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E-Commerce In Agriculture: Development, Strategy, and Market Implications

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E-COMMERCE IN AGRICULTURE: DEVELOPMENT, STRATEGY, AND MARKET IMPLICATIONS

W. Parker Wheatley*, Brian Buhr, and Dennis DiPietre*****

Perspectives on Organizational and Structural Implications of E-Commerce on Agriculture

Electronic commerce and associated information technologies have grown to the point that they have reached the vaunted status of defining the "new economy." The most recent driving technology behind electronic commerce is the Internet. Using computers for communication purposes has long been possible, but the two core features that differentiate the Internet are distributed computing and its open architecture. Distributed computing refers to the concept of having access to multiple applications through networked computers all capable of performing similar tasks. Historical information exchange systems for electronic data interchange (EDI) such as value added networks (VANs) required significant investment in both hardware and software coding and were largely proprietary and limited competition (Kekre and Mudhopadhyay, 1992). The Internet provides a common and open architecture where regardless of location or time, multiple users with a personal computer and a browser can access applications at the same time. Although the Internet is a communication tool, application platform, and database, the digital economy also relies on infrastructure technologies that allow for the digitization of the physical world. For example, bar code scanning technology, radio frequency identification (RFI) technology and magnetic strip or embedded chip technologies must be in place to convert the physical world to the digital world of the Internet. The mantra of farm management for years has been "if you can measure it, you can manage it." The electronic measurement technologies open the world of what *can* be measured and then communicated to other users in the supply chain and throughout agricultural markets.

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This paper relies on the economic and business literatures as well as the experiences of the authors with both electronic commerce firms and traditional agribusiness firms to provide a road map for economic and policy issues, which will arise from the adoption of electronic commerce in agriculture. Much has been written about e-commerce implications in the broader economy, but little attention has been focused on the implications for agriculture. We argue that agriculture has unique characteristics affecting its entrance into the digital world. Through research and experience in industry, we have come full circle from the hyperbole of the "new economy" to the quote by Hal Varian: "Technology changes. Economic laws do not." The economic and policy implications of the Internet and information technologies on agricultural commerce will be driven by four factors: (1) the ability of the Internet and digital measurement technologies to allow for product differentiation and identity preservation through the increased flow of information on product attributes and related information in the agri-food supply chain, (2) the structure and business development of firms providing Internet commerce applications, (3) the ability of individual producers and agribusinesses to adopt information technologies and use them in ways that improve the capacity for coordination in the areas of production, logistics, and marketing, and (4) the regulatory environment that emerges to monitor electronic commerce. However, to make inferences, draw conclusions, and suggest research about each of these forces, we must first review and present how e-commerce has been and is currently practiced. Furthermore, we must investigate more deeply the Internet and related technologies and their actual and potential implementation. Once we have a clear perspective of the objects of interest, we can then better discuss and propose research directions relative to the four issues noted above.

Electronic Commerce in Agriculture: Past and Present

Origins and Early Developments of Electronic Commerce

Electronic markets in agriculture have existed for at least the past three decades. Electronic markets arose in the early 1970's as some agricultural markets were becoming or had become somewhat vertically coordinated or integrated. In considering electronic markets, the concern to be addressed was that a system of decentralized and closed trading would fail to convey adequate overall market and price information to producers, processors, and distributors

(Forker, 1975). Several private and public supported electronic exchange mechanisms began to develop. In particular, an electronic computerized egg exchange (Egg Clearing House, Inc., 1972) arose because producers were concerned that without an open market mechanism, there was little foundation upon which fair exchange contracts could be formed (Henderson, 1982). Similarly, with rising concerns about the effects of cotton contracts between producers and buyers on the open market competitive process, TELCOT was established in 1975 to promote transparent cotton price discovery. These systems were developments in electronic marketing that promoted open information and access to markets (Kohls and Uhl, 1990). Other experiments include the Hog Accelerated Marketing Systems (HAMS), the National Electronic Marketing Association, and CATTLEX (Henderson, 1984). Except for TELCOT and the Egg Clearinghouse, most of these experiments never achieved a critical volume to sustain them. While neither TELCOT nor the Egg Clearinghouse holds a large share of their respective markets, both remain as open market checks on the contracting process. As for the meat industry, an area of particular importance given the rapid and increasing dependence of contracting in organizing exchange between producers and processors, no significant long-term success was found with electronic trading in the early years of these markets.

In more recent years, however, some European electronic marketing ventures have been successful. In Belgium, an electronic marketing system was able to obtain a 6 percent share of the market for slaughter cattle (Viaene, Gellynck, Verbeke, 1998). In the United Kingdom, Electronic Auction Systems, Ltd. (EASE) was the first firm to allow for electronic trading of beef and sheep via auctions in the United Kingdom, and it has achieved a certain degree of market penetration in the exchange of livestock and grains. (Borman, Karcher, Taylor and Williams, 1993). However, given the relative ease of setting up these auctions, several competitors entered the market thereby reducing the liquidity of the EASE markets. Furthermore, the existence of several systems imposed additional costs on electronic livestock auctioning because each system needed to maintain its own network of agents to perform grading of livestock in the field. Increased costs associated with the existence of parallel systems of agents as well as the reduced liquidity have hindered investment in systems and upgrades (Graham, 1999). Given these impediments and despite a degree of market penetration, these closed access systems[1] have not revolutionized the market of agricultural commodities in there respective countries.

The First Years of Internet Agricultural Markets and Technologies

In tying electronic commerce to economics, a useful paradigm is to consider the Internet as a market for information. The analogy to the competitive market model of economics is nearly identical. The multitude of potential and actual client and server computers are analogous to buyers and sellers in the market paradigm. A client computer is buying or requesting information, while a server computer is selling the information (e.g., decision tools, market forecasts, and exchange/trading mechanisms). The market orientation may be even more perfect for the Internet because client computers can also be a server and vice versa. Hence, at any given time a computer may be either a buyer or seller of information. In many cases in the physical world, market participants are only either a buyer or seller. For example, when a farmer asks the price of a product via the Internet, there is also the opportunity for him to release information as to his production prospect, local weather, etc. Alternatively, a firm can buy content from one provider and repackage it with its own informational goods and services for distribution to others. The second market condition is low barriers to entry. Digital information and computer software have as one of their fundamental attributes as very low marginal costs of reproduction. The first copy of output price data or of a bargaining/auction program may be very expensive, however, subsequent copies are virtually free. Given that computer hardware itself is declining in price, the primary barrier to entry revolves around intellectual property issues and nearly all costs are variable costs with regard to adoption and use of the Internet and concomitant information technologies. The third condition of a competitive market is that products are homogeneous. The Internet's primary product is digital data. At its most fundamental level, this is the true definition of a homogeneous product; however, the combination of the binary digital data does provide for product differentiation. That is, the variety of standards and potential for network externalities benefiting one or the other standards may impinge on this market aspect in the short run. We will deal with this question and related liquidity concerns later in this paper. Nevertheless, the software of the Internet has frequently been able to overcome many

[1] These systems are closed in the sense that the marketing infrastructure requires capital investment for trading technology such as for specialized computer terminals.

incompatibilities among different platforms. The fourth and final component of competitive markets is costless access to information (e.g., price information). The fundamental principle of distributed computing where virtually all information available on the Internet is easily accessible, means that the Internet will foster increasingly cheap and easy access to information.

Essentially, the Internet's architecture is such that a competitive market for information on physical markets is formed. Consequently, the evolution of the Internet as a tool for commerce is altogether natural. However, as with physical markets, its efficiency depends on implementation. The current and rapidly evolving e-commerce models represent attempts at an early point along the learning curve of such technology. There have been a number of failures and increasing consolidation among agricultural e-commerce firms. However, the successes and persistence of several firms reflects the fact that the technical advancement of the Internet may well overcome the historical constraints posed by narrow proprietary exchanges and information providers in agriculture. Before discussing theoretical, research, and policy concerns more deeply, we first provide a summary of how we characterize agricultural e-commerce initiatives to this point as well as providing examples of each subcategory.

<u>Content Providers</u>

The earliest form of entrants provided "content." Content typically includes news, research publications, and simple decision tools (e.g., mortgage calculators). Land grant universities and agricultural journals and newspapers occupy this space in addition to commercial businesses and third party e-commerce firms. The primary difficulty in profiting from such business is that news and information has a public goods character about it. Although some sites may have subscription fees for access, they are largely non-excludable and non-rival. Non-rivalry has its limits with technology based on bandwidth of the Internet; however, currently it is difficult to envision a scenario where demand exceeds the network's ability to supply access.

Sample Content Providers:

> *AgWeb.com* is a collaboration of Farm Journal (an agricultural media firm), Safeguard Scientifics (Internet software, communications, and e-services developer and operator), and Madison Dearborn Partners (private equity investment firm). Originally based only on content – information and decision tools - they also are a portal to "storefronts," which are simply online sales fronts

for existing input suppliers. Note, while currently only serving the above mentioned areas of the market, they do indicate some interest in providing more Agribusiness-to-Grower services (see description below).

@griculture online(www.agriculture.com) - This site is sponsored by Successful Farming magazine and the content provided is very similar to AgWeb.com. Rather than a portal for storefronts, it has an agreement with XSAg.com to provide input sales services.

CargillAgHorizons (www.cargill.com/aghorizons) - This example is provided as a departure from other content providers in that it is provided by an agribusiness firm with the goal of providing consulting information to producers (specifically, to producers with which Cargill does business). Operated mostly as an information service, we will consider later how existing firms are utilizing e-commerce in other ways.

Miscellaneous Other Sites: Vantagepoint.com, Agribiz.com, DTN.com, AgriMarketing.com, Progressivefarmer.com

Agribusiness-to-Grower Sales (A2G)

Agribusiness to grower Web sites either sell input supplies to agricultural producers or allow producers to sell output to others. In other markets, these would be classified as business-to-business (B2B) services. The distinction is made here because in their current form, growers are passive – just as consumers are passive in business-to-consumer commerce (B2C) – so the analogy is similar to B2C. Other than for spot sales, the exchange typically does not offer any additional connection between the grower and the seller. This is a strategically critical point in that growers' passiveness in transactions will likely continue to place them in the "price-taking" role of traditional agricultural markets. A2G sites include third party suppliers (those suppliers, which have no direct involvement in manufacturing or distribution of the product) as well as physical companies marketing directly (e.g., Cargill or Land O'Lakes).

The basic value of A2G sites is that they reduce search and matching costs as well as lowering other sales transaction costs. Increasingly, they include back-office applications, which manage sales logistics (inventory management, invoicing, shipping orders, and aligning trucking) and transaction services (e.g., credit, bundling of related products, application and use information). All sites also provide content, including news, weather, market reports, and possibly decision tools.

Sample A2G sites:

XSAg.com – Focused on input supply sales (animal health, seed, machinery parts, crop inputs). XSAg.com originated on the same model as Priceline.com, providing an intermediary role for marketing excess farm inputs by commercial agribusiness. They originally used a reverse-posted price format, just as Priceline.com, where the buyer makes an offer (see definitions of market definitions below). As a third party exchange, they now have posted price formats and reverse-auctions as well. They provide value-added services such as shipping, billing, bundling and product application information.

