Current Agriculture, Food & Resource Issues

A Journal of the Canadian Agricultural Economics Society

Impact of Identity Preservation of Non-GMO Crops on the Grain Market System

Jennifer M. Vandeburg, Joan R. Fulton, Frank J. Dooley, and Paul V. Preckel
Research Associate, Assistant Professor, Associate Professor, and Professor, respectively, Department of Agricultural Economics, Purdue University[1]

The Issue

The events of 1999 highlight the importance of the need for identity preservation (IP) of products that result from genetic modification. In April of 1999, Archer Daniels Midland Co. and A. E. Staley Co. announced that they would not accept product that was not approved for export to the European Union. By the time the 1999 harvest arrived, decision makers in the grain marketing industry realized the nature of their business had dramatically changed in just one growing season. In particular, they needed to preserve the identity of all grains and oilseeds intended for European and Japanese markets.

During the remainder of the 1999 growing season, consumer concern about the safety of genetically modified organisms (GMOs) increased. The need for IP represents a substantial challenge for the grain marketing system, since the system has evolved over time to handle large volumes of homogeneous product. The objective of this study is to examine the impact of IP for GMOs on the grain handling system for a typical region in the eastern corn belt.

Implications and Conclusions

A cost-minimizing linear programming (LP) model is used to track the shipments and costs through the marketing system from farms to grain elevators to grain users. The objective is to minimize total variable costs, subject to grain flow and facility capacity constraints. By examining the impact of alternative configurations of capacity and handling costs, estimates of increases in system costs and grain flows are developed.

This study compares two different grain segregation strategies: segregating grain within the elevator and designating specific elevators as IP-only facilities. As the cost per unit for grain segregation increases, the designated plant strategy becomes the most cost-efficient strategy.

—————— ≋ 29

Introduction

Recent advances in seed breeding and genetics have resulted in a substantial number of new corn and soybean products. In some cases, these new products differ from their commodity counterparts due to different manufacturing properties (e.g., high oil, high starch, or low phytic acid for corn) that imply different best uses for the product. In other cases, different field properties, which are often associated with genetic modifications via biotechnology (e.g., RoundupReady , and Bt), imply marketing restrictions. These differences in manufacturing properties and field performance have resulted in the need for separate handling and tracking of these products, which is often called identity preservation.

Recent events have highlighted the need to preserve the identity of products that result from genetic modification. On April 13, 1999, Archer Daniels Midland Co. and A. E. Staley Co. announced that they would not accept product that was not approved for export to the European Union. During the remainder of the spring and summer of 1999, consumer concern about the safety of GMOs increased in many regions of the world, most notably in Japan and Europe. Even within the U.S. market some consumer groups were suggesting that universal labelling of all food products should be implemented. By the time the 1999 crop was ready for harvest, decision makers in the grain handling system realized that they needed to preserve the identity of all grain and oilseeds intended for the European and Japanese markets. In particular, many of the contracts with European and Japanese buyers stipulated a 99 percent purity of non-GMO product in the delivery.

The impacts of these changes are important. The grain market infrastructure has evolved over time to handle large volumes of homogeneous product and is not structured to efficiently handle IP products. Ideally, a major structural change such as an increased need for IP would be phased in over several years. However, in this instance, the grain handling system did not have the luxury of a phase-in approach – large end-users simply changed the "rules of the game" in mid-season. The 1999 crop needed to be segregated to preserve the identity of the non-GMO product if sales were to be made to Europe and Japan. Another important factor in this situation is the relative volume of GMO and non-GMO product. Depending on the region of the country, GMO corn and soybeans represent between 40 percent and 70 percent of total production. Increased requirements for IP present significant challenges for the grain marketing system.

The objective of this study is to examine the impact of identity preservation for GMOs on the grain handling system. The following section describes the model used in this analysis along with the alternative scenarios that are examined. The results of the analysis are reported in the third section along with a discussion of implications for the grain marketing system. The final section contains conclusions and suggestions for future research.

The Model

A transshipment model, using the variable costs associated with moving grain through the market system from the farm gate to the end user receiving pit, is employed. This linear programming (LP) formulation takes into account costs of handling, segregation, and storage at elevators. In addition, costs of shipping grain from the farm to the elevators, between elevators, and to end-users are included.

The objective for the model is to minimize total variable cost, which is the sum of elevator handling cost, elevator segregation cost, transportation cost from farmer to elevator and elevator to end-user, and elevator storage cost. Grain is transported by truck or rail and flows from the farm, through the elevator, to the end-user. Grain flow is restricted by five constraints: the rate at which grain disappears from the farms, maximum receiving capacity for each elevator, maximum storage capacity for each elevator, maximum shipping capacity for each elevator, and user demand. The model covers one crop year, which is divided into quarters.

