E-Business and Distribution Channel Strategies in Agribusiness Industries

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Abstract

The explosion of e-business activity presents many challenges to manufacturers, distributors, and dealers as they select a distribution channel for the delivery of products, services, and information. The expected growth in Internet sales by agribusiness firms is analyzed to provide insight into the selection of an e-business distribution channel. Agribusiness firm managers were surveyed regarding the application and perceived impacts of e-business activity on their firm's operations. Firm characteristics and manager perceptions regarding the impact of e-business activity were analyzed descriptively and in regression analysis to understand the drivers of expected Internet sales growth. Expected Internet sales growth was found to vary by the firm's position in the distribution channel. Yet, firms with greater levels of existing e-communication with either customers or suppliers and with managers perceiving greater ability of e-business activity to improve inventory management and logistics issues have higher levels of expected Internet sales.

E-business and Distribution Channels in Agribusiness Industries

Agricultural input supply industries face severe and profound challenges in the distribution of agricultural inputs from manufacturer to end-user. Over time the traditional dealer/distribution system has evolved into a more complex distribution network that includes manufacturers, wholesalers/distributors or brokers, retailers, and the customer. Several factors are restructuring and reconfiguring the traditional dealer/retailer based distribution system. Some manufacturers are bypassing distributors and retailers and going directly to the farmer. In other cases, e-business is introducing completely new models for distribution. Yet in many cases, local retail outlets continue to flourish.

What explains the success of these various distribution channel alternatives, and how might one make intelligent distribution channel choices in this increasingly competitive and electronically linked business environment? What challenges does e-business present to the traditional distribution system? What roles might manufacturers, distributors, and dealers need to play in this new environment of electronic exchange?

This paper will first identify the challenges facing the traditional distribution system and implications for system participants. The discussion continues by describing the pressures for change in agribusiness industries and presents a conceptual model of the distribution channel. Next, the impacts of e-business on the agribusiness distribution channel are discussed using results from a survey conducted by the Center for Agricultural Business at Purdue University. Finally, implications for manufacturers, distributors and dealers are discussed followed by a concluding summary.

Pressures for Change

Four sources of change are pressuring traditional distribution channels in the agribusiness industries. First, the customer base for most agribusiness firms is fragmenting, in part due to the growth in large commercial producers. At the same time, traditional or family farm businesses remain important to most suppliers. An increasingly important segment for some firms is the emerging lifestyle/rural resident producer who may have much different product and service needs relative to traditional or large commercial farmers. Different distribution channels may be required to deliver different product, service, and information bundles to these different customer segments.

A second pressure on traditional distribution channels is increasing customer expectations (Akridge, et.al., 2000). Along with customers' diverse set of needs, they expect higher levels of performance from their suppliers with respect to price, speed of response, quality, etc. Suppliers are expected to be continuously better, faster, and cheaper in providing the value bundle. This is driven by: 1) market pressures at the farm gate which force even more effective decision-making, and 2) more intense competition among agribusiness firms for the business of fewer producers.

A third source of pressure on traditional distribution channels is new technology that expands the capabilities and the efficiencies of distribution systems. Three areas of such technology are particularly important: logistics management technology including global positioning systems and bar-coding; communications technology including the Internet, Intranets, bandwidth expansion, and e-business; and information systems technology such as SAP, Oracle, or Aribia.com. This new technology is profoundly impacting distribution efficiency and effectiveness.

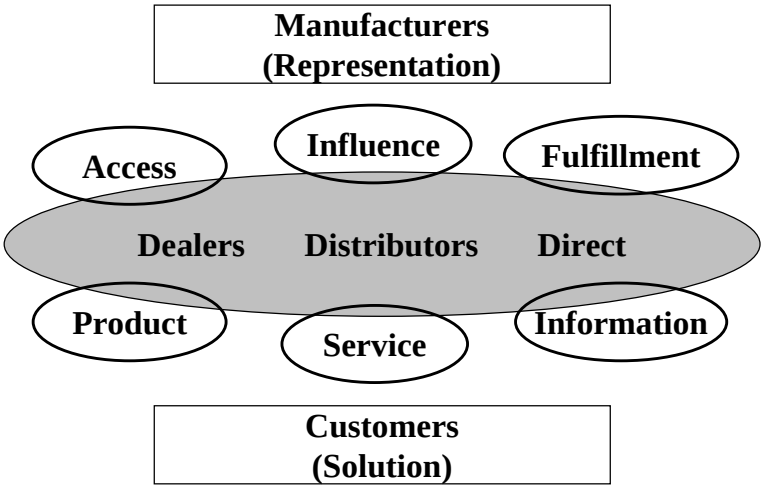
A fourth source of pressure for traditional distribution channels is a changing basis of market competition. Performance gaps continue to narrow among products, and shorter product life cycles are becoming common in the agribusiness industries. Product proliferation also complicates distribution strategies. Furthermore, new players with new business models including telemarketing/direct sales, e-business, and direct delivery from manufacturers to farmers are gaining a foothold. Competition in this environment is increasingly focused on flexibility and responsiveness, speed to market, quality, and end-consumer acceptance, as well as cost.

