The Dynamics of Information Technology-Driven Change and Agribusiness Tomorrow

S. T. Sonka and T. A. Doehring
University of Illinois, Urbana, Illinois and
Agricultural Education & Consulting, Savoy, Illinois[1]

Abstract

The incessant nature of change in capitalistic systems has been exemplified by the effect of information technology, especially the Web, on the US economy. A key strategic question for agricultural managers is how those forces of creative destruction will unleash themselves in the food and agricultural sector. This paper describes the strategic evolution by which information technologies can interact with market and social needs to fuel the development of a knowledge-creating system with agriculture. Four new capabilities are identified that will be required for the production agriculture segment of the sector to perform effectively in a knowledge-creating world. Opportunities and challenges for sector managers also are defined.

Introduction

"The full importance of an epoch-making idea is often not perceived in the generation it is made… A new discovery is seldom fully effective for practical purposes till many minor improvements and subsidiary discoveries have gathered themselves around it." (Alfred Marshall as quoted in The Economist)

Although Marshall's quote was written more than 100 years ago, it is amazingly consistent of our perspective of how the Web will ***redefine*** agribusiness in the future. The insight provided by Marshall and, in our opinion, the key to anticipating the dynamic changes facing the sector is to understand that redefinition does not come from the technology itself. Rather redefinition comes from the complex interactions of the technology, internal changes in the sector, and external pressures on the sector.

Adopting this strategic perspective, this paper will describe the strategic evolution by which information technologies can interact with market and social needs to fuel the development of a knowledge-creating system with agriculture. The result of this process would be the redefinition of agriculture as a knowledge-creating system. The second segment of the paper identifies four capabilities that will be needed at the production agriculture segment of the sector. Redefinition of an industry always provides both opportunities and challenges for sector managers. Therefore the paper's third section provides three key managerial implications related to the potential redefinition of the sector and the Web's role in that process.

[1] Steve Sonka holds the Soybean Industry Chair in Agricultural Strategy at the University of Illinois at Urbana-Champaign and is a partner in Agricultural Education & Consulting, a financial and strategic management consulting firm in Savoy, Illinois. Todd Doehring is a Management Consultant with Agricultural Education & Consulting.

Precision Agriculture and Knowledge Creation

The use of precision agriculture allows information that formerly was only available tacitly to now be available explicitly[2]. The crop yield monitor is an interesting illustration. Crop farmers are, and probably always have been, passionately interested in knowing how their own crops are yielding. Conversations among farmers during harvest typically include a discussion of yields. Historically, numerous clues were employed; such as how many "rounds" it took to fill a wagon or the sound of the combine engine. The information created was tacit in nature but the judgments formed by that knowledge influenced future decisions. The use of yield monitors now provides that information in an explicit form.

Employing information technology to make information explicit that formerly was available only tacitly is an example of technology enhancing the separability of transaction information. Separability refers to the extent to which specific information attributes can be captured in association with each transaction. However, separability by itself is not sufficient to fuel strategic change. In addition aggregation potential must exist and be exploited. Aggregation potential refers to the extent to which those information attributes can be leveraged to gain economic value beyond the purpose of the original transaction. Sampler has documented that separability and aggregation potential are the key characteristics needed for information technology to redefine industries.

The geographic dispersion and biologic uncertainty inherent in production agriculture suggest that it may be difficult for the individual producer to aggregate information and to perform the sophisticated analysis required to achieve the knowledge spiral that ultimately might be available. New tools are needed to achieve those goals.

Electronic communications and the Web are affecting activity throughout the economy, allowing aggregation potentials to be exploited and by fueling the knowledge spiral. Adoption of these technologies in production agriculture currently lags behind the sectors that are most advanced in this area. However, that doesn't necessarily mean that such adoption will not occur in the future. For example, production contracts for identity preserved grain are being executed over the Web via the OSCAR (Optimum Sales Connection and Resource) system.

Another indication of the potential for use of these technologies in production agriculture is provided by the Cyberfarm experience (Sonka and Coaldrake). Cyberfarm is an Internet web site created by a group of Illinois farmers and local agribusiness managers. The group's goal is to identify the capabilities that they would like to see this technology provide to improve their business performance.

Meeting informally over the last few years, the group has identified a number of applications that they see as relevant and potentially valuable to them. For example:

- "Posting" yield maps to web sites so that crop consultants and advisors can examine and evaluate that information in preparing recommendations for future action.
- Preparing a landowner's diary web site, where landowners (who often do not reside in the local area) can be kept informed about weather, production, and marketing conditions on an on-going basis.

[2] Explicit knowledge refers to knowledge that is transmittable in formal, systematic language. Definitions, equations and theories in journal articles and textbooks are examples of explicit knowledge. Tacit knowledge refers to the "mental models" that all decision makers possess of "how the world works". Tacit knowledge also can be thought of as know-how, experience and skill that we all use (Nonaka and Takeuchi).