DirectAg.com - Focuses on input supply sales (animal health, seed, machinery parts, crop inputs). Although a third party, they are different from XSAg.com in that they are more of a catalog service for agribusiness companies, offering products at posted prices. The model is very similar to the well-known Amazon.com as they attempt to achieve scope in sales as a one-stop shop for inputs. They also provide online financing for input purchases made.

e-Markets.com – Represents a hybrid version of exchange. e-Markets.com has applications, which allow purchase of seed inputs direct from suppliers, as well as an exchange for outputs (grain only). Unique among third party sites, they almost exclusively rely on direct linkages between growers and agribusinesses. They have contracting applications where they act as a facilitator of the contracts and orders. They also offer logistics functions for parties using their exchanges. e-Markets is very nearly what one would consider an outsourced e-commerce strategy, where in nearly all cases there is a specific agribusiness company executing the actual transaction with e-Markets providing the forum to match parties.

Rooster.com – Rooster.com was originally established by a consortium of Cenex Harvest States Cooperatives, Cargill, Dupont with ADM joining this group of investors later. It was originally geared toward both input and output sales, focusing on the consortium's input supplies and grain procurement. Since

November 2000, it has broadened its group of strategic investors to further support its goal of becoming an open and unbiased Internet market for agriculture with the primary goal of providing electronic support for traditional market relationships. Since February 2001, it has further sought to broaden its approach by merging Pradium.com (also originating from the same establishing consortium) with its business operations. The Pradium component of the business will allow market participants (e.g., commercial grain handling between manufacturers, shippers, processors, and elevators) to exchange and interact outside of the traditional avenues in an open market place.

Farms.com – Farms.com began as an independent third party exchange. However, it is now a consortium of agriculture information service providers (i.e., Data Transmission Network (DTN) and an agricultural marketing and consulting firm, Sparks Commodities). In the parlance of Sawhney (1999), they would be considered a 'metamediary' with a broad scope of input and output exchanges and auctions across nearly all agricultural commodities. They are heavily focused on unique content and decision tools.

The Seam (www.theseam.com) - is the Internet descendant of TELCOT, the electronic exchange discussed earlier in the paper, and was initiated by a consortium of cotton merchants (including Hohenberg brothers a division of Cargill), cotton cooperatives (including the Plains Cotton Cooperative Association, the founder of TELCOT), and textile mills. As a purportedly neutral enterprise, The Seam extends the TELCOT technology and provides exchange services to growers and agribusinesses involved in the cotton trade.

Miscellaneous Other Sites: Agrimall.com, Farmbid.com, Powerfarm.com, eMerge Interactive.com, and CattleSale.com.

Agribusiness-to-Agribusiness Exchanges (A2A)

A2A exchanges operate at a higher level in the agri-food supply chain typically facilitating logistics and exchanges between first handlers (e.g., fluid milk plants) and processors and manufacturers (e.g., cheese or ice cream plants). One major difference is that they are often proprietary exchanges in that they are unobservable to non-members. This closed access attribute is largely a result of their scale, volume, and high degree of focus (e.g., dairy or meat products only). Hence, the number of total participants is low but the volumes of transactions can be huge. Although including pricing features in some cases, A2A is heavily focused on logistics management applications including collaborative planning and forecasting, inventory management and transactions management (invoicing, bills-of-lading, shipping, order management, etc.). An analogy in non-agricultural industries is Covisint, a collaborative procurement and supply chain tool launched by General Motors, Ford Motors and DaimlerChrysler.

Sample A2A sites:

ProvisionX.com - ProvisionX.com is touted as a neutral exchange (in nearly all cases, the exchange itself is a separate corporate entity). It was formed by a consortium of IBP, Smithfield Foods, Excel Corporation, Tyson Foods, Farmland Cooperative, and GoldKist, companies that represent the major meat and poultry slaughter and processing companies in the United States. Its exchange was launched on March 29, 2001 and is primarily oriented toward order management and sales.

Dairy.com - Dairy.com, founded as a consortium of dairy cooperatives, cheese processors, and manufacturers, is also touted as a neutral exchange. Initial members of the founding consortium included Land O'Lakes, Dairy Farmers of America Cooperative, and Kraft Foods, although it now includes over 38 firms as trading companies. Its exchange is primarily a posted bid-ask bartering format with sellers posting asking prices and buyers posting bids (offers). Negotiation is primarily one-on-one. Although they are working on a collaborative supply management application, it is not apparent what logistic or services solutions are offered, or, which might be included.

Vtraction.com – Vtraction.com provides one of the more interesting e-commerce initiatives in that it is a "cooperative" of several Web sites including Farms.com, Tradingproduce.com, Foodtrader.com, WineryExchange.com, Agrositio.com, with Rabobank (the largest agricultural and food credit provider in the world) as the organizing partner. Several of these "cousins" share a common exchange engine developed by the iTradeNetwork. This company is geared towards commercial firms and handles back-office logistics as well as exchange functions. There are no transaction fees in any of the exchanges, but revenues are generated by ancillary service activities such as credit provision.

Miscellaneous Other Sites: IceCorp.com and Agmotion.com.

Commodity Futures and Derivatives Markets

To this point, all previous examples have involved the buying and selling of actual physical commodities. However, e-commerce is being adapted to traditional futures commodity exchanges as well. The major advantage as far as adaptation is that these exchanges are virtual in the sense there are no direct logistics issues (other than trade clearing functions) to deal with. However, regulatory concerns as well as institutional foot dragging have slowed their development. Unlike securities trading, commodities trading is highly risky involving both margin accounts and the ability to short sell. Historically, commodities trading is highly regulated and strictly the domain of licensed traders and brokers. Therefore, online commodities trading has been subject to a great deal of scrutiny prior to its approval. Secondly, and equally as important, institutions and traders have been opponents – especially floor traders who have significant equity and value in their "seat" on the floor of the exchange. Current Chicago Board of Trade Full Memberships (seats) are trading at about $328,000. Opening access to exchanges through electronic commerce has been perceived as lowering the value of the seats and therefore is a concern to traders. In addition, many traders consider face-to-face interaction an important aspect of effectively trading in an open outcry format. Although these issues have slowed the adaptation of electronic commerce to commodity exchanges, all major U.S. agricultural commodities exchanges currently either are trading electronically or have electronic trading capabilities.

Sample Futures Sites:

eCBOT – Electronic CBOT trading essentially mimics the open outcry trading environment with a paperless system. It allows member firms to place orders electronically to their floor traders, eliminating runners and the need for printing paper orders. The floor trader essentially uses an electronic order entry device to confirm the order placement in the electronic management system. Back-office order clearing and matching is also done electronically to reduce execution and matching errors. Essentially, this system maintains all the institutional structure of traditional commodity trading but eliminates the high volume of paperwork involved. A second avenue is the electronic trading platform *alliance/cbot/eurex* trading alliance, which operates as a dedicated network and allows electronic trading of derivatives. This trading initiative among CBOT and Eurex is directed to institutional traders.

Globex2 – This electronic trading environment was initiated by the Chicago Mercantile Exchange (CME) and is proprietary to members of the CME. The primary products traded are currency, financial and equity index futures. However, they do include a mini-contract in lean hogs and in feeder cattle as well as standard contracts on stocker cattle, fresh pork bellies, and pork cutouts. It allows for full electronic trading and provides clearing and matching functions for orders.

Enrononline – Enron online is perhaps the most sophisticated electronic derivative and commodity trading platform. Enron trades primarily in energy, pulp, paper, weather derivatives and other "off-exchange" commodities. Their e-commerce platform allows for pricing, order execution, and logistics. Enron creates its products and derivatives itself and hedges on the existing commodities exchanges, but exchanges the derivative products with their clients.

While not comprehensive with regard to all agricultural e-commerce initiatives, this overview should provide a general idea of the scope of current activities in agricultural e-commerce. Importantly, this overview ignores the agri-food system downstream from processors, including distribution, wholesale, and retail operations. Such issues are beyond the scope of this report, but it is important to note that this 'beyond processor' section of the agri-food supply chain will play an increasing role in the direction of agricultural production and manufacturing. In fact, one might argue that these downstream components of the supply chain may be nexus of a larger amount of supply chain information given its closer proximity and alignment with consumers.

The Technological Architecture and Business Development of Agricultural E-Commerce

The history of open electronic markets in agriculture, while relatively long, has not provided significant hope for those who might believe such markets are a panacea for producers and buyers alike. Like any market mechanism, the test of their relevance and usefulness ultimately will be reflected in the choices of market participants and will depend on the choices of firms and associations of firms in structuring and organizing agricultural exchanges and markets for the Internet.

The Unique Side of Agricultural E-Commerce: The Physical Side

One of the distinct challenges for agriculture e-commerce initiatives is the non-uniformity of products that are being transacted. Difficulties associated with this non-uniformity are reflected in the fact most of the successes in agricultural e-commerce have been in packaged products such as fertilizer, farm chemicals, animal health products and machinery parts, or in commodity markets, which are fungible. The adaptation of electronic commerce systems to more heterogeneous or quality differentiated agricultural outputs remains as a difficult impediment to implementation and yet potentially an area of significant opportunity. In the simplest context, we know that livestock have differing quality traits that affect their end-use just as a function of their growth and meat/fat characteristics. Similarly, different varieties of wheat have different milling qualities. These attributes can easily be handled by grading standards since many of these traits are observable; however, what can be done about non-observable traits? This is increasingly an issue with GMO's in crops and differing production practices (e.g., antibiotic free or hormone free) in livestock. The recent Starlink corn debacle provides an apt example of the need to somehow link digital and physical information. There are firms engaged in physical identity preservation, including Aginfolink and Destron Fearing to name two; however, while technology is evolving, this monitoring process will not be as simple as labeling a commodity, it will require verification. Tests can be used but they are expensive.

Importantly, the origins of infrastructure in tracking products lies in the retail food industry. For several years, grocers have implemented frequent shopper programs, wherein customers fill out a form and receive a scanner read card that records limited demographic data and correlates it with purchases. Internet commerce also brings a new twist to retailing and the consumer interface. Firms such as Webvan.com[2] and SimonDelivers.com are attempting to develop distribution centers and eliminate the physical structure of the retail store to home deliver groceries. Each of their business models includes the ability, by definition, to electronically track consumer purchases and, therefore, potentially create continual replenishment direct to the consumer. This enables virtual integration of consumer preferences and purchasing patterns into the supply chain. To this point the information has primarily been used for point of purchase merchandising, such as category management schemes and featuring of products. This limited use is primarily due to the limited transmission of data beyond retail to manufacturing, processing and production. As electronic commerce enhances the efficiency of transmitting information beyond firm boundaries, individual producers may be able to gain access to information previously available only to those capable of conducting extensive market research programs. This will further aid producers in differentiating their product and enhance the value they obtain from the marketing system in addition to increasing incentives to invest in identity preservation technologies.

Importantly, electronic traceability is fundamentally necessary to allow individual producers to gain benefits from electronic commerce. Traceability is defined as the ability to identify and verify attributes of products whether observable or unobservable to the end-user. If a product can be clearly traced from producer to processor and processor to consumer, there is an increased capacity by market participants to differentiate their products at both stages in the producer to processor relationship. For example, if a processor can more easily identify and verify that a particular product is organic coming from the farm level, they have an increased incentive to enter such markets as well as make efforts to differentiate their final products. This leads to an important question for e-commerce in agriculture. Can the Internet, along with digital information technologies, allow for increased production differentiation, while at the same time, improve access to markets by a diverse set of participants?

[2] Note: As this paper was being completed, Webvan.com filed for bankruptcy, July 9, 2001.