The system consists of a 50-mile by 50-mile region in the eastern corn belt of the United States. Corn yield for this region is assumed to be 130 bushels per acre, and soybean yield is assumed to be 45 bushels per acre. The farms are distributed evenly throughout the market region. Each farm's acreage is divided evenly between corn and soybean production. Disappearance of grain from the farms is highest in the first quarter and declines in each quarter thereafter, to reflect actual flow patterns in a typical year in the region.

Grain flows from the farms to thirty-one elevators, which are divided between four classes of elevators (A, B, C, and D) based on size and shipping ability. Class A and B elevators are smaller facilities that ship only by truck. Class C and D elevators are larger and are able to ship grain by truck or rail. All elevators receive grain by truck. Grain may also be transshipped from Class A and B facilities to Class C and D elevators. Complete details of this model are found in Vandeburg (1999) and reflect the current structure of grain elevators in the eastern corn belt. Elevator handling costs, per bushel, are based on information obtained from interviews with industry experts. Due to economies of scale, handling costs per bushel decrease as the size of the facility increases. Handling cost at a Class A facility is eight cents per bushel; at a Class B facility, five cents; at a Class C facility, three cents; and at a Class D facility, two cents.

There are seventeen end-users in the system. Of the end-users located within the model market region, some receive grain only by truck and others receive grain by truck or rail. There are also end-users located outside the market region, and they receive grain only by rail. One set of out-of-region users is in the Southeast of the United States, and the other set is on the Illinois River. User demand is high in the first quarter, peaks in the second quarter and declines thereafter, reflecting the typical flow of grain during the market year.

Grain is transported by truck or rail. Truck freight rates are based on interviews with industry experts. The farm-to-elevator rate is five cents per bushel plus two-tenths of a cent

per bushel per loaded mile. The elevator-to-elevator rate is one cent per bushel plus two-tenths of a cent per bushel per loaded mile. This reduced freight rate is based on the assumption that, due to the speed with which an elevator can load a truck, the fixed loading fee would be lower.

Rail shipments are assumed to be either fifty- or one hundred-car unit trains. Rail freight rates are determined using the Uniform Railroad Costing System Phase III Movement Costing Program (Interstate Commerce Commission, 1990).

Within the market region there are two multiplant grain handling firms as well as several single-plant independent firms. The groups of elevators operated by these multiplant firms are comprised of a variety of elevator sizes, with different handling costs for each class. The handling costs for these multiplant firms are aggregated into a whole-firm weighted average handling cost, which is applied to all of the firm's facilities, regardless of size. As is often found with locally owned cooperatives, these plants are operated as a group, instead of as independent profit centers.

We examined four scenarios. Scenario one, the base case, involves only the production and handling of commodity corn and commodity soybeans. There are no restrictions on grain flow with respect to the elevators used.

Scenario two, the In-House Segregation with Low Segregation Cost case, involves the need to preserve the identity of crops. In this scenario, there are four crops in the system: commodity corn, commodity soybeans, IP corn, and IP soybeans. IP corn and IP soybeans are assumed to have the same crop yields as their commodity counterparts. The non-GMO corn and non-GMO soybeans are modeled as the IP crops, since they will lose value if contaminated with GMO crop. The total volume of IP grain is modeled as 65 percent of the corn crop and 45 percent of the soybean crop, representing the actual production patterns in the eastern corn belt in 1999. Each elevator in the system can handle any of the four crops. The costs of segregation are adapted from Herrman and Boland (1999), Hurburgh (1994), and Vandeburg (1999) and differ by elevator type. In this model the segregation costs are six and a half cents per bushel for Class A, four and a half cents per bushel for Class B, three cents per bushel for Class C, and two cents per bushel for Class D elevators. Segregation costs apply to all bushels of IP crop. There are no segregation costs for the commodity crop.

Scenario three, the In-House Segregation with High Segregation Cost case, is the same as scenario two except that segregation costs are doubled. Scenario three is introduced to examine the impact of altering segregation costs. Since the practice of IP of grains is new for many participants in the grain handling system, only limited research has been performed to measure segregation and IP costs. Experience is already starting to show that the actual costs of IP are higher than previously estimated. In particular, testing cost is greater for products with tight purity requirements, such as non-GMO grains, as compared to products like high-oil corn. In the case of non-GMO grain shipments, there is also the risk of a shipment being rejected for not meeting the purity requirements when it reaches the buyer. The cost of find-

ing a new buyer for the contaminated shipment can be high and increases with the size of shipment. This supports the importance of considering a scenario with higher segregation costs.