- Having crop scouts take digital photos of problem areas in fields that then can be communicated to producers on web sites; so that the producers might be able to decide upon actions without physically visiting the site.
- Being able to retrieve transaction data from elevators regarding quantities and quality conditions of grain delivered by the producer.

Although only a few of the applications identified by this group, these illustrate that communication between producers and their suppliers, advisors, and customers is perceived as a high priority need. This should not be surprising because these applications are analogous to important applications of information technology in other sectors.

The Cyberfarm applications are intriguingly consistent with the concept of aggregation potential. The Web offers the capability to aggregate information from production agricultural sites at much lower cost than ever before available. This means that knowledge creation within agriculture could be based upon data from actual farm operations.

This could be a breakthrough of monumental proportions. Throughout the manufacturing sector profound improvements have occurred when systems were implemented that could effectively employ data from their own operations to learn how to reduce costs and improve quality. Also rigorous analysis of the transformation of the banking and retail sectors documented that simply using information technology to capture data provided minimal advantage to firms. Rather it is through analysis of aggregated data and effective use of that new knowledge that competitive advantage is gained.

A Knowledge-creating Agriculture

Just as it was critically important to examine adoption of information technology across the economy to obtain insights relative to the evolution of precision agriculture, it also is useful to consider changes occurring in the non-production segments of the agricultural value chain. This section will consider these broader sector dimensions.

Figure 1 depicts the agricultural value chain as comprised of five segments; from genetics (input suppliers) to consumers (end users). (Certainly this is a very general depiction of the segments within the sector and is only one of many characterizations that could be drawn.) In this figure, physical product is shown as flowing from left to right with cash flowing from right to left through the sector. Information, however, is shown as flowing only from one subsector to the next.

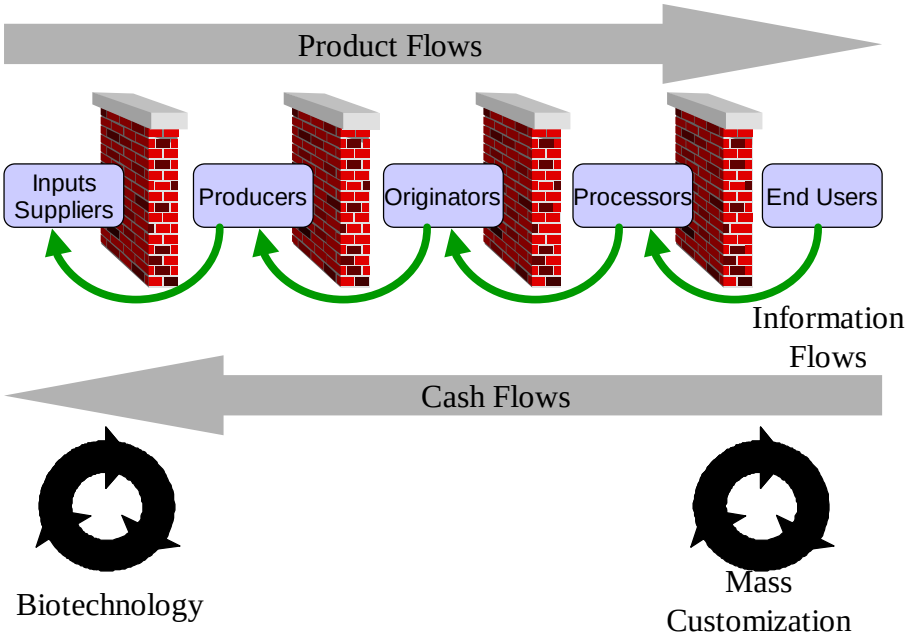

Figure 1. The evolving agricultural value chain.

The commodity nature of the sector is visually depicted with brick walls drawn between each segment. This commodity orientation has important implications. First the capability to coordinate a large and diverse sector such as agriculture with minimal information flow throughout the sector has been a major strength. This is one reason that American agriculture has been successful. However, one side effect of this structure is that knowledge creation tends to be concentrated within each segment in the chain rather than across the chain.

Another feature of Figure 1 is the notation indicating that knowledge creation through the use of information technology is occurring in non-production ag segments of the sector. Downstream in the sector (towards the right edge) technologies are being employed to provide consumer offerings that are ever more finely tuned to meet the desires of ever smaller consumer segments. The phrase, mass customization, describes this trend. Here the goal is to provide products and services that are customized to meet specific consumer needs but at the low cost levels formerly available only through mass production. Information technologies are critical to these developments.