Logistics, Supply Chain Management and E-Commerce

Early Efforts at Supply Chain Management via Electronic Media

Electronic logistics applications are not new, and originated with Electronic Data Interchange (EDI) between firms. EDI primarily serves as a direct conduit for firm-to-firm communications of purchase orders, invoices, and other communications. The primary difference compared to Internet logistics applications is that EDI systems were firm specific and offered little connectivity without significant hardware and software investments. Because of their "direct lines," they offer higher security than the Internet; however, the main advantages to EDI are that it improves speed of communication, reduces errors because of limited intervention once an order is placed, and reduces direct paper costs. Still, the costs of investment in EDI and its peripheral nature to the business reduced its adoption.

There are three major technological changes, which have occurred since the original development of EDI on mainframe based systems. First, the mainframe moved to the desktop in the form of PC's, therefore, the costs and accessibility to EDI improved. Second, internal production processes were automated. The automation process created a production data stream, which introduces another important link in the chain of internal firm communication of information to external communication. In this context, bar code technology was developed over 25 years ago by the Uniform Codes Council; and, associated holographic scanners allow for the reading of barcodes to capture data regarding product name, weights, sales value, etc. An example in the grocery industry is the implementation of bar code scanners at checkout, and automated robotic "pickers" at distribution warehouses. Now, sales information can be quickly transferred via EDI so that appropriate items are picked and packaged for store delivery without need for manual processing of a purchase order or having to control stocks. Predicated on an information partnership, this approach has replaced purchase orders with production schedules and inventory balances. Rather than have purchasing agents review raw material requirements and place purchase orders, purchase orders can be placed automatically based on pre-determined inventory levels. Third, the Internet introduces a <u>critical</u> technology improvement over EDI. That is, the Internet contributes an open architecture and enables a more cost effective networking of any number of suppliers. Several challenges still remain: developing a common set of flexible communication standards, improving security of Internet-based networks, and further improving available tools (e.g., bar codes) to electronically track raw physical agricultural commodities.

Supply Chain Management Standardization Issues

There are basically two aspects to standards in traditional EDI. The first aspect is simply the implementation of compatible computer hardware and software systems. Left to their own devices, firms could develop any number of hardware and business software architectures, which have no guarantee of compatibility. Obviously, with high costs of development to start with, this problem hindered EDI adoption. The second issue is more mundane, there also needs to be a standard for the information that is to be communicated. Two firms may have two entirely different purchase order formats. If they do not match, it is impossible to convey the data between the two appropriately. In the past, trade groups were formed to address standards development to overcome these issues. All major American EDI transaction groups are now covered under the general umbrella of the Accredited Standards Committee (ASC), and are referred to as the X12 group of standards. With increasing globalization, the United Nations has provided a forum and developed UN/EDIFACT (United Nations Electronic Data Interchange for Administration, Commerce and Transport).

With regard to the related bar code technology, which allows for rapid data entry, UCCNet is an effort by the Uniform Codes Council to develop Web-based standards for data entry, and transmission for Web-based electronic data interchange. Such technology, once standardized may provide a foundation for identity preservation and raw material tracking. UCCNet also jointly works with the Voluntary Inter-industry Commerce Standards Association (VICS) as well as ebXML.org, which is the committee responsible for development of electronic business XML standards. Such standardization of protocols will aid and augment adoption of standardization and information technology.

Even with standards, infrastructure costs significantly reduce the accessibility of EDI to small businesses. The Internet and related technologies may change that. First, rather than each company maintaining a separate infrastructure for supporting EDI, the computing infrastructure is shared via servers in a network. Similarly, the applications provided begin to naturally have synergies as businesses begin to share the development. The major challenge of commonality of software and even data files remains; however, a new standardized language, extensible mark-up language (XML) is being developed and promises to provide a common platform. A simple comparison of HTML and XML illustrates how they differ. To display information through a Web browser on an order of 50 gallons of Atrazine (a herbicide) purchased from a dealer in Jefferson, Iowa would look like what we show below. The output is purely a text file and if this is to be entered into a database, it must be converted into appropriate fields or tables by additional code. Any asynchronous text will result in database errors.

```
<p> Atrazine
<br> Jefferson, Iowa
<br> 50 gallons
```

Now, XML would show the same information as follows:

```
</product> Atrazine
<dealer> Jefferson, Iowa
<quantity> 50 gallons
```

In this case, XML not only provides the data (Atrazine, Jefferson, Iowa, 50 gallons) it tells the reader what it is; therefore, there is no need to go back and query a database, and similarly, the <product> tag tells any application that this is a product so it only requires standardization of the tags and not the overall format of the information required of a text file.

The ability to communicate seamlessly across firms and to monitor within firm processes as indicated earlier, leads to the concept of collaborative planning, forecasting and replenishment. The idea is that once a supplier and a buyer can communicate their status, it becomes possible for them to jointly plan production activities such as inventory, shipping and delivery. For example, if I am a retailer selling packaged meat products, my sales and inventory data is shared with my vendors which in turn schedule deliveries based on this information. However, to accomplish this task, base levels of inventories must be established, ordering and delivery timing must be determined, and intervention strategies must be developed. All of this requires a high level of collaboration between entities. Another relevant technology, which is only just being developed to exploit the information of the Internet, is notion of intelligent agents. Intelligent agents are software, which can be programmed to interact in markets and bargain with human agents working at a terminal or other intelligent agents. This development will help to overcome what has been called the limits of human attention in gathering information as well as in negotiating trades. Ultimately, the importance of these software, communications, and logistics innovations is that they greatly improve the efficiency of standardizing all types of databases and paper material and should enable lower cost implementation of inter-firm logistics. They also should become much more accessible to smaller businesses.

The primary driver of communications and logistic efforts are retailers, distributors and manufacturers; therefore, much of the work to date leaves the production agriculture supply chain beyond the first handler or processor outside these activities. The primary problem is that agricultural bulk commodities (such as meat, milk, etc.) are largely fungible and often blended at processing, or in the case of meats disassembled to complete a final consumer product. Traditionally, there was not a perceived need to trace food throughout the supply chain. As mentioned, increased concerns about production protocols (hormones, antibiotics, organic, etc.) and the arrival of GMOs, has given impetus for maintaining product identity back to the original producer. The above technological improvements in data management may be implemented in the A2G sector of the market as well; however, the exchange mechanism used to coordinate such transfer is still being debated. While many firms are attempting to maintain product identity via vertical integration and coordination, the Internet may in fact allow more open procurement and logistics operations.

Agribusiness Web Site Development Issues: Virtual Market Creation

The technical architecture of the Internet and e-commerce platforms will be left to information technology specialists, however, it is important to understand the business or economic architecture of the Internet. Earlier in this paper, the analogy of markets and Internet structure was developed. Here the focus is more on the structure of the sites. In general, Web-based e-commerce sites consist of: (1) a database, (2) a search and match algorithm, (3) an exchange mechanism or market model, and (4) security. While there are a number of ways to implement each of these components, depending on hardware platforms, software, and coding expertise, these are the building blocks of any exchange.

<u>Databases – The Heart of E-Commerce</u>

In all markets, there is a need to identify the buyer, seller and products to be sold. Traditionally, this base information is revealed at the time of transaction. Electronic databases allow for capturing this information in a digital format and then enable the other resulting applications such as searching, matching and exchanges. The advent of the concept of relational databases in the late 1960's allowed for arranging unordered tables through operations to create a highly flexible set of operations to generate new tables of information. The contribution of the Internet as mentioned earlier is that the databases can be maintained on a central host server and queried by any number of clients. This allows for entry and extraction of data from the database by multiple users anywhere. The analogy to markets is that the database now is the centrum or market center around which commerce evolves. People bring their "digital" goods into the database, allowing sellers and buyers to identify the product and the value. All other constructs of e-commerce revolve around making the market (or database) function more efficient in clearing the market. Figure 1 provides a screenshot of XSAg.com's auction site illustrating an order form. In order to "make the market" for 2,4-D (an herbicide), the quantity of the product must be defined, it's dates for offer must be defined, delivery information is needed, and the seller's identity must be added. All this information is captured in the database so that interested buyers can query the database to see what offerings might be there. This is a relatively simple example, but one can imagine the complexity if one were to think about the database required for grain sales. There are an extremely large set of potential buyer and seller locations, an extremely large spectrum of quality or attribute specifications, and of course a very large number of potential market participants. An effective e-commerce strategy must first develop a database architecture, which can manage this complex array of market information.

Databases themselves provide little value. They provide data, not information. To bring databases to life requires development of querying routines. Also, they must be accessible to users. In the case of XSAg.com, it is relatively easy for a user to input the six or seven key pieces of information directly through the web interface. However, imagine the complexity of a market for a grocery store. No individual could possibly key in the estimated 10,000 unique product codes necessary to utilize an online ordering application. However, because of the open architecture of the Internet it is possible to have my database communicate with your database to seamlessly populate the market database. The current challenge is to find software solutions to bridge these business-to-business data exchanges. As we alluded to earlier, extensible markup language (XML) seems to be the frontrunner.