Scenario four, the Designated Plant case, has the four crops: commodity corn, commodity soybeans, IP corn, and IP soybeans. With this strategy, specific designated elevators receive only IP grains, so these crops are isolated from the commodity crops. IP grains may not be received at the other elevators. Since the designated facilities can now operate normally, without segregation concerns, no segregation cost is assessed. In reality, setting aside a grain elevator for a single commodity is only a feasible strategy for firms with multiple plants, so in our model the designated plants are always those that are part of a multiplant firm.

Results

Of key interest is the composition of costs for each of the four scenarios. Shipping, handling, segregation and total costs for all four scenarios are displayed in table 1. In each of the three IP cases (scenarios 2 to 4), total costs increase in the range of 3 percent to 9 percent over the base case. The greatest cost increase occurs for the case where all elevators potentially handle a mix of commodity and IP grains, and the segregation costs are high. If segregation costs are low, or if only designated elevators handle IP grains, then the additional costs to the system are at the low end of the range at 3 percent to 5 percent. Thus, the increased transportation costs, as well as the increase in handling costs, under the dedicated plant scenario (4) are more than offset by the elimination of segregation costs.

Since the magnitude of segregation costs is uncertain at this time, perhaps the best strategy is to segregate grain using the designated plant strategy. As new investments in storage and grain handling capacity are installed over time, incremental costs of allowing for IP grains in the system will fall. At that time, it may be worthwhile to reconsider the decision between in-house segregation and the designated plant strategy.

Table 1 Selected Costs for All Four Scenarios

Scenario	Shipping cost ($millions)	Handling cost ($millions)	Segregation cost ($millions)	Total cost ($millions)
1 Base case	30.834	3.663	0.000	37.540
2 In-House Segregation, Low Segregation Costs	31.134	3.554	1.726	39.456
3 In-House Segregation, High Segregation Costs	31.312	3.515	3.263	41.132
4 Designated Plant	31.635	4.099	0.000	38.776

Conclusions and Further Research

There are noteworthy cost differences across the alternative scenarios. The designated plant strategy had lower total costs than either in-house segregation strategy. As the cost of maintaining IP increases, using designated plants becomes the cost-effective strategy.

The results reported here, combined with those reported by Vandeburg, suggest important implications for the designation of specific elevators as IP-only facilities. In particular, we conclude that the volume of IP grain relative to the total volume of grain handled influences whether it is cost effective to designate specific elevators as IP-only facilities.

Vandeburg's analysis involved small volumes, relative to total volumes, of IP grains (such as a value-added crop like high-oil corn). The conclusion from that analysis was that it is only cost effective to designate IP-only facilities when the processor of the product is local. In Vandeburg, the smaller, truck-only elevators were designated as IP-only facilities since the small volume of IP grain could not warrant designation of a larger rail facility. If the processor is local, where truck transportation from the elevator is the most efficient, then the designation of the small elevators as IP-only can be cost effective. If, however, rail transportation from the elevator to the processor is most efficient, the designation of the smaller elevators as IP-only is cost prohibitive. In this latter case, additional handling and transportation costs, to move the grain from the designated facility to the train loading facility, make the scenario unattractive.

The results of the research presented here provide a different and important message when it comes to decisions to designate elevators as IP-only. When the volume of IP grain is large relative to the total volume of grain handled, as is the case with the GMO/non-GMO situation, designation of facilities can be an attractive alternative even when the end user is located outside the market region. With large volumes of grain requiring IP, the facilities being designated are larger elevators that have lower handling costs and are able to ship by rail.

Uncertainty regarding the cost of segregation also makes the designated plant strategy the preferred one for some decision makers. The segregation costs used in this analysis include only direct costs and incorporate the expense of one specific testing method as examined by Herrman and Boland and by Hurburgh. The cost of testing for GMO grain can be much higher than the costs examined in the above-noted studies. In particular, these costs depend on the purity level and trace-back protocols required by the buyer. In addition, indirect costs related to the risk of contamination, such as having a shipment rejected by a processor, can be extremely high. In reaction to this problem, elevators are already using the designated plant strategy, as mentioned in Kilman (1999).

While applicable to any grain handling firm, the results of this study are of particular interest to grain marketing cooperatives. Many are multiplant firms and are facing the decision on how to best utilize a variety of facilities, including small, aging elevators. Our results indicate that designating a specific elevator as an