The combined effect from these four pressures is that traditional distribution channels (those including a dealer, a distributor, a wholesaler, and a carrier/transporter) are increasingly under siege. There is tremendous pressure to shorten the distribution channel, while increasing its effectiveness and efficiency.

A Model of Distribution Channel Choice

A model of distribution channel choice and the determinants of that choice, is proposed to frame the decision process. The model captures the critical role of the customer's need for solutions and the manufacturer's demands for representation from the distribution channel (Figure 1). In essence, the customer expects a total system solution from the distribution channel that includes a properly positioned product, service, and information package for each customer or customer segment. The manufacturer expects and/or demands access to the customer and influence over the purchase decision process, as well as the fulfillment of customer expectations by the distribution channel.

Figure 1. A Model of Channel Decisions



Key customer characteristics that impact their product, service, and information expectations from the distribution channel include customer size and size distribution, geographic location, goals and values, business characteristics, and overall buying behavior. Solution characteristics include timeliness and urgency of delivery, degree of bundling in-use, degree of customization, physical product characteristics, service execution, and information characteristics. A manufacturer's desire to obtain access, have influence, and achieve fulfillment on the part of the distribution channel will be impacted by manufacturer size, strategic growth plans, brand strengths, product mix, logistical capabilities, and commitment to current distribution channels. All of these factors -customers, solutions, and manufacturers- combine to profoundly impact the type of distribution channel that will emerge

Further complicating distribution channel decisions today is a literal explosion of information and communication technology, and the opportunity to use e-business capabilities to reconfigure the distribution channel. The fundamental challenge for the distribution channel is to meet customer expectations for solutions and manufacturer demands for representation, and do

so while satisfying increasingly high demands for efficiency and low cost, responsiveness and flexibility, and effectiveness and timeliness.

The Impact of E-Business

The rapid development of e-business presents challenges and opportunities to agribusiness at all levels of the channel as they develop their distribution strategies. This challenge is especially difficult given the seemingly continual flow of new information technology and software applications. Nevertheless, agribusiness firms are forging ahead with their e-business strategies, in part fearing they will lose customers to competitors if they do not take some position. In this section, the results of a survey on applications of e-business in agribusiness, sponsored by Purdue University's Center for Agricultural Business (CAB), are reported. Survey results are reported on general opinions about e-business, and implications for distribution strategies and distribution channel choices. For purposes of the survey e-business was defined as business activities performed over the Internet. E-business is not limited to the sales of goods or services via the Internet. It includes, yet is not limited to, the distribution of company information, marketing and product promotion, after-sales service, inventory management, and logistics.

Survey and Respondents

The survey was constructed in August 1999 and the survey instrument was faxed to 4,954 agribusiness mangers from 3,321 firms on August 26,1999. Of the 4,954 faxes, 1,001 were not received, reducing the base to 3,953. By October 20th, 1999, 755 completed, usable surveys were faxed or mailed back, giving a total effective response rate of 19.1%. The analysis presented

here is limited to manufacturers, distributors, and dealers, thereby reducing the number of useable surveys to 643.

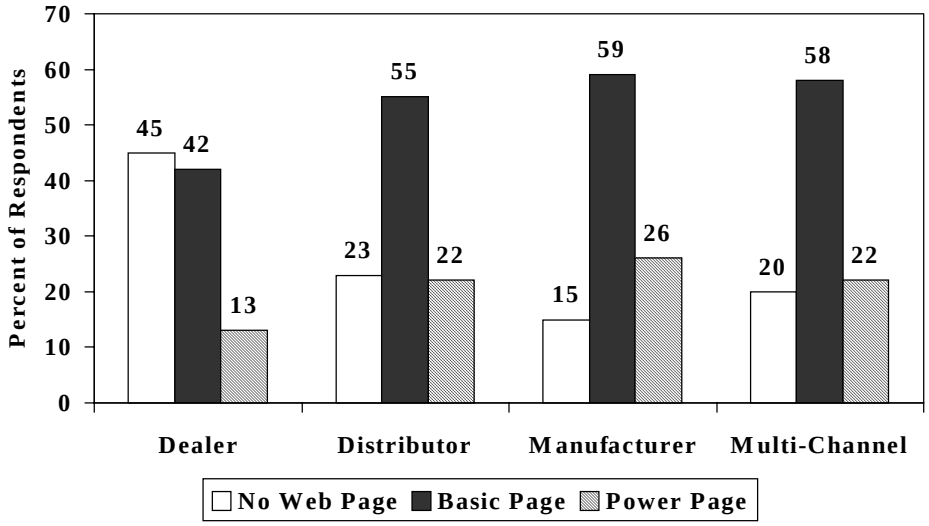
Most firms (79 percent) have a web page. Firms with web pages were distinguished on the basis of eleven features that might be found on their pages (Table 1). Six of the basic features were found on the web pages of most firms. These six features -- technical information about products, prices, background information about the company, a dealer directory, links to trade associations, and links to other information sources – are relatively easy to include on a web page. The other five, more sophisticated, features are online ordering, online payment, online communities, custom content, and password protection.