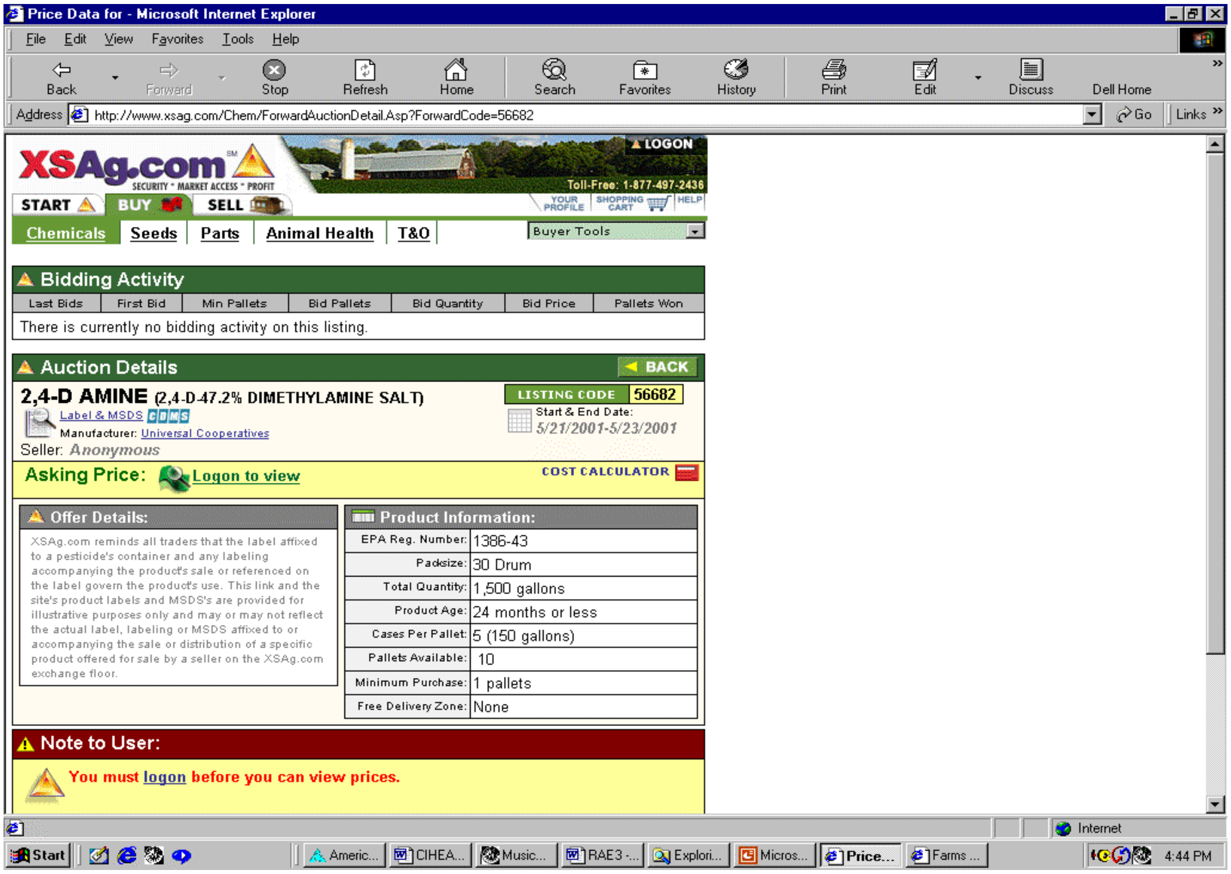

Figure 1. Data Input for XSAg.com

<u>Search and Match Algorithms</u>

In traditional marketplaces, people and products are physically present and it is incumbent on them to find the best buyer or seller. This process can have very high search costs. However, in an Internet environment, once the database is established, the foundation for the market or exchange exists where search and match algorithms allow the database to be queried in an open architecture and potential trading partners can be easily located. In simple settings where there is a single attribute of preference, this process is quite easy; however, as additional objects of preference are added (e.g., product type and delivery date), these computer-based algorithms allow for such multi-attribute search and match processes more efficiently than physical analogs. Just as with physical markets, the objective is to minimize search costs of two market participants with mutual objectives of finding one another and completing an economic transaction. Such Internet-based mechanisms provide a simple means of reducing costs of procurement through the market. As an extension of the search and match problem, such mechanisms allow for aggregation and/or disaggregation of orders. That is, more than one seller can contribute to a given buyers order and vice versa. This arrangement opens the market to a broader set of potential buyers and sellers.

The Exchange or Market Mechanism

Now we have an infrastructure for trading (database) and a mechanism to identify potential buyers and sellers (matching and searching). The question is how do we establish price at which to settle the transaction? Exchange mechanisms themselves consist of two components: (1) the price discovery mechanism and (2) the rules governing the use of the market mechanism. The rules dictate how the price mechanism will be organized. It will typically set times of sale (origination of bids or offers and closing of bids and offers) in the case of auctions, requirements of participants (e.g., bonding, licensing, earnest money, or reputational verification), location (although in Internet terms this becomes irrelevant unless certain regions are excluded for purposes of limiting subsequent shipping), settlement conditions (cash at sale, cash at delivery, credit requirements, down payments, etc.), dispute resolution (either mediation or civil legal penalties), warranties or guarantees (e.g., what to do if goods are damaged in transit) and other aspects. Following is a brief taxonomy of market mechanisms, followed by a discussion of the relevant economic and structural issues related to their use.

Posted Prices

Posted price mechanisms are simply the case where either the buyer or seller offers a take-it-or-leave it price. They are often referred to as static price mechanisms, but in the long run, posted prices are dynamic as well. If supply falls for a given product in response to excessively low posted offers per unit, the buying party will increase the posted price. In the very short-term (say in the next hour or day) posted prices will be static; however, over the period of a month, even posted prices can be quite dynamic. The primary advantage to posted prices is their very high bargaining efficiency.[3] However, pricing efficiency may be low given that the "true" willingness-to-pay by the marginal buyer and the "true" willingness to accept by the marginal seller may not be

[3] We define bargaining efficiency as a relative measure of the costs of arriving at an agreement of price for a specific quantity and other product attributes of a product.

found. This is particularly valid where sellers may have different output supply functions (marginal cost functions) and some may be willing to accept less per unit of product than a buyer is posting as the price. Hence, in this case, the buyer loses the surplus those lower cost suppliers might be willing to accept. This bargaining versus price efficiency tradeoff will be a common thread of comparing market mechanisms. To improve the dynamics of posted prices, some exchanges use automated posted price adjustments. For example, a buyer (seller) may originally set the price at a relatively low (high) level, then based on a growth (decay) function algorithm the price is increased (decreased) until someone takes the price. These functions may be simply time oriented, or more complex processes. In one agricultural case, the price is lowered by the marginal cost of storage and production as a function of time. Such mechanisms reduce the monitoring costs of posted prices and automate the price discovery process.

Bargaining or Negotiated Price Discovery

Bargaining simply enables two or more parties to negotiate direct settlement prices. The seller or buyer may make the original price offer, then the opposite party counter-offers and this process continues until they reach an agreed upon price. While electronic markets reduce the search and match costs of bargaining, they do not eliminate the inherent communication costs of back and forth bargaining. Bargaining mechanisms in general will have greater price efficiency, but lower bargaining efficiency relative to posted prices. Bargaining has the added dimension that it can introduce strategic negotiation and multiple attributes over which participants can bargain. For example, the two parties can negotiate alternative delivery times or locations at different prices, in addition to other aspects of the trade such as lot size. Allowing for such bargaining over attributes may well improve the welfare of agents; however, it is at the cost of higher bargaining costs and lower efficiency in that sense. Figure 2 shows an example of a bargaining interface at Dairy.com.

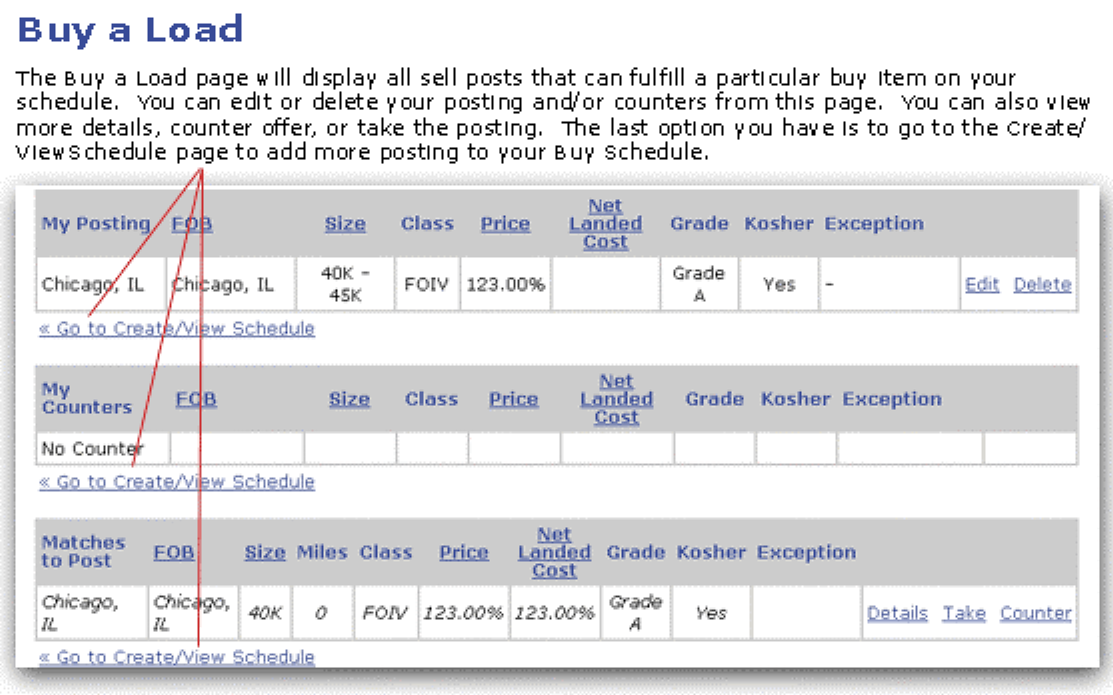

Figure 2. Dairy.com Bid-Ask Management Screen

Auctions

Auction mechanisms are the preferred mechanism when pricing and allocative efficiency is the primary objective. This brief review only scratches the surface of potential auction mechanisms, by describing only the most predominate forms. As electronic markets innovate and grow, new variations will be used. As a rule, potential users must perceive a given auction mechanism as "fair" or it may not succeed. There are three basic types of open auction mechanisms Dutch auctions, English auctions, and double auctions. From these three types, a larger subset of auctions can be derived.

Dutch Auctions – Dutch auctions are named for auctions that originated in the floral markets in Holland. The original asking price is set high and the price then lowers in defined increments until a buyer "hits" at a price level. Two major considerations with Dutch auctions are that they tend to favor the sellers side in fair markets, in other words, the price established tends to be higher than the "true" market price and second, they are not naturally collusive for buyers. A collusive ring would attempt to set the price at the lowest price the seller would accept. However, assuming all buyers do not have similar valuations of winning the auction items, the buyer with the highest valuation would have an incentive to place a bid before the price reached the sellers' collective reservation price. Thus, the ring would be broken without a need to enforce anti-collusion measures.

English Auctions – English auctions begin with a low price and the price increases until the item is sold. English auctions tend to favor buyers all else equal, but they are naturally collusive. With prices increasing, everyone in the cartel has a mutual incentive to stop bidding at the pre-defined target price. Additional bidding by any individual will reduce their own welfare and all will stay with the agreed on price fix. Therefore, English auctions must be carefully monitored to ensure that bidding rings do not develop. Figure 3 shows an example of an English auction interface at Farms.com.

