority of agricultural input firm managers acknowledged e-commerce will dramatically change their business, their perceptions varied as to how farmers would embrace e-commerce. Firms with e-commerce capabilities perceived stronger benefits of the Internet and e-commerce emerging from logistics, information, and market expansion than other firms. Managers of e-Commerce firms also reported that the ability to provide more product offerings through additional product choices, easier comparisons, and product recommendations would enhance farmer adoption of e-commerce.

A clear distinction regarding Internet strategies also emerged between e-Commerce firms and other agricultural input firms. E-Commerce firm managers expressed a stronger perception than their Internet and No Website counterparts that convenience factors will encourage farmer adoption. The survey, however, was not capable of identifying causality. Did e-commerce capabilities determine manager perceptions, or did manager perceptions determine e-commerce capabilities? While causality could not be determined, differences of opinion and differences of e-commerce capabilities did exist.

Future research could shed important insight into e-commerce use and its impact on U.S. agribusinesses. Additional work could focus on how e-commerce implementation shapes the perceptions regarding e-commerce. Are firms capable of producing the benefits they expected by implementing e-commerce technologies? And how have their perceptions changed? What are the challenges of e-commerce implementation, especially the unexpected challenges? Moreover, future research could examine the relationship between agribusiness firms and their suppliers, as most previous e-commerce research in the food and agricultural sectors has focused on the relationship between agribusiness firms and their farmer customers.

While e-commerce has moved out of its infancy stage of development, perceptions about e-commerce and the implementation of e-commerce strategies will continue to evolve. As indicated by our survey results, firms implementing e-commerce technologies clearly perceived greater benefits emerging from improved logistics, information, and market penetration. Firms that identified buying convenience and broader product offerings through greater choice, comparison, and recommendation as factors supporting farmer e-commerce adoption implemented

e-commerce strategies to fill farmer needs. Clearly, challenges remain in e-commerce adoption. Until opinions converge, the use and implementation of Internet and e-commerce capabilities by agribusiness firms will remain highly diverse.

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Appendix A: Survey Questions

You and Your Company:

What is your position/area of responsibility within your company? *Mark appropriate response.*

☐ President/CEO/Owner
☐ Vice President/General Manager/Division President
☐ CFO/Controller/Treasurer/Finance
☐ Marketing (Manager, Director, Product)
☐ Sales/Sales Management
☐ Production/Operations/Distribution/Logistics
☐ Human Resource Manager
☐ Research and Development
☐ Other: _____

What are your company's primary business interest(s)? *Mark those your company is involved in.*

☐ Advertising
☐ Animal health
☐ Association
☐ Chemicals
☐ Consulting
☐ Crop equipment
☐ Education
☐ Farming/Ranching
☐ Feed
☐ Fertilizer
☐ General supply
☐ Government agency
☐ Grain merchandising/Processing
☐ Lending
☐ Livestock equipment
☐ Seed
☐ Trade publications
☐ Other media
☐ Other: _____

Your company is best described as a: *Mark all that apply.*

☐ Manufacturer
☐ Distributor
☐ Dealer
☐ Other: _____

Your company is: *Mark appropriate response.*

☐ A Cooperative
☐ Privately Owned
☐ Publicly Held
☐ Other: _____

The scope of your operating unit's distribution of products/services is: *Mark appropriate response.*

☐ Local ☐ National
☐ State-wide ☐ International
☐ Regional (multiple state)

Is your business a single establishment or a branch operation of a larger company? *Mark appropriate response.*

☐ Single establishment ☐ Branch operation

What is the gross annual sales of your operating unit/total company? *Mark only one in each column, based on 2003 sales figures.*

Operating Unit	Total Company	
☐	☐	Less than $10 million
☐	☐	$10 million to $49 million
☐	☐	$50 million to $99 million
☐	☐	$100 million to $499 million
☐	☐	$500 million to $999 million
☐	☐	$1 billion or more

General Opinions:

General Opinions About e-Commerce:
Please give us your opinion on each of the following statements, rated on a 5-point scale where 1 = Strongly Agree, 2 = Somewhat Agree, 3 = Neutral, 4 = Somewhat Disagree, and 5 = Strongly Disagree

	1	2	3	4	5
(a) E-commerce will fundamentally change the way we do business in the next 3 years.	☐	☐	☐	☐	☐
(b) The emergence of e-commerce will greatly reduce the role for local dealers in our industry in the next 3 years.	☐	☐	☐	☐	☐
(c) E-commerce will improve my company's ability to manage inventory levels in the next 3 years.	☐	☐	☐	☐	☐

General Opinions About the Internet:
Please give us your opinion on each of the following statements, rated on a 5-point scale where 1 = Strongly Agree, 2 = Somewhat Agree, 3 = Neutral, 4 = Somewhat Disagree, and 5 = Strongly Disagree

	1	2	3	4	5
(a) Information about increasingly complex products is difficult to provide over the Internet.	☐	☐	☐	☐	☐
(b) Farmers are unwilling to buy products on the Internet.	☐	☐	☐	☐	☐
(c) Personal relationships are difficult to develop over the Internet.	☐	☐	☐	☐	☐
(d) Distribution (logistics) issues will limit the sale of my industry's products over the Internet.	☐	☐	☐	☐	☐
(e) The Internet allows our company to expand into additional markets.	☐	☐	☐	☐	☐
(f) The Internet is useful for education and training.	☐	☐	☐	☐	☐
(g) The Internet is a critical tool for research in my business.	☐	☐	☐	☐	☐
(h) We use the Internet for a number of recreational activities.	☐	☐	☐	☐	☐