Table 1. Web Page Features, by Type of User

Feature	Percent of firms with feature	
	Basic Web	Power Web
Basic Feature		
Contains technical information about products sold	76.8	88.5
Provide pricing information about products sold	14.0	30.8
Provide background information about the company	94.2	95.6
Provide a dealer directory (information where products are sold)	35.1	51.6
Provide links to industry trade associations	41.9	65.4
Provide links to other data/information sources (e.g., USDA, etc.)	40.7	68.1
Advanced Feature		
Allow for online ordering, but use traditional means of payment	5.8	41.8
Allow for online ordering and payment	1.7	25.8
Include online communities (e.g., chat rooms, bulletin boards, etc.)	5.8	44.0
Include areas with content customized to different audiences or individuals	17.4	78.6
Include password protected areas, only accessible to registered members	8.2	69.8

Firms with at least two of the more sophisticated features are classified as power web firms. Twenty-four percent of all firms in the survey have power pages, while another 55 percent have basic web pages. Password protection and online communities are found in 79 and 70 percent of the power web firms, respectively (Table 1). Forty-two percent of the power web firms receive online orders, with traditional forms of payment, while an additional 26 percent receive online orders and payment. In contrast, only six percent of basic web firms receive online orders with traditional payment, and two percent receive online orders and payment.

Figure 2. E-Business Strategies by Channel Position



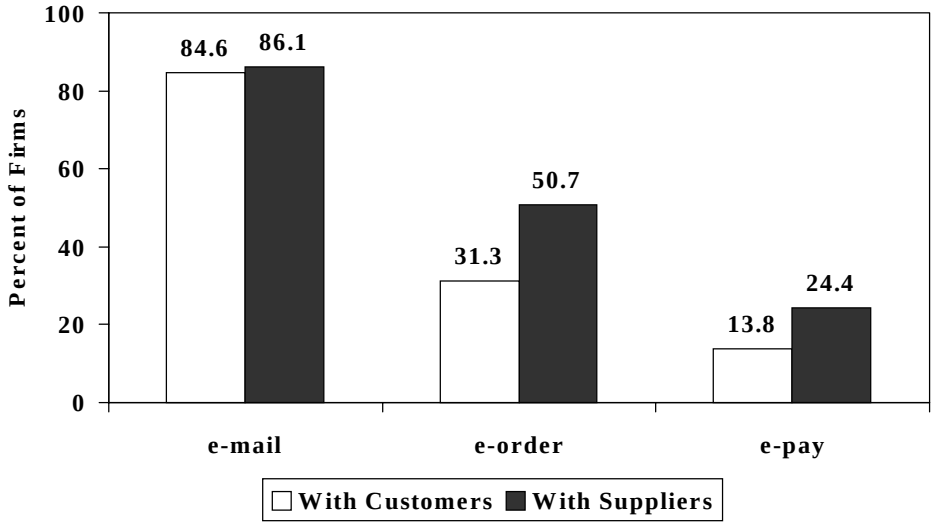
E-business strategies vary by the firms channel position (Figure 2). The percentage of dealers reporting that they did not have a web page (45 percent) was twice as high as firms in other channel positions (distributors 23 percent, manufacturers 15 percent, and multi-channel 20 percent). Moreover, the percentage of dealers with a power page site (11 percent) is roughly half the percentages of distributors, manufacturers, and multi-channel firms with a power page site,

22, 26, and 22 percent respectively. E-business strategies are not being embraced as strongly by dealers as other channel participants.

Impacts on the Distribution Channel

Customers and the competitive arena are driving agribusinesses to adopt individualized solutions that enable them to bring together product, service, and information in unique ways. Advances in information technology facilitate delivering these customized bundles to customers. Therefore, it is important to understand how agribusiness firms are using e-communications and e-commerce and its impact on the distribution channel.