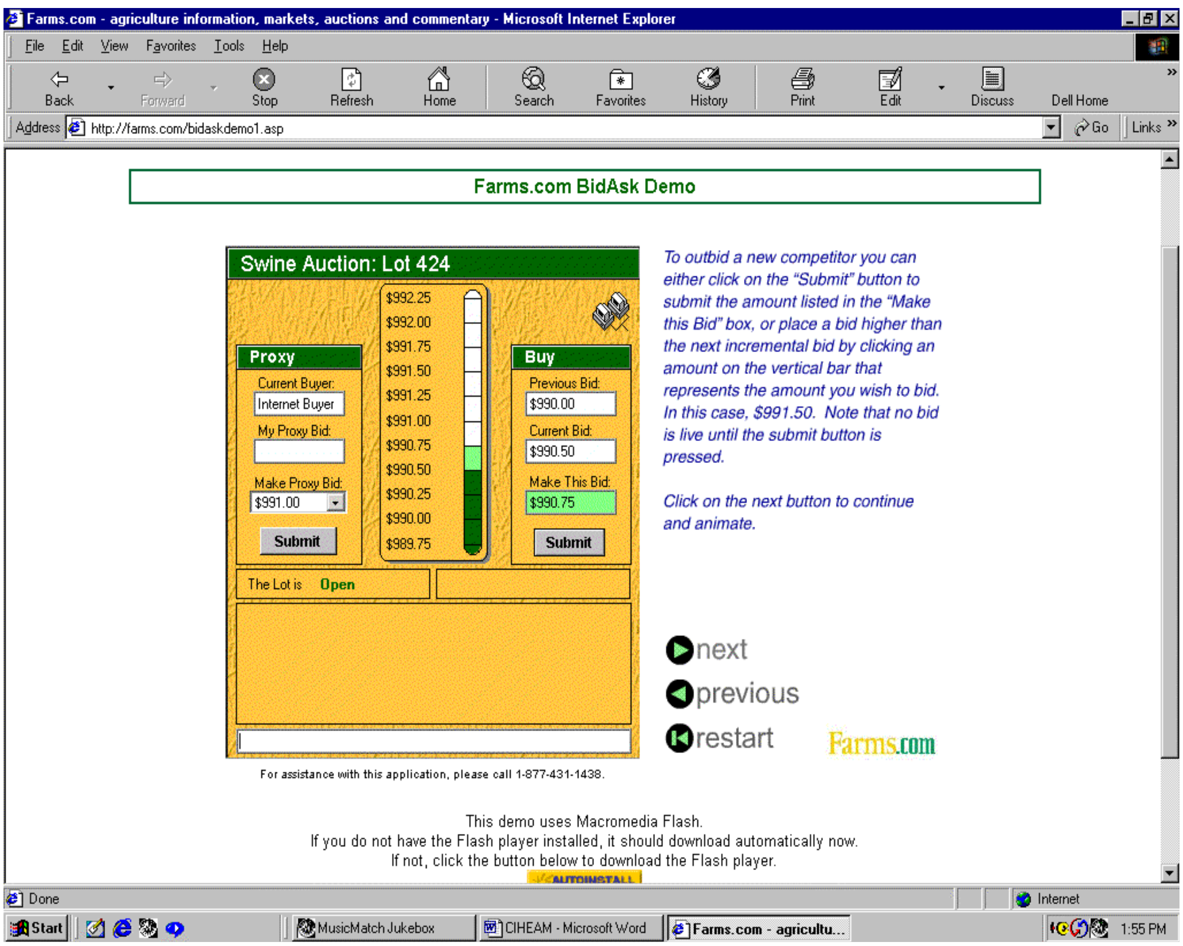

Figure 3. Farms.com English Auction Illustration

Double Auctions – In double auctions, both the buyers and sellers make instantaneous bid-ask offers. Double auctions are most familiar in commodity futures exchanges. The exchange provides the function of the auctioneer and rules surrounding the auction, but buyers and sellers establish prices simultaneously. Double auctions work well for highly homogeneous markets where all product definitions are predefined, so the only product attribute to be discovered is the price. In these cases, double auctions are highly efficient in terms of pricing and bargaining. When products are heterogeneous, double auctions could be illiquid and inefficient in arriving at prices for products.

Reverse-Auctions – Direct auctions are as described above in that the seller originates the sale by offering a quantity whether in a Dutch or English format. In reverse auctions, the buyer originates the bidding by asking for bids to supply a certain good, then suppliers compete to offer the lowest price possible. In the United States, this format is very familiar in government contract bidding.

Interestingly, when comparing use of auctions, bargaining, and posted-price mechanisms, agriculture tends to favor a form of posted price mechanism where the buyer (meat packer or grain elevator) originates the price for a given quantity. Notably, this pricing takes on a dynamic quality as it can change from day to day.

Several other types of mechanisms are used. These include first-price and second-price sealed bid auctions as well as combinatorial auctions.

Sealed Bid Auctions – Sealed bid auctions are generally conducted either as first-price or second-price auctions. Sealed bids mean that participants know only their own bids and not the bids of other participants. Sealed bids eliminate strategic behavior and learning during the auction process. However, sealed bids can be subject to collusion by bidders outside the time of bid submission, and hence there must be strict enforcement. Because of the lack of learning in a static sense, sealed bid auctions may be structured as repetitive auction markets where sealed bids during one auction period are posted prior to a subsequent second bid period. Therefore, participants can learn from other's behavior and adjust their bids accordingly. First-price auctions give the good(s) to the highest bidder in the case of a direct auction or the lowest offer in the case of a reverse auction and the winner must pay(charge) the highest(lowest) bid(offer). Second-price auctions give the good(s) to the highest bidder in the case of a direct auction or the lowest offer in the case of a reverse auction and the winner must pay(charge) the second highest(lowest) bid(offer). Under restrictive assumptions, a first-price sealed bid auction will likely elicit the same outcome as a Dutch auction; while, a second-price sealed bid auction will yield the same outcome as an English auction. It is unlikely that such auctions would be used in agriculture, but we include them to complete the portfolio of options available.

Combinatorial Auction Markets – Traditionally, we think of auction markets as defined by the product being auctioned. For example, buying a single rare book on eBay. However, auctions are being extended to products whereby assets or rights related to the primary good are also included in the auction because they complement or substitute for the item being offered. The proposal for using combinatorial auctions appears prominently among proposals to sell communications bandwidth in the United States, where it is believed that there is a great deal of complementarity of different bandwidths thereby making preferences by firms for certain combinations of bandwidths super-additive. Given this attribute of preferences for bandwidths, it was believed that higher revenues could be obtained by allowing for combined-value bids, (i.e., a bid for a bundle of bandwidths as opposed to a single bandwidth). While not currently used in agriculture, the spatial and temporal nature of agriculture may support the notion of non-additive preferences for goods and services for agriculture. An example in agriculture is to combine transportation with grain marketing. In this case, not only is the grain price determined, but also the value of transportation of grain to the buyer or seller. That is, a producer is not only concerned with the transfer price of a bushel of corn, but is simultaneously concerned about the costs associated with transporting the product to a processing or storage facility. By bundling rights and assets in a single transaction, the costs of aggregation and of administering ancillary services such as transportation could be lowered by reducing the number of markets a given participant must enter to complete an entire production transaction. Unfortunately, the theoretical pricing efficiency issues of combinatorial auctions are not as clear and implementation could be complicated.

Contracting

One could classify contracting as an extension of bargaining with a more long-term perspective. In addition, contracts allow parties to arrange for a larger set of issues such as price, quantity, product attributes, transportation, timing, as well as a broad set of complementary services without need for face-to-face discussions. As opposed to posted prices, bargaining, and auctions, contracting tends to be for longer-term planning and coordination among firms. Given the large amount of recent work on contracting in agriculture, we will not go into depth into the various types; however, suffice it to say, that the Internet simply would serve as a mechanism to reduce search costs, monitoring costs, and administrative costs of contracting. We discuss the strengths and weaknesses of this mechanism relative to other options later in this paper.

Security

The last component of an exchange mechanism is its security architecture. This has three dimensions. First, being the security of the computer system itself to prevent hackers from entering and either destroying or copying data. Second, the system must enable users to have access only to information for which they have permission to see. That is, the intermediary may collect private information from users to expedite negotiations; however, no party would want all of this revealed to their counterparts in any of the mechanisms discussed above. Third, it includes enforcement of trading rules, which is likely external to the Web site itself. Security, as with any market, creates the environment under which trade occurs and failure to effectively develop security systems will destroy a market regardless of how compelling an exchange mechanism is.

Business Development of The Internet

Before investigating in greater depth how the institutions and applications of electronic commerce will impact firm behavior and market structure in agriculture, we will first give a greater treatment as to how such institutions have emerged. Original agricultural e-commerce firms were innovative start-up firms with little connection to traditional bricks and mortar businesses. These A2G and A2A firms sought to obtain rents from organizing exchange mechanisms and information services in an open format. This competition was clearly seen by bricks and mortar firms concerned about how it might affect their procurement strategies and market positions. As expected, bricks and mortar firms soon found their own Internet commerce strategies and launched their own or affiliated Internet businesses (bricks and clicks). Bricks and mortar firms were able to leverage their years of experience and commercial relationships and utilize the Internet as one component of their marketing strategies (Gulati and Garino, 2000). While there are Internet "pure-plays" in business-to-business commerce (e.g., Chemdex, Plasticsnet, E-steel), B2B commerce has been quickly adopted by traditional bricks and mortar firms. General Motors, Chrysler and Toyota have formed Internet-based supply chain mechanisms. In agriculture, as noted earlier, several firms formed alliances to create Rooster.com and Pradium.com; while IBP, Excel, GoldKist, Tyson Foods, Smithfield Foods and Farmland Industries announced a joint venture to develop an electronic trading platform for meat products ProvisionX.com. The challenge for firms purely operating on the Internet is to generate revenues without increasing transactions costs by charging commissions or subscription fees. Bricks and clicks firms have a natural market advantage since the Internet simply represents one additional procurement mechanism among their existing manufacturing or distribution chains.

While e-commerce ventures by bricks and mortar firms may also translate into cost savings by disintermediating brokers and other sale and procurement positions, the impacts of ownership of these ventures for individual producers is not clear. It is likely that individual producers would be better off with independent third party market makers, but given the alignment of the existing supply chain, these mechanisms will face stiff competition from bricks and clicks.

The Interface of Internet Technology with Market Design, Firm Organization, and Industry Structure

Technology Adoption and Control – The Real Digital Divide

Will individual producers have full access to e-commerce technology? The technology can be broken into two components: the hardware/software aspect itself and the strategic and tactical use of the technology. Generally, digital technology has a cost structure characterized by high sunk costs for development but very low variable costs associated with replication and dissemination. Once an application or electronic agent has been created, the costs of replicating the application or adding a user is practically zero, particularly in the case of Internet commerce, where there is no need to provide a medium such as compact discs or floppy discs to distribute the program to users. There is, however, a barrier to individual producer use of the technology and applications in that individual producers may find it difficult to generate their own electronic agents or applications. That is, individual producers are not likely to participate in the development of commerce applications, as these will be developed either by their commercial trading partners or third party market intermediaries. Who develops commerce applications as well as who owns them will have important strategic implications for how individual producers engage in electronic commerce and who benefits. A party engaged in the transaction may have an incentive to develop applications that suit their strategic market positions at the expense of other parties in the transactions. While economic theory suggests that such a strategy would fail, as few other market participants would use such a mechanism given any overt bias, it is nevertheless possible to introduce small factors into a mechanism without signaling any gross bias. Third party electronic commerce providers argue that they can develop unbiased exchanges or market algorithms while not facing a direct conflict of interest (Kaplan and Sawhney, 2000). Unfortunately, as noted earlier, these third party mechanisms operate on very small margins in the face of stiff competition. The digital divide often spoken of, as access to technology will not likely persist, however, as we alluded to earlier, the digital divide in strategic control of applications and implementation is still possible.

Information Economizing, Mechanism Choice, and Firm Organization

In the previous sections, we have reviewed the history of electronic commerce in agriculture, the technological advances in logistics and supply chain management in the food and agriculture system, and the architecture of exchanging products and services with the Internet as the communications technology. We now provide an overview of how we see the implementation of such technologies via the Internet in the organization of exchange mechanisms, firms, and industries. Before addressing these concerns, we first list the areas in which information technology and the Internet reduce costs and change the nature of the relationships among firms. The impacts of the Internet will be noticeable as they move us farther down the road of technical efficiency in communicating and processing information within and between firms (as telephones, facsimile, and EDI have before).

The salient information management economizing features of Internet technology are the following.

1. The Internet as a communication technology is able to significantly reduce the costs associated with the paper work of organizing trade. No longer must a paper trail be kept by individuals and sent with multiple hard copies to various participants through physical mail

services or facsimile machines. The Internet allows participants to send and maintain files of contracts and trading data in a digital format as well as provide easy access to such information to authorized individuals and firms.