Use of Internet and e-Commerce:

Please respond to the following two questions, rated on a 5-point scale where 1 = None, 2 = 1%–5%, 3 = 6%–15%, 4 = 16%–25%, and 5 = 26%–100%

What proportion of your end-user customers:	**1**	**2**	**3**	**4**	**5**
(a) Communicate with your company by e-mail?	☐	☐	☐	☐	☐
(b) Place orders for your products over the Internet (but still make payment by mail or traditional means)?	☐	☐	☐	☐	☐
(c) Place orders and make payment for your products over the Internet?	☐	☐	☐	☐	☐
With what proportion of your suppliers does your company:	**1**	**2**	**3**	**4**	**5**
(a) Communicate with your suppliers by e-mail?	☐	☐	☐	☐	☐
(b) Place orders for their products over the Internet (but still make payment by mail or traditional means)?	☐	☐	☐	☐	☐
(c) Place orders and make payment for their products over the Internet?	☐	☐	☐	☐	☐

Does your company have a website? (a) ☐ Yes ☐ No

(b) If "Yes," check all of the features on your website:

- ☐ Technical information about the products that you sell
- ☐ Pricing information for the products that you sell
- ☐ Background information about your company
- ☐ A dealer directory (information on where your products are sold)
- ☐ Links to industry trade associations
- ☐ Links to other data/information sources (e.g., USDA, universities)
- ☐ Online ordering (but traditional means of payment)
- ☐ Online ordering and payment
- ☐ Online communities (i.e., chat rooms, bulletin boards, message centers, virtual coffee shop, etc.)
- ☐ Areas with content customized to different audiences or customers
- ☐ A password-protected area, only accessible to registered customers or suppliers
- ☐ Other: _____

(c) If "No," does your company expect to develop a website?

- ☐ No
- ☐ Yes, in 2005
- ☐ Yes, in 2004
- ☐ Yes, but not sure when

Perceptions Regarding Farmer Adoption:

Several reasons have been suggested as possible barriers to farmer adoption of e-commerce. For each of the following potential barriers, please rate the barrier on a scale from 1 to 5, where 1 = "Not A Barrier," 3 = "Neutral," and 5 = "A Major Barrier."

	1	**2**	**3**	**4**	**5**
(a) Farmers do not have Internet access.	☐	☐	☐	☐	☐
(b) Farmers lack the required trust to make Internet purchases.	☐	☐	☐	☐	☐
(c) The Internet offers limited ability to provide product recommendations to farmers.	☐	☐	☐	☐	☐
(d) The Internet offers limited ability to provide after-sale services to farmers.	☐	☐	☐	☐	☐
(e) Farmers are unable to find desired information conveniently on the Internet.	☐	☐	☐	☐	☐
(f) Farmers question the security of e-commerce.	☐	☐	☐	☐	☐
(g) Farmers question the privacy of e-commerce.	☐	☐	☐	☐	☐

Several reasons have also been suggested that support rapid adoption of e-commerce and purchasing over the Internet by farmers. For each of the following reasons why farmers will buy products over the Internet, please rate the reason on a scale from 1 to 5, where 1 = "Not A Factor," 3 = "Neutral," and 5 = "A Major Factor."

	1	2	3	4	5
(a) Prices for products will be lower if purchased over the Internet.	☐	☐	☐	☐	☐
(b) Information can be obtained more easily over the Internet.	☐	☐	☐	☐	☐
(c) More product choices will be available over the Internet.	☐	☐	☐	☐	☐
(d) Buying over the Internet is more convenient than traditional channels.	☐	☐	☐	☐	☐
(e) It is easier to make product comparisons over the Internet.	☐	☐	☐	☐	☐

Appendix B

Table A1. Characteristics of Survey Respondents, 1999 and 2004

	Percent of Firms	
Description	1999 (N = 682)	2004 (N = 161)
Type of Firm:		
< Crop	42.2	50.3
< Livestock	11.8	7.5
< Crop and Livestock	30.6	28.6
< Other: Lending, Consulting, Marketing	15.4	13.7
Channel Position of the Firm: **		
< Manufacturer	44.5	34.2
< Distributor	12.5	9.9
< Dealer	15.4	24.2
< Multi-channel Position	20.0	17.4
< Other: Financial and Consulting	7.6	14.4
Ownership Structure of the Firm: *		
< A Cooperative	17.5	23.6
< Privately Owned	50.4	50.9
< Publicly Held	29.9	20.5
< Other	2.2	5.0
Scope of the Operating Unit's Distribution of Products/Services: ***		
< Local	12.6	22.0
< State-wide	4.0	5.0
< Regional (multiple states)	21.3	23.3
< National	13.7	18.2
< International	48.4	31.4
Gross Annual Sales of Your Total Company: **		
< Less than $10 million	22.0	30.5
< $10 million to $49 million	19.5	17.2
< $50 million to $99 million	9.8	11.3
< $100 million to $499 million	12.1	11.9
< $500 million to $999 million	5.7	7.3
< $1 billion or more	30.9	21.9

Note: Single, double, and triple asterisks (*) denote significantly different at the 0.10, 0.05, and 0.01 levels, respectively.