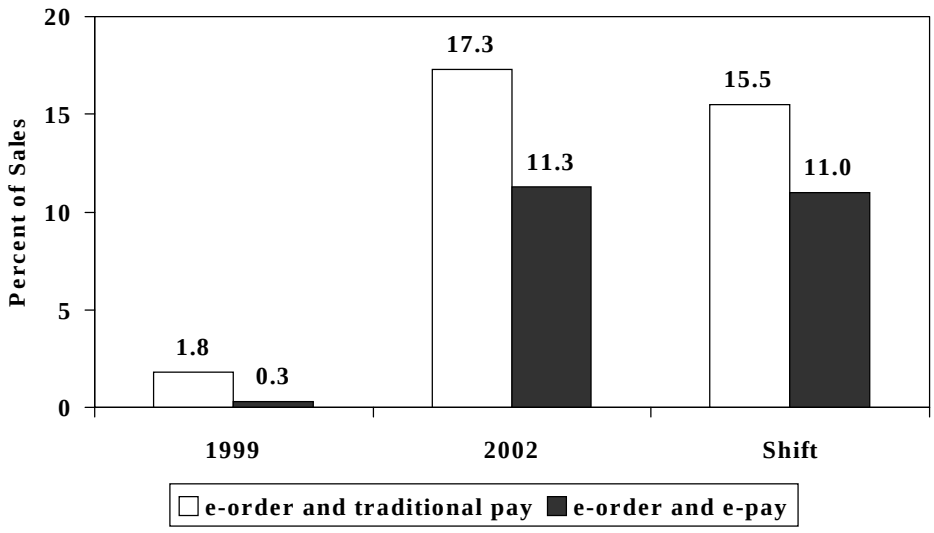
Figure 3. Percent of Firms using E-communications



Most of the agribusiness firms report using e-communications with their customers and suppliers, however, e-commerce use was less frequent. Virtually all firms (85 percent) use e-mail with at least some of their customers and suppliers (Figure 3). Usage of e-mail is more prevalent among larger firms and those with power page web strategies. Only in the use of e-mail to

communicate with end-user customers did e-communications usage vary by channel position. Dealers were less likely to use e-mail to communicate with end-user customers (66 percent) than distributors, manufacturers, and multi-channel firms (91, 88, and 87 percent, respectively). Firms are more likely to use online order and payment systems with their customers than with their suppliers. As a result, e-business may result in more rapid changes in the distribution channel from a particular firm back to its suppliers than with its' customers. But as a firm learns about the benefits of web-based transactions with suppliers, moving forward to customers is a natural evolution.

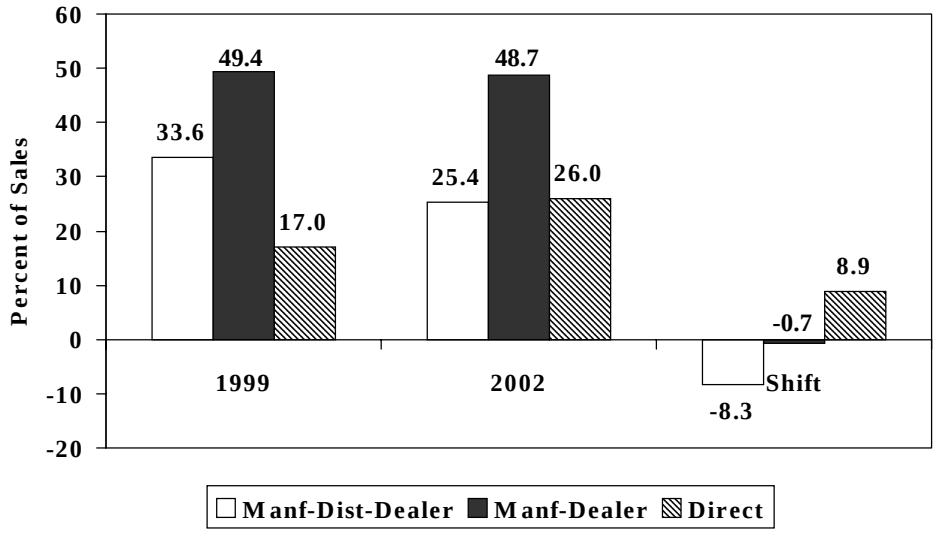
Figure 4. Sales made via the Internet



The expectation of this natural evolution is supported by the expected growth in Internet sales. In 1999, 1.8 percent of the sales of responding firms were made via the Internet, with payment by traditional means (Figure 4). An additional 0.4 percent were made as online sales with online payment. By 2002, the percentages for these two classes of sales are expected to rise

to 17.3 and 11.3 percent, respectively. No differences were identified across the demographic variables. This expected rapid increase in e-commerce volume is similar to that identified in other sectors of the U.S. economy.

Figure 5. Shifts in the Distribution Channel, 1999 to 2002



The expected rise in Internet sales is expected to drive a shift to a more direct sales channel. The proportion of sales direct from manufacturer to the farm customer will increase almost 9 percentage points from 1999 to 2002 according to survey respondents (Figure 5). Almost all of the increase will come at the expense of a reduction in sales for the traditional distribution channel of manufacturer/distributor/dealer. Firms with web strategies see an even greater shift to direct selling, at 11 percent of total sales. Midsized and large firms see increases in direct selling of 10.5 percent versus only 4 percent for firms without a web page. Perhaps reflecting the inevitable, distributors report the highest shift away from distributor (their own) participation in the distribution channel.