2. Through its open architecture and possibly intelligent software agents, the costs of looking for and gathering information on possible trading partners, is reduced. That is, rather than relying on a series of telephone calls to different regions as to the availability of particular products or services, individuals and firms can seek out such information without leaving their office and with fewer messages being used to get such information as opposed to multiple telephone calls, faxes, etc.
3. The need to find suppliers or buyers of proper size is reduced. That is, software reduces the need for individuals who aggregate orders and offers in a given market. The technology allows for software that can provide such aggregation services with relatively open access.
4. In terms of bilateral relationships between producers and processors, video data and other electronic measurement/monitoring devices, when coupled with the electronic media of the Internet, will reduce the costs of a monitoring. Monitoring costs would include site inspection and audits of record keeping. Similarly, if records are kept electronically, producers directly enter data, which is transmitted to their processing counterpart. That is, if a particular processor is interested in monitoring the production processes of the given supplier, such mechanisms more easily assure that production practices adhere to the processor's needs. Increasing such information flows reduces the pervasive problem of moral hazard often seen in contractual relationships.
5. There is a lowered informational cost of tracing the flow of products through the production system, i.e., from producer to processor. For example, each producer has an identification number that is attached to a given shipment of product and, therefore, when shipments are received at a processing or storing facility, the manager can use the code as a basis for product tracking and identity preservation. While such tracking does not completely solve the issues because of other technological constraints (e.g., we cannot bar code meat, corn, etc. and it does not reduce operational separation costs), it does assist in processing information and thereby allow for more precise pricing and qualification of products.
6. One could also raise the question as to whether the informational capacities of the Internet could substitute for storage and/or product inventories. (Milgrom and Roberts, 1988) That is,

because the Internet opens the flow of data on product availability, location, and logistics, farmers and processors can coordinate activities without as much need to use intermediary storage and holding facilities.

One consequence of the above informational cost reducing factors of the Internet is that the information about location, type, and quantities of goods produced no longer needs to be concentrated with an individual or firm, but is available in digital form through the Internet and related software thereby more efficiently managing information and reducing the potential for human errors in such management. Also, such informational decentralization (i.e., potentially removing market data from individual and propriety venues to a public digital arena) opens the trading process to a more diverse set of market participants as well as a more heterogeneous set of products and services. All of the above issues highlight the fact that the cost of processing information and monitoring activity between firms is reduced. Similar issues are overcome in vertically integrated firms. Aside from vertically integrated firms with "intranet" systems, the ability of more individuals to observe market and product data provides valuable information to decision makers at the farm, processor, and regulator levels to help them better organize processes and logistics in a coordinated but potentially decentralized way. How do we expect firms and industries will change with regard to their organization as well as their organization of exchange? We now discuss in more detail how such issues may affect each of the following: exchange mechanism choice, firm organization, and industrial structure. We will also discuss potential theoretical and empirical approaches to obtaining answers to these questions.

Exchange Mechanism Choice

Economists as well as policy makers and market participants have often been concerned about the nature of the exchange mechanism. As far back as Forker (1975), there have been issues raised about the potential for "real-time" electronic trading. In addition to item 3 in the above list of cost reductions, traditional arguments in favor of non-Internet-based electronic markets have included: (1) lower costs due to the elimination of transportation to central markets, as well as reduced loss due to animal stress in transportation, and (2) increases in pricing efficiency and competition as the number of potential buyers and sellers increases. However, even with these potential gains, various costs are imposed by such arms-length mechanisms: (1) the need for clearly defined grades and product descriptions, (2) the necessity of a critical market size/volume to support market infrastructure (i.e., market liquidity), and (3) the need for rules and enforcement mechanisms that assure standards on grading and financial accountability. Furthermore, even on the Internet, such market structures have other impediments: (1) the possibility that individuals will just bypass or not use such systems in order to avoid any user costs, and (2) the difficulty of communicating terms of trade on such things as delivery and quality. Andrew McAfee (2000) remarks that peer-to-peer Internet networks (i.e., private networks and contracts) avoid fees and by definition allow for direct negotiation.

Henderson (1982) indicates that while electronic marketing may lead to increased competition, improved market information, enhanced market access, and greater pricing accuracy and allocative efficiency, the questions of whether overall marketing and transaction costs are reduced remains open to question. That is, bilateral/contract trading involves minimal travel by buyers and sellers (i.e., products are not shipped until the deal is complete), and the buyer and seller are known to one another and are able to deal with details such as product description and contracting rules relatively easily. Henderson also argues that contracting in the exchange of agricultural produce has grown up very much because of its lower transactional costs.

Given the current status of trading various agricultural markets, we believe that there is little likelihood that the overall nature of trading relationships will change in terms of the relative usages of contracts and auctions in the near term. However, we would like to discuss in greater detail how information technology and the cost reduction mentioned above might lead to a better outlook for auction markets and related exchange mechanisms in agricultural markets relative to contracts over the longer run. Importantly, we believe that the degree to which an auction framework persists or how contracts are restructured in the Internet era depends very heavily on the product characteristics and industry structure of a product as follows:

- Are buyers concerned about the way a good is produced?
- What are the dimensions and measurability of quality differences?
- Are the goods perishable and what are the temporal dimensions of availability?
- What are the historical relationships in trading the commodity?
  - What is the industry structure (size and number of potential participants)?
  - What types of exchange have prevailed prior to the arrival of the Internet?

For example, open input supply markets are very similar to other markets on the Internet where products are well defined and cataloged or posted prices work very efficiently. However, few agricultural electronic markets have successfully created the market environment for the output side of farm production. In that light, one direction of research is to look at those few ventures that have achieved some success and clearly answer the questions above. One can then look at other commodities that are not currently widely traded via the Internet to arrive at differing product characteristics that may cause such differences in use. Even before that, it would be worthwhile to go through the various important agricultural products traded into the United States in order to have an overall catalog of initial positions of commodity trade prior to the arrival of the Internet. From there, researchers will be better able to arrive at broader theoretical and empirical generalities about the impact of Internet technologies on agricultural marketing.

Auction Markets as Exchange Mechanisms for the Internet

As a general overview of the tensions, which drive adoption of different exchange mechanisms, we will now take heed of the general concerns discussed above with regard to the long-term viability of auction markets as part of the exchange portfolio of agents in a given commodity grouping. This discussion provides a starting point from which researchers can then add the unique characteristics of the various agricultural industries.

It is worth noting that the primary purpose of auctions has traditionally been to expedite sale/purchase of goods/services, obtain truthful revelations of the valuations of auction participants, and prevent dishonest negotiations among participants, which result from asymmetries in information and/or market power. In that context, this section will provide a brief discussion of the theory of auctions, their relation to agriculture, and the growing discussion of optimal auctions for the Internet and for complex transactions. For the sake of clarity, we consider auctions to be mechanisms by which participants bid to buy/sell goods/services or a combination of goods and services under preset rules specifying who will be the winner(s) of the process and how much they will pay for the goods/services. Furthermore, as discussed earlier, auction rules may preclude some individuals/firms from participating, delineate the types of bids that may be made, and can specify how participants must behave (Wolfstetter, 1999). While one often only thinks of auctions in the context of unique items such as art, there is a significant history of auctions being used in agriculture, even if not as the dominant trading mechanism. As recently as 1994, the volume of pork sold by auction or in terminal market arrangements was expected to be 1.2 percent of total volume in 1998 (USDA, 1996).

The theoretical literature on auctions has grown rapidly since the early 1960's and the theory has been applied widely to meet the needs of business and governments for a variety of purposes. The foundations of the literature have been well-developed since that time; however, much of what relates to the concerns of agriculture remains to be developed more fully despite what appears to be the relative simplicity of trading agricultural commodities. In particular, the literature on multi-unit objects and the bundling of heterogeneous objects (i.e., transportation services, financing, and the commodities) is still in its infancy and many issues remain to be worked out (Klemperer, 1999).

Nevertheless, several theoretical papers have alluded to issues that may very well impinge on the development of effective auctions for agricultural commodities on the Internet. In particular, fees have often been considered as a revenue generator for Internet auction mechanisms. However, recent work on double auction markets suggests that the addition of fees will not impede convergence to competitive equilibrium prices but will result in lower quantities of goods exchanged and consequently less market efficiency (Noussair, Robin, and Ruffieux, 1998). Another paper by Jeitschko (1999) highlights the fact that if goods of a particular type are auctioned sequentially (e.g., in lots), price formation in such a market will depend on participants' knowledge about the overall quantity that will be sold. If buyers are unaware of how many lots will be sold after the first auction, the auction will yield declining prices in each of the subsequent auctions; however, if it is learned in the course of the sequential auctions, for example, that the ultimate supply falls short, then prices of subsequent lots may in fact increase. Also, Ausubel and Cramton (1998) discuss certain problems related to multi-unit auctions whereby strategic behavior by bidders (i.e., signaling low demand) can lead to allocative inefficiency. In the context of designing appropriate auctions or exchange mechanisms for the Internet, the issue of when auctions occur, how often goods can be put up and or demanded, if transaction fees are to be charged, and how participants must reveal their supply and demand for products, becomes very important when one considers the potential strategic and market efficiency issues arising from the above mentioned theory.

Another study by Lu and McAfee (1999) notes that auctions are superior to bargaining mechanisms, therefore, indicating that auctions can be the optimal trading mechanism under certain circumstances. The circumstances in which the model is developed includes homogeneity of agents and where transaction costs are equivalent. However, greater heterogeneity of agents, as is often the case among buyers and sellers in agriculture, tends to favor auctions because of their ability to allow for rapid search and match of buyers and sellers. That is, one would expect that greater heterogeneity of agents could strengthen this result. However, transaction costs of obtaining all of the other auxiliary services tend to favor bargaining or the creation of contracts in agriculture. Furthermore, since such bargaining can be for a multiple-period set of transactions (i.e., an agreement to supply a product for t periods into the future) and thereby spread the relative inefficiencies of bargaining in search and matching, the theoretical basis for the superiority of auctions is not matched with reality.

Once auctions overcome the disparity in transaction costs associated with obtaining auxiliary services, then the predictions of Lu and McAfee may prove to be true in the exchange of agricultural commodities. We will discuss at greater length below how the informational and administrative cost reduction resulting from the Internet appear to overcome this “transaction cost” factor.

While these theoretical works provide some intuition about what concerns arise in the implementation of auctions, work in other areas has presented ideas about the actual implementation of such trading mechanisms in both analog and digital forms. Two approaches dealing separately with the seller’s side and the buyer’s side problems have been developed in the past two years. Beam, Seque, and Shanthikumar (1999) have attempted to determine how sellers should optimally auction their goods (i.e., how much should be auctioned at any given time) based on the equilibrium price predicted by their model. Specifically, their work presents a mathematical model (orbit queue) which, using some approximations and simplifying assumptions, provides a useful initial treatment of optimal auctions on the Internet by sellers. Unfortunately, their mechanism does not allow for producers, i.e., sellers to consider multiple outputs and/or services to be provided to a buyer or buyers.

More recently, Gallien and Wein (2000) have looked at the buyer’s side of problem of Internet auctions by designing and analyzing smart markets for industrial procurement. They remark that while online B2B auctions are expected to grow rapidly this decade, the early implementation was poorly adapted to the selection of suppliers in procurement markets when there are capacity constraints, transportation costs, supplier switching costs, and quality requirements. In accord with the earlier remarks by Henderson, Gallien and Wein indicate that the transfer price is but one dimension of the overall transaction. With that in mind, they develop a model under the context of capacity constraints.[4] These authors propose the use of Smart Markets, which are exchange institutions supported by a computer executing an optimization algorithm to solve the allocation problem associated with each given set of bids. After making certain simplifying assumptions about the behavior of procurers, they implement there mechanism using a linear programming framework and attempt to relate how this model will provide a useful framework of an electronic trading system, which enables real-time complex industrial transactions.