At the very upstream edge of the sector (towards the left side of Figure 1), profound changes also are occurring. Clearly the advent of biotechnology and the initial widespread adoption of genetically modified crops have been well documented. Interestingly, biotechnology too can be thought of in the context of the separability and aggregation potential concepts. The relevant transaction can be thought of as passing genetic characteristics from one generation to the next. Therefore today's advances in biotechnology techniques can be conceptualized in terms of the specificity of the information that is being transferred as we're now able to explicitly separate more information attributes with each transaction. Further the area of bioinformatics focuses on the identification of potentially valuable sequences across phenomenally large and diverse data sets; analogous to the aggregation potential concept.

Figure 1 shows two large knowledge spirals (Nonaka and Takeuchi) to depict the influences of biotechnology and mass customization. This depiction highlights the gap existing at the level of production agriculture. Capitalistic market economies exist to creatively destroy such economic gaps. At least potentially, precision agriculture (defined to include electronic communications) will provide tools instrumental in filling this gap.

The result of this process is the redefinition of agriculture as a knowledge-creating system. Drawing upon experiences in other sectors, it appears that four capabilities will be needed within production agriculture to effectively operate within such a system. Those four capabilities are:

1. Estimation of the effect of production agriculture operations on customer value,
2. Quantification of the economic and agronomic results of on-going farm operations,
3. Provision of credible evidence that farm operations conform to societal expectations (environment and food safety), and
4. Linkage to the research systems that will produce knowledge to fine tune current operations and to create the next generation of agricultural capabilities.

Managerial Implications

Redefinition of an industry always provides both opportunities and challenges for sector managers. Three key managerial implications are particularly important relative to the potential redefinition of the sector and the Web's role in that process.

Be aware of the interactions of biotechnology, precision agriculture and electronic communications

From the viewpoint of knowledge creation, production agriculture is not the only component of the sector that is undergoing substantial change. Similar forces exist across the sector. Further, advances in biotechnology, precision agriculture, and electronic communications are likely to be synergistic in their application.

Indeed it is informative to think about three knowledge bases being created in the sector that have not existed in the past. These relate to biotechnology, precision agriculture, and mass customization for customers and consumers. Interestingly, fully exploiting the potentials of each individual knowledge base requires interaction among the three.

Consider the timing and sources of value that drive adoption

Considerable excitement and enthusiasm exist regarding precision agriculture. However, it's difficult to identify large direct benefits for specific applications. When quantified, the benefits appear to be positive but relatively small. The benefits that are learned by aggregate analysis of previously unavailable data, however, can turn out to be strategically vital. In such settings, a series of valid short-run decisions to not adopt can turn out to have been strategically disastrous.

In such situations, prior experience in the sector often is not helpful; sometimes it is detrimental. Instead it is necessary to speculate as to potential futures. Drawing upon experience in other industries and conceptual frameworks from economics and strategy, it is possible to speculate regarding the Web's role in value creation:

- Decision makers will strive to make tacit data explicit for transaction elements that are important to them. Therefore adoption of yield monitors is occurring even if direct economic benefits can not be quantified.
- It is likely that aggregation across farm firms will be needed to achieve significant economic benefits.
- Aggregation can provide economic benefits through three means:
    1. Enhancing market coordination for farm output,
    2. Reducing cost inefficiencies between input suppliers and producers, and

3. Developing new agronomic paradigms to directly improve crop production.

- Interestingly, most attention has been devoted to the third means (agronomic paradigm improvement). However, because of biologic uncertainty and because new research paradigms will be required, this is the most difficult of the three approaches and likely will require several years before improvements will be forthcoming. Conversely market coordination benefits and cost reductions do not require new science to be usefully employed. Instead, communication and novel sector linkages have been the key missing links to enhancing performance in these areas.

Managing intangibles becomes increasingly important

Historically, control of physical assets has been of critical importance in production agriculture. The quality and amount of land, livestock, buildings and equipment have been, are, and will continue to be key factors affecting farm profitability. However, experience from other sectors stresses that intangible, knowledge-based assets will become increasingly important.

If precision agriculture and electronic communications enhance sector coordination and performance as suggested in the prior sections, the most effective managers will need to enhance their skill sets to include management of intangibles. Doing so is likely to include actions such as the following:

- Building information linkages and relationships across the sector value chain,
- Actively enhancing information management capabilities, even if immediate direct economic benefits are not expected to be large,
- Being able to test and evaluate alternative production systems before the effectiveness of those systems is widely known in the market,
- Monitoring economic and market developments across the agricultural value chain and in other sectors,
- Understanding both the operational and strategic benefits of technologies that create knowledge in the sector.

Summary

The incessant nature of change in capitalistic systems has been exemplified by the effect of information technology on US industries and its economy. Application of advanced information technologies has enhanced consumer goods, altered production systems, and redefined market systems and, in doing so, has creatively destroyed numerous elements of the American economy. A key strategic question for agricultural managers is how those forces of creative destruction will unleash themselves in the food and agricultural sector. New insights, skills, and capabilities, such as those outlined above, will be needed to respond to and exploit those creative forces.

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