Determinants of Expected Internet Sales

Regression analysis was conducted to provide additional insight into the expected changes in the sales and payments made over the Internet. Two models were estimated where the dependent variables were the expected change in sales made via the Internet with traditional payment and the expected change in sales made via the Internet with Internet payment. These models were estimated for manufacturers, distributors, and dealers respectively.[1]

The dependent variables were regressed against a series of variables. The first set of independent variables, CUSTOM and SUPPLY, measures the present level of e-communications with customers and suppliers, respectively. Companies with higher levels of e-communications are expected to have higher expectations of future sales and payments made over the Internet. Another variable, NOORDER, indicates firms that do not have online ordering or online ordering and payment features on their company web site.

The second set of variables controlled for firm size and scope. LARGE is a dummy variable indicating firms with sales greater than or equal to $1 billion. MEDIUM is a dummy variable indicating firms with sales between $50 million and $1 billion. INTL is a dummy variable indicating firms with an international business scope, while NATL is a dummy variable indicating firms with a national scope. Finally, CHAN is a dummy variable indicating if the firm participated in multiple levels of the distribution channel. For example, firms that are both a manufacturer and a distributor or a distributor and dealer are considered to participate at multiple levels of the distribution channel.

[1] Lack of response for *ORDERNET* and *PAYNET* limited the number of observations to the numbers reported in Table 2. The models are estimated with ordinary least squares (OLS). The data has lower and upper truncations at –100 and 100, respectively, suggesting the use of Tobit estimation methods. However, a histogram of the dependent variables indicates that the minimum is –5. While the maximum is 90 limited bunching at these tails indicates that OLS methods would be appropriate. Models estimated with Tobit methods provide same results as OLS.

The third set of variables measures managers' perceptions regarding the impact of e-commerce and Internet usage on the supply chain. Agribusiness managers were asked their general opinion regarding e-commerce usage and their perceptions about the barriers and factors that influence e-commerce usage by farmer customers. All opinion and perception responses were provided on a 5-point Likert scale. Factor analysis was performed on the opinion and perception responses to develop measures for five functions of a supply-chain - logistics, transaction, negotiation, information, and promotion. It is posited that managers' perceptions on the impacts of the Internet on the performance of the supply-chain functions will influence the expected changes in orders and payments over the Internet in the next three years. A description of the grouping of the opinion, barrier, and factor questions into individual supply-chain function categories is given Appendix I. A more complete description is presented in Henderson et. al. (2000). Model results are presented in Table 2.

In general, the estimated model provides better explanation of the expected change in Internet sales with traditional payment than the expected change in Internet sales with Internet payment. R-square measures for the models of Internet sales and traditional payment are 16.79, 24.25, and 25.73 for manufacturers, distributors, and dealers, respectively. R-square measures for the models of Internet sales and payment are 11.9, 26.26, and 19.98 for manufacturers, distributors, and dealers, respectively. Moreover, the model provides better fit for the expected change in sales for distributors and dealers than manufacturers.[2]

[2] Variance inflation factors were analyzed and did not indicate collinearity problems in the estimated models.

Table 2. Expected Sales Growth with Traditional Payment and Online Payment Regression Results

	Expected Change in Sales Growth					
	Manufacturers		Distributors		Dealers	
	Trad. Payment (1A)	Online Payment (1B)	Trad. Payment (2A)	Online Payment (2B)	Trad. Payment (3A)	Online Payment (3B)
CUSTOM	0.933	1.219	4.516 *	4.616 *	0.418	2.845
	1.062	*0.967*	*1.476*	*1.246*	*1.749*	*1.851*
SUPPLY	1.870 *	1.113	0.891	1.522	0.903	1.946 *
	0.796	*0.719*	*1.132*	0.973	*1.019*	*1.102*
NOORDER	6.486 *	2.880	-0.777	0.443	8.149 *	3.373
	2.635	*2.374*	*3.139*	*2.604*	*3.929*	4.143
LOG1	2.056 *	1.718 *	2.002 *	1.669 *	3.653 *	1.086
	0.914	*0.814*	*1.166*	*0.982*	*1.168*	*1.236*
TRAN1	0.000	0.839	2.307 *	2.402 *	1.629	1.509
	0.999	*0.893*	*1.315*	*1.118*	*1.319*	*1.414*
INFO1	-0.206	-0.440	0.464	-0.028	0.886	0.434
	0.996	*0.889*	*1.265*	*1.069*	*1.184*	*1.268*
PROM1	2.528 *	1.703 *	0.724	1.676	3.490 *	1.975
	0.979	*0.878*	*1.269*	*1.083*	*1.281*	*1.679*
NEG1	2.129 *	1.597 *	1.818	0.680	-1.380	-0.488
	1.046	*0.933*	*1.353*	*1.139*	*1.238*	*1.316*
LARGE	-2.103	0.112	-1.365	-4.410	-0.053	-1.903
	2.238	*2.020*	*3.166*	*2.748*	*3.759*	*4.080*
MEDIUM	0.108	1.358	0.937	-1.967	6.993 *	3.313
	2.372	*2.131*	*2.875*	*2.451*	*2.507*	*2.650*
INTL	-0.199	0.322	-1.419	-1.597	-5.298	-4.884
	2.332	*2.087*	*2.712*	*2.272*	*4.223*	*4.477*
NATL	5.848 *	3.727	5.684	0.836	-0.742	3.734
	2.999	*2.688*	*3.735*	*3.187*	*4.391*	*4.798*
CHAN	-3.071	-0.574	-5.639 *	-1.679	-0.415	-5.320 *
	1.988	*1.781*	*2.434*	*2.080*	*2.867*	*3.102*
Constant	2.800	0.481	5.714	-1.196	1.195	-3.050
	3.958	*3.564*	*4.828*	*3.998*	*5.847*	*6.212*
R-sq	16.79	11.9	24.25	26.26	25.73	19.98
N	283	279	141	139	121	119