Notably for agriculture, Gallien and Wein (2000) remark that diseconomies of scope could make their framework inoperative since it is unable to capture the fact that a participant may not have adequate transportation or other logistical abilities needed to handle the complete transfer. On a practical level, Roddy (2000) argues that since many buyers and sellers in open market exchanges must conduct complementary transactions of goods and services such as transportation, storage and insurance after the trade itself is completed, the time and money spent on the subsequent arrangements often eliminates the value created by the electronic exchange in the first place. That is, it may be necessary to involve other suppliers in the transaction and, therefore, a combinatorial auction may be more appropriate. The idea of such auctions is not new relative to the age of the Internet. Gross and Licking (1999) remark that software has become available that will "allow buyers and sellers to bundle their requirements into far more complex and flexible bundles." As alluded to earlier in this paper, economic efficiency may be enhanced if procurers are allowed to bid on combinations of different goods and services. In seeking to benefit from such efficiency gains and as a consequence of growing computer power, many firms have begun to offer software to deal with such auctions (de Vries and Vohra, 2000).

Because of the potential complexity of determining the winners of combinatorial auctions, only recently have researchers obtained determinations of winners in ways that are computationally manageable as well as being optimal in an economic sense, where previous

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[4] N.B. They do not deal with problems related to transportation costs or switching costs because of the sheer complexity of adding these dimensions in a linear programming framework.

attempts did not guarantee optimality or were too computationally intensive (Sandholm, 2000). The work on automated agents will allow for the effective implementation as well as allowing for economic modeling and experimentation of this framework relative to others. As early as 1993, researchers developed models that would allow for optimization-based trading of commodities using "intelligent" automated agents (Lee and Lee, 1993). More recently, Sandholm (1999) developed software that allows for the use of both artificial intelligence along with combinatorial auctions. This paper does not seek to explain the actual computer implementation of such mechanisms, but suffice it to say that the technology is available to handle such complex transactions across multiple exchanges and the cost reductions discussed above come into play in this arena.

As to problems of market liquidity, if multiple exchanges exist for the same type of product, problems of inadequate market participation in any given market could arise. Market participants are quite aware of this problem, however. Jordan (2000) remarks that if a large number of exchanges and related markets are to coexist, mechanisms must allow for cross-listing on separate sites thereby increasing the liquidity of each of the sites. Appropriate payment methods across exchanges could ensure that revenues are shared equitably among market makers. Similarly, as suggested by Wise and Morrison (2000), such exchanges will need to evolve into a cooperative structure such that exchanges will no longer serve as for-profit centers but will be have a public good quality to them such that they operate at cost. Alternatively, different exchanges will merge. As noted earlier, recent mergers and acquisitions in the Internet sector seem to indicate that this is the direction in which firms are moving. Specifically, Rooster.com and Pradium.com, two pioneeers in the agricultural Internet exchange and information center area recently agreed to join forces in providing exchange services. Similarly, Farms.com recently acquired Cybercrop.com to better attain adequate markets size and scope.

While the applications and use of auctions has had limited success, the Internet, coupled with the other information technologies, offers a new beginning for these mechanisms to allow for greater transparency and to potentially increase efficiency of pricing as well as eliminate some of the administrative costs associated with contracting and the dynamic costs associated with the inflexibility imposed by contracts. In summarizing the issues discussed above and linking them to the cost reducing technologies discussed earlier, the following list shows how open exchange mechanisms can accomplish tasks necessary to maintain their current share of physical markets with some long run possibilities for growth.

(1) In accord with our listing of cost-reducing effects of the Internet, items 1, 2, and 3 (pages 28 and 29) help to eliminate costs associated with allied services related to the commodity transfer, which some agents consider to be more significant than efficiency gains from improved competition provided in the arrival at the transfer price for the commodity. That is, the technology can allow markets to overcome the same problems that contracts overcome. In particular, technology is available to allow firms to easily procure transportation, storage, financing, and related logistical services with the same security and ease that private treaty contractual arrangements provide.

(2) Similarly, software and Internet technology allows for open exchange mechanisms to further reduce search and matching costs associated with finding suppliers with particular attributes and/or abilities. In that vein, as noted in items 4 and 5 (page 29) of the information cost economizing list above, the technology allows for differentiation of commodities based on their attributes (e.g., extra-lean pork, natural pork, GMO, non-GMO, etc.) as well as assist in the preservation of such products' identities. Since many processors have particular needs in this area, exchange mechanisms must allow for this degree of specificity. Furthermore, if exchanges are to succeed they must perform this searching and matching in such a way that the costs of obtaining suppliers are less than when contracts are used.

(3) Exchanges must allow for the aggregation of the goods from several suppliers into a bundle for a particular procurer. Given that item 3 (page 29) in our earlier information cost reducing list shows that this is possible, successful markets will incorporate this capability. That is, buyers should not be restricted to depending on large producers to obtain their supplies. Such a mechanism would permit greater competition among suppliers and open access to smaller producers. Conversely, the system should allow for disaggregation so that several smaller processors could buy a subset of a large producers output.

(4) Unfortunately, the biggest problem that open exchanges and auctions still face is achieving market liquidity. This is a problem of network externalities, which any such potential market will face. Participants benefit from the participation of other firms in the

market; therefore, this could lead to under-participation and below top-level social benefits of such markets. Furthermore, the problem of achieving market liquidity is also one of competing exchanges as noted earlier. If multiple exchanges deal in a particular commodity and cross-listing by participants is costly, then the overall liquidity of any given exchange will be lower as some potential participants opt out of some of the markets (i.e., participants will concentrate in only one subset of the possible exchanges available to them). Only through cooperation, mergers, and/or market exit by market intermediaries will this be overcome. As noted, there has been some indication that exit and mergers have been the method, which firms are adopting.

In closing this section on auction markets, we note that rules and regulations of the market mechanism can be as important as the auction format chosen. Poorly defined and loosely enforced rules will certainly lead to market failure. Market clearing and settlement rules are critical to ensure that payment is made and received and that products are delivered and received in appropriate time spans and conditions. Furthermore, as noted in the theoretical discussion above, time is a critical dimension. When will the auctions occur and what will their durations be? Auction time must be convenient, but with the Internet 24 hours a day and 365 days a year are available, there are a multitude of timing dimensions. The key point of timing is to help ensure enough volume or liquidity in the market, and setting a convenient time enhances that possibility. As to duration, we note that urgency (i.e., shorter auctions) helps stimulate liquidity, but at the same time it can limit entrants into the market. Whether to have anonymous bidding or open exposure rules is also important. Open exposure is important because it can enforce truth telling and avoid shill bidding. However, anonymity can be important where the entrance of known individuals or firms can influence the market. This is particularly the case when there are highly concentrated markets. For example, Cargill can influence behavior of market participants through its actions in a market; therefore, open exposure rules may pose problems for such markets. As alluded to above with regard to shill bidding, the Internet poses particular issues because of its open architecture and difficulty in enforceability. Recently, eBay uncovered cases of shill bidding in their auctions for rare paintings and rapidly moved to prosecute to ensure the integrity of their auctions. Similar procedures must be developed for electronic agricultural markets, with severe penalties for cheating. Cheating would include shill bidding (i.e., a bidder with no intention of buying a product entering the market on behalf of the seller to move the price up), collusion (side agreements to force prices upward), and misrepresentation of products. Failure to act swiftly and forcefully will undermine trust in participants and degenerate the market.

The Implications of the Internet on Contracting and Vertical Integration

Above we have discussed how the Internet could be implemented to improve the efficiency of auction mechanisms irrespective of the commodity type. Now, we discuss at greater length than we have elsewhere, how contracting is similarly improved as well as address the question of how these improvements will affect the tradeoff between auctions, contracts, and vertical integration as coordination mechanisms. Such clarification will highlight and provide support for our belief that while there will be improved efficiency in the overall exchange of products, it is unclear whether firms will switch from one mechanism to another in the short run. In one specific example, e-Markets.com provides services in linking and supporting negotiations among potential contracting parties. Agmotion.com provides a similar service in linking suppliers to buyers. These services help to reduce the search and administrative costs (i.e., paper work) of contracting. In general, for the same cost reduction reasons that auctions are made efficient, contracts are also improved; however, for long-term arrangements where contracts are important, the Internet may allow auctions for contracts.

Open exchanges have certainly been a hot topic in the discussion of business-to-business e-commerce, however, to date they have had limited success. That may be because unlike consumers who are typically buying a very small volume of any particular item, agri-food supply chain participants make frequent and large scale purchases of a myriad of agricultural and food inputs and outputs. In addition to the question of price, the primary issue of concern is sourcing desired products and in particularly maintaining operationally efficient levels of capacity in the distribution, handling, processing and manufacturing stages of the chain. This can be a significant challenge in agriculture given production uncertainty.

However, with increasing clarification of contracting protocols, one can imagine firms participating in the contracting analogs of posted-price, bargaining, and auctions for contracts. For example, a "posted-price" contract on the Internet by Hormel would essentially be a listing of the contract provisions and the pricing. All takers up to the fulfillment of Hormel's needs would then be given contracts. Alternatively, Hormel could state the contract provisions and have producers bid to be the suppliers. Given the question of complementarities; however, mechanisms allowing for combined negotiations for a variety of services might be even more useful. Market participants may be able to enjoy more transparent price discovery and efficient allocation with the reduced long-term administrative costs and assured supplies of contracts. One caveat should be inserted, however. That is, given the relatively small number of buyers in many agricultural markets, we could observe tacit collusion through price signaling in contracts, but this same caveat will hold under a mandatory price reporting regime as well. Furthermore, if there is a sufficiently large competitive fringe in the processing/buying side of the industry, such a problem is mitigated.

The next question with regard to the impacts of the Internet and information technology on vertical relationships is whether monitoring cost reduction provide for reduced incentives to have a small network of approved buyers/suppliers as opposed to having open access. One would suspect that improved monitoring would make it easier for firms to negotiate contracts at arms length; however, there may be attributes of some agricultural industries that require the confidence and trust built into approved buyer/suppler networks.

Beyond the question of how contracts will perform relative to auctions and whether contracts will be auctioned, how do the cost reductions of Internet information technologies affect the decision to engage in vertical integration? This question is central and goes back to Coase (1937) in which he argues that a firm will grow (i.e., in this case, vertical integration will take place) up to the point where the costs of an extra transaction within the firm is equal to the cost of carrying out the same transaction by means of exchange in the open market. Transactions costs include issues of search costs for best suppliers, monitoring costs of production methods, and the more mundane issues of logistics and scheduling when there are significant adjacent firm size discrepancies. Consequently, the search, match, and aggregation capabilities of the Internet would be relevant to this decision (i.e., reducing the need for integration); however, in a Williamsonian world, other issues are relevant as well. That is, Williamson (1975) argues that if individuals are boundedly rational and at least some agents are given to opportunism, contractual incompleteness introduces potential costs to contracts when there is uncertainty about the future and if there is some degree of asset specificity involved. In such a case, it is possible for one contracting party to hold-up the other party's activities and extract rents given that the second party has made investments in assets that reduce outside opportunities. Similar arguments have been made in the agricultural context with regard to poultry and swine production contracts.

While we could argue that the increased capacity for real-time visual and written monitoring of the behavior of contracting parties as well as quicker communication methods helps to mitigate such possibilities of hold-up and, therefore, improve the possibility for contracting in agriculture, Grossman and Hart (1986) have warned that the link between lower cost contracting and increased reliance on market-mediated transaction may not hold. Optimal asset ownership is also determined by who most efficiently will hold the residual rights of control. An implication of their theory is that any change in contractibility will induce a new set of non-contractible decision rights, which in turn will force reevaluation of who should best hold residual rights of control. How contractibility affects asset ownership and the boundaries of the firm thus depends on the details of what becomes contractible and what remains in the set of residual rights (Baker and Hubbard, 1999). Of course, in practice these issues are intertwined to form a complex incentive structure for disintermediating the price discovery mechanism of the market in favor of simply managing product transfers between stages of production. In that light, a frequently cited incentive for integration has been that the demand to manage product flows and quality may outweigh concerns about pricing products in the market. The Internet's capabilities to improve logistic and production information management systems and, therefore, improve management and efficiency of integrated production systems is a factor favoring integration.