* Significant at the alpha = 0.10 level. Numbers in italics are standard errors

Existing levels of e-communications were found to be associated with higher expected growth of Internet sales. Manufacturers with greater levels of e-communications with their suppliers were more likely to have higher expectations of Internet sales growth with traditional payment in the next three years (Model 1A). On the other hand, distributors with greater levels of e-communications with their customers were expected to have higher growth in Internet sales with traditional payment and in Internet sales with Internet payments (Models 2A and 2B). While e-communications had a limited relationship on Internet orders with traditional payment for dealers (Model 3A), e-communication with suppliers was found to encourage growth in Internet sales with Internet payment (Model 3B).

Firms with web sites that lacked current capabilities for online ordering and online ordering and payment had greater expectations for growth in Internet sales. Manufacturers and dealers without e-commerce features were found have higher expectations for growth in Internet sales with traditional payment (Model 1A and Model 3A). This suggests that future Internet sales growth is not expected to arise from firms with an existing Internet presence, but from those developing a presence on the Internet in the near future. Could these higher expected growth rates be caused by overblown expectations from firms that have no idea what they are getting into?

Consistent relationships between general firm characteristics and expected changes in Internet sales growth failed to materialize from the empirical results. Firm size categories were found to be significant only for dealers' expectations of Internet sales growth with traditional payment (Model 3A). The scope of the firms' product distribution was only found to be significant for manufacturers' expectations of Internet sales growth with traditional payment (Model 1A). The presence of a firm in multiple levels of the supply-chain was only significant

for distributors' expectations of Internet sales growth with traditional payment (Model 2A) and dealers' expectations of Internet sales growth with Internet payment (Model 3B).

Manager perceptions regarding the impact of the Internet and e-commerce on the functions of the supply-chain were related to the expected changes in Internet sales. The perception that the Internet and e-commerce would impact the logistics and distribution functions of the supply-chain had the strongest and most consistent relationship with expected growth in Internet sales (*LOG1*). Manufacturers, distributors, and dealers indicating that the Internet would improve inventory management and that distribution issues would not limit sales were found to have higher expectations of Internet sales growth. This finding suggests that logistics and inventory management issues are main driving forces behind the implementation of Internet strategies. Also, the perception that distribution issues will not limit sales signals the perception that channel conflicts will not be an issue in e-business activity.

Expected growth in Internet sales is also related to manufacturers' and dealers' perceptions regarding the impact of the Internet on the promotion function of the supply-chain. Manufacturers and dealers that perceived an ability to provide recommendations on a broader product line over the Internet were more likely to have greater expectations of increased growth in Internet sales (*PROM1*). Manufacturers (Models 1A and 1B) disagreeing that farmers lacked the trust required for Internet purchasing and disagreeing that personal relationship were difficult to develop over the Internet were also found to have higher expected growth in Internet sales (*NEG1*). Finally distributors' (Models 2A and 2B) perceptions regarding the impact of the Internet and e-commerce on the transaction function of the supply-chain are related to the expected growth in Internet sales (*TRAN1*). Managers perceiving that farmers were willing to buy products over the Internet, that Internet buying was more convenient for farmers, and that

farmers' security and privacy concerns would not limit Internet sales had higher expectations for growth in Internet sales.

These results indicate diverse motivations behind the expected growth in Internet sales. Higher levels of present e-communication and improvements in logistics functions of the supply-chain generate higher expectations of growth in Internet sales. However, firm characteristics such as firm size, market scope, and market channel position and the perceived impacts of the Internet on other functions of the supply-chain do not consistently emerge as having a strong relationship with expected growth in Internet sales. But, it is important to note that expected Internet sales growth is higher in firms that do not currently possess online ordering or payment features on their web site.

Conclusion

In short, agribusiness has a relatively broad, but not yet deep, e-business base from which to build. Extremely rapid growth is forecast in the level of Internet sales from 1999 to 2002. This growth will be accompanied by some shift to direct distribution. There is some difference of opinion across channel participants with respect to the magnitude of the impact, in addition to a difference in the motivation behind the expectations of Internet sales growth.

However, two points emerge from the analysis. One, manufacturers, distributors, and retailers with high levels of e-communication contact with existing customers or suppliers had higher expected Internets sales growth. Two, manufacturers, distributors, and dealers that perceive a greater ability of the Internet to improve the logistics function of the supply-chain expect higher levels of Internet sales growth. The lack of consistency emerging from the empirical results suggests that further analysis of the expected growth and implementation of e-business is needed. Cluster analysis is one methodology that could be utilized to search for

groups of firms that have similar perceptions regarding e-business impacts on the supply-chain. Then these groups could be analyzed for consistency in regards to firm characteristics, e-business strategies, and expected changes in the firms' distribution channel.

Clearly this is a time of transition with respect to distribution in the agribusiness industries. E-business firms offer new virtual storefronts and alternative distribution models. Existing dealers and distributors are re-evaluating their positions, resulting in consolidation and new competition at this level. Manufacturers now have even more ways to reach their producer/customers. During this transition period, many alternative business models will be tested in the market. Manufacturers that perceive Internet impacts on the negotiation function of the supply-chain may develop different models than distributors perceiving an impact on the transaction function and dealers perceiving impacts on the promotion function. And, the models that survive will satisfy the twin objectives of efficiently meeting the customer's need for solutions and the manufacturer's need for representation.

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Appendix I

This appendix describes the creation of the variables used to measure manager perceptions of Internet impacts on the supply-chain. Distribution channel choice has traditionally focused on logistics as managers emphasized inventory management and transportation/shipping (Boehlje et al., 2000). The supply-chain concept has extended this viewpoint by incorporating marketing, information access, product promotion, and relationship building into the channel selection process.

One way to view the distribution channel is through the seven functions performed by the supply-chain (Boehlje et al., 2000). These processes involve aspects of resource procurement and output distribution in addition to the manufacturing or production process. This view of the supply-chain highlights the role multiple participants play in each of the processes and enables firms to generate efficiencies through coordination within these functions. Channel selections are driven by improved efficiency in the seven functions of the supply-chain briefly described below. Henderson et. al. (2000) contains a more complete description of the supply-chain functions.

Manufacturing/processing is the primary function of any business as they transform procured inputs into single or multiple outputs. **Logistics** is a second function performed in the supply-chain. Inventory management and customer support are chief concerns among businesses as they strive to improve the efficiency in their logistics systems (Stern, El-Ansary and Coughlin, 1996). **Promotion** of products is a third function performed in a supply-chain. Businesses engage in marketing and advertising to promote their product, provide information, and make product recommendations. Promotion allows businesses to improve sales by reaching more segmented end-users (Stern, El-Ansary, and Coughlin, 1996). **Financing** is the fourth function

in the supply-chain as businesses raise funds to finance projects. **Information** functions in the supply-chain are becoming more important, as gathering, exchanging, and using information is a major business cost (Garcia, 1995). More efficient access to information is eroding profits and becoming a more intensified basis for market competition (Kambil, 1995). **Transaction** functions in a supply-chain deal with the procurement of goods and services. Improved low-cost communication is improving the efficiency of the transaction process through added convenience. **Negotiation** is the final function in a supply-chain and centers on the efficiency of communication among participants throughout the system. Trust and community building improve efficiency in the supply chain (Garcia, 1995). A description of the grouping of the opinion, barrier, and factor questions into individual supply-chain function categories follows.

Table A1. General Opinions about E-commerce

	Question and Statement	Supply Chain Process
(O1)	E-commerce will improve my company's ability to manage inventory levels in the next three years	Logistics
(O2)	Information about increasingly complex products is difficult to provide over the internet.	Information
(O3)	Farmers are unwilling to buy products on the Internet	Transaction
(O4)	Personal relationships with customers are difficult to develop over the Internet.	Negotiation
(O5)	Distribution (logistics) issues will limit sale of my industry's products over the Internet.	Logistics

Managers were asked to indicate their level of agreement with the previous statements on a 5-point Likert scale. For (O1) responses were categorized as 5 = Strongly Agree, 4 = Somewhat Agree, 3 = Agree, 2 = Somewhat Disagree, and 1 = Strongly Disagree. For (O2) to (O5) responses were categorized as 1 = Strongly Agree, 2 = Somewhat Agree, 3 = Agree, 4 = Somewhat Disagree, and 5 = Strongly Disagree. The change in the coding system was done to provide consistent positive expected signs among the variables.