Importantly, integration is not a panacea for concerns about direction and residual rights of control and decision making over production. Without market signals, integrated firms face the challenge of efficiently allocating production resources, capital and revenues. With ongoing technical change, such institutional rigidity can create distortions in integrated production systems relative to the allocation an efficient market would provide. Furthermore, whereas historical information exchange systems for EDI (electronic data interchange) such as VANs (value added networks) required significant specific investments in both hardware and software coding and were largely proprietary and limited competition (Kekre and Mudhopadhyay, 1992), the Internet provides a common and open architecture where regardless of location or time, multiple users with a personal computer and a browser can access applications at the same time. This aspect of the Internet further clouds the view of how and what types of asset specific issues will arise in electronic commerce. With Internet-based electronic commerce still in its infancy, it is nearly impossible to predict the outcome, but it surely will introduce a new dynamic to the nature of agricultural firms.

As an extension of this argument over the relative strengths of the various market exchange mechanisms and the implications of the Internet, we would like to treat traceability, identity preservation, and production differentiation as a separate issue. The agri-food sector has handled this traceability problem to date by forging very tight vertically contracted or integrated business structures. Essentially, firms have managed supply chain integrity by fiat. For example, Smithfield's Lean Generation pork products are derived from their NPD line of swine genetics. This brand also carries the Heart Healthy seal of the American Heart Association. Smithfield can make these claims because they have an integrated production chain, which allows segmentation and identification of those specific pork products. It is much more difficult for an individual producer to maintain this identity through the production chain as the genetic attributes are not observable and measurement or sampling and segmentation by animal is expensive. As alluded to earlier, electronic identification (bar codes, radio frequency ID's, embedded chips) offer the potential for cost effectively obtaining attribute data and seamlessly passing it to subsequent segments of the supply chain. The Internet is the cost effective medium for this information transfer. This may enable individual producers to more effectively "brand" themselves to downstream supply chain partners and enhance smaller scale traceability. Consequently, there will be less need for tight integration in maintaining identity within the firm thereby mitigating the traditional incentives for integration in this case. Theoretically, such open mechanisms could also lead to more product innovation at the farm level. Ultimately, by improving traceability through open mechanisms and reducing the need for integration, there may be increased efficiency of asset allocation and management by integrators as well. That is, vertical integrators will no longer need to dilute their capital through capital investments in multiple supply chain segments. This comment leads to what we believe to be the central economic structure question of e-commerce in agriculture: Can e-commerce in combination with digital information technologies mitigate incentives for rapid consolidation and vertical integration?

Regulatory Issues and The Role of Government

To this point, the Internet has resembled a free-for-all competition among businesses attempting to market themselves as market intermediaries and contractual facilitators. Nevertheless, there is a rising need for regulation to influence the future development of the Internet. Three regulatory issues are as old as markets themselves: market fairness, taxation issues, and intellectual property regulations. A new issue, which will also affect agriculture, is privacy. Most of the physical world issues of market function are similar: providing accurate weights and measures, representation of product, and delivery requirements are all handled under existing common contract law or other commerce laws. As noted earlier, eBay is currently embroiled in the issue of shill bidding in their auction markets, including markets for rare coins. While eBay stands to lose a great deal in terms of reputation and credibility, there are no external regulations on the conduct of their auctions. Given similar potential problems for electronic agricultural commerce, there is no agency that regulates electronic trading of physical assets. While the Commodity Futures Trading Commission has rules governing all futures contracts whether electronically or physically traded, no regulations deal with the type of electronic spot markets and contractual facilitators, which have grown up over the past three years. Effective regulation of these markets will have important implications for ensuring fair and valid exchanges in agricultural commodity markets.

The privacy issue is also potentially problematic. Digital information is easily storable and the computer technology that collects it also allows for sophisticated analysis. The most valuable use of this information is in tracking purchasing habits or sales habits of suppliers. The utilization of historical purchasing patterns is known as "push" marketing. Input suppliers may be able to monitor the buying habits of producers and thereby use sophisticated marketing techniques to direct their future buying patterns. For example, a producer who purchases herbicide resistant crop varieties will likely be pushed towards herbicide suppliers with compatible products. Although this can be helpful in assisting producers in bundling appropriate technologies, a producer must be cognizant of who receives what information and how it will be used. Alternatively, if there are open exposure rules, buyers can more easily monitor the historic behavior of suppliers and act strategically in markets or contracts to obtain rents from the exchange process.

We mentioned earlier in this paper that there are consortia of existing agribusiness firms that have joined to create e-commerce platforms. In the case of livestock, owners of one e-commerce platform control approximately 70-80% of the total meat processing capacity in the United States. The obvious concern raised is one of collusion and price-fixing. Given that electronic information can be shared very efficiently, it would be quite easy for them to simply link buying protocols and begin to manipulate markets. Years of investigation of pricing practices in the livestock and packing industry have mostly been fruitless due to a lack of documented pricing practices. As such, while electronic markets present challenges to regulators as noted above, the digitization of this process leaves an electronic trail, which could actually provide an excellent vehicle for monitoring transactions and verifying trading practices. Up to this time, regulatory agencies such as the Grain Inspection and Packers and Stockyards Association and the Justice Department have been slow to move on how to address the new world of e-commerce and competition.

Summary, Conclusions, and Suggestions for Research Priorities

The theoretical and real-world concerns we have voiced in this paper beg the question of how the Internet and information technology can and will be exploited. Throughout the paper, the idea has surfaced that electronic-commerce and exchanges may have profound effects on the organization and structure of agriculture. These structural impacts will be both direct and indirect. The direct structural impacts will be created by *who develops* agricultural e-commerce applications. The indirect impacts will be from *how the use* of the Internet begins to alter market dynamics and firm behavior as information and communications improve.

As suggested above, various business models have been used in the last few years to develop business-to-business exchange mechanisms for the Internet. The early mechanisms were extremely simple auction or posted-price mechanisms; however, these mechanisms were far too crude to meet the needs of an increasingly complex agri-food sector, which demand traceability of goods, efficient transactional modes, and adequate market liquidity. While electronic commerce is currently undergoing some growing pains, it will become a ubiquitous fact of trade in coming years. To the extent electronic commerce mediates transactions costs and improves information access and exchange, there is the potential to reduce incentives for vertical integration and vertical contractual coordination. For open electronic agricultural markets to survive they must achieve adequate liquidity and provide sufficient utility to participants by: (1) cooperating among themselves to allow for cross-listing/bidding or by merging, and (2) provide mechanisms that allow for a variety of transactions from simple to complex within some form of auction or exchange framework. The first of these will provide adequate market size to allow such auctions to effectively match buyers and sellers, and the second of these will allow buyers and/or sellers to obtain a complex bundle of goods and services very rapidly and thereby eliminate the transaction efficiency advantage of traditional contracting approaches.

The corollary to the efficiency improvements for open exchange mechanisms is that to the extent e-commerce improves management information systems and logistics control, it may also improve the efficiency of integrated systems. If integrated firms, firms using contracts and private networks are to persist, they must leverage their current transaction economies on the Internet and thereby trump the efficiency gains of open exchanges. Given the potentially greater profit motive for participating firms and intermediaries in private arrangements, many companies have and are investing in private network building.

In the end, we have illustrated the competitive benchmark for electronic market systems — they must offer at least the benefits of vertical integration and contracting or they will not supplant or even exist in parallel with such mechanisms. Electronic logistics may offer possibilities for independent producers as well. In particular, electronic traceability can spread benefits of branding and consumer access to smaller operations, which had previously been unable to maintain identity or obtain access. The outcomes of the broader e-commerce structural impacts will rest directly on how effectively electronic logistics platforms are developed and if efficient electronic exchange mechanisms are developed. Otherwise, Internet-based e-commerce is as likely to narrow agricultural supply chains as to expand their scope. The only certainty is that electronic commerce will alter the nature of firm interaction. Individual producers must be aware of the potential strategic implications if they are to take maximum advantage of this new technology. What will be the nature of the agricultural firm and market in the age of the Internet?

In answering this broad question, researchers and policy makers must break it down into a number of smaller but still extremely complex tasks and questions. In closing this work, we present a view and summary on research priorities for more rigorous analysis of the impact of electronic commerce on agricultural firms and industrial structure. Using our current knowledge, we must arrive at clear definitions of product differences and dimensions in agriculture. Furthermore, we must catalog from studies already performed the different industrial structures across commodities and products in agriculture. Efforts must be made to incorporate the literature on technology adoption in agriculture as well as that on information technology adoption in other industries/sectors to derive a conceptual and empirical framework for the adoption of Internet technology in agriculture. While this issue is related to others, gaining insights into this area will help us to understand better the rate at which the Internet's mechanisms will affect relations within agricultural industries.

As discussed, there are several important issues with regard to the development of Internet intermediaries. Particularly, researchers need to develop a conceptual model describing the qualities of business models of Internet intermediaries that survive. As an initial approach, researchers should investigate currently successful firms as a basis for this research, and then attempt to model how successful firms will operate and in which industries they will work. Important questions are the following. What factors determine the methods by which firms overcome problems of network externalities among competing exchanges? What industrial specific factors affect this choice? In this same context, we should investigate theories that will help us to explain ownership of intermediaries (i.e., which parties have the greatest incentives to own "intermediaries," producers, processors, third parties?). Importantly, how will ownership affect the portfolio of exchange mechanisms and services provided by different types of intermediaries? We can use information on different products and their industrial structures to attempt to catalog how different products may give rise to different intermediary structures.

Another question, which is quite relevant given the current status of Internet commerce in agriculture, is what type of auction markets would be preferred (aside from the question of whether any would be preferred at all). That is, if we believe that auction markets will not dominate but will still play a role in helping firms to sell surplus production or make capacity goals for processing, we should develop theory explaining auction mechanism choice when only small proportion of inputs are derived from processors through auctions. Which participants gain and lose from different mechanisms in a direct sense? How does the commodity specific industry structure affect this choice? How might this price discovery process affect the structure of contracts?

Perhaps one of the most complex problems we have discussed is competition among exchange mechanisms (i.e., between auctions, contracts, and vertical integration). Will the search, match, aggregation, and monitoring cost reduction reduce contracting relative to auction markets over the long run and in what type of industries? Will there be auction bidding for contracts as networks or as open mechanisms? Similarly, will monitoring cost reduction and related traceability capabilities of the Internet increase or reduce vertical integration?

While not discussed at length in the paper, we must also consider how Internet technology will affect horizontal relationships within agricultural industries. What aspects of those industries when interacted with the cost reducing capacities of the Internet will lead to more horizontal integration in the processor and or producer levels? For example, regardless of regulatory impediments, does the ability to share and manage information increase the incentive of North Carolina integrated firms to buy out Midwestern processors?

The Internet and associated information technologies will affect businesses and industries throughout agriculture. In the context of agricultural economics, as we better understand how information technology affects agricultural markets, we will be able to contribute clearer suggestions and proposals to businesses and government with regard to development and regulation of these markets and their physical counterparts.

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