Opinion: Managers were asked to express their level of agreement with seven general opinion questions related to e-commerce (Table A1). Each question is categorized into one of the seven

supply-chain processes. The first opinion question (O1) asked whether e-commerce improved inventory management and is grouped into the logistic function. The second question (O2) stated that information regarding complex products is difficult to distribute over the Internet. Responses to this question are categorized into the information function. In the third question (O3), managers were asked if farmers are unwilling to buy products over the Internet. Statement responses are classified in the transaction process. Managers were then asked for their opinion on whether personal relationships are difficult to develop over the Internet. This statement (O4) addresses manager perceptions on the impact of e-commerce on the negotiation process. In the final opinion question (O5), managers were asked whether distribution issues limit sales over the Internet, a logistics function question.

Table A2. Barriers to E-commerce Adoption by Farmers

Question and Statement	Supply Chain Process
(B1) Farmers lack the required trust to make Internet purchases.	Negotiation
(B2) The Internet offers limited ability to provide product recommendations to farmers.	Promotion
(B3) Farmers are unable to find desired information conveniently on the Internet.	Information
(B4) Farmers question the security of e-commerce.	Transaction
(B5) Farmers question the privacy of e-commerce.	Transaction

Managers were asked to indicate the degree on a 5-point Likert scale to which the statements indicate a barrier to e-commerce adoption by farmers where 5 = Not a Barrier and 1 = Major Barrier.

Barriers: Managers were also asked on a 5-point Likert scale about their perception of potential barriers to farmer adoption of the e-commerce (Table A2). Responses of not a barrier are given a value of 5, while responses of a major barrier are given a value of 1. The first barrier statement (B1) asked managers if they perceive the lack of trust by farmers to make Internet purchases as a barrier to e-commerce adoption. This question addresses the trust-building or negotiation

process of the supply-chain. The second question (B2) asked managers if they perceived the limited ability to provide product recommendations over the Internet were a barrier to farmer adoption. Product recommendation is part of the promotion process of the supply-chain. The third question (B3) addressed manager perceptions on farmers' inability to find desired information conveniently over the Internet was a major barrier. The managers were then asked if the perceived questions of security (B4) and privacy (B5) are barriers to farmer Internet adoption. These questions addressed the impact of e-commerce on the transaction process of the supply-chain.

Table A3. Factors Supporting Rapid Adoption of E-commerce by Farmers

Question and Statement	Supply Chain Process
(F1) Information can be obtained more easily off the Internet.	Information
(F2) More product choices will be available over the Internet.	Promotion
(F3) Buying over the Internet is more convenient than traditional channels.	Transaction
(F4) It is easier to make product comparisons over the Internet.	Promotion

Managers were asked to indicate the degree on a 5-point Likert scale to which the statements were a factor supporting e-commerce adoption by farmers where 1 = Not a Factor and 5 = Major Factor.

Factors: Managers were also asked their perceptions regarding four factors that support the rapid adoption of e-commerce by farmers (Table A3). Using a 5-point Likert scale, responses of not a factor are coded as 1, while responses of major factor are coded as 5. The first factor question (F1) was concerned with the information process of the supply-chain. Managers were asked if they perceived the ability of farmers to obtain information easily over the Internet favored farmer e-commerce adoption. The second question (F2) addressed the promotion process as a factor of e-commerce adoption by farmers. Managers were asked to indicate whether the availability of more product choices over the Internet would be a major factor of farmer e-commerce adoption.

Managers were then asked if the convenience associated with buying over the Internet is a major factor in farmer e-commerce adoptions (F3). Buying convenience is part of the transaction process of the supply-chain. Finally, managers were asked if they perceived that the ease of product comparisons over the Internet would be a factor in farmer e-commerce adoption (F4). Product comparisons are part of the promotion process of the supply-chain.

Factor analysis was performed on the variables in each of the supply-chain functions separately to generate a set of latent variables to be used in the regression equations to control for the collinearity between individual variables.[3] For each supply-chain function, multiple factors had eigenvalues greater than one. However, only the first factor, which explained the largest portion of the variance of the original variables for each supply-chain function, is included in the regression to establish a more parsimonious model.[4]

[3] Survey questions were grouped according to the seven functions or process after survey implementation. The e-commerce survey was not designed under a supply-chain management framework. Thus, two functions were not addressed in the questionnaire: manufacturing and financing. Despite this limitation, insight into the drivers of expected Internet sales growth can be obtained by analyzing the perceived efficiency gains of the other supply-chain functions.

[4] When all factors were included in the model only the factors that accounted for the largest variance explained were found to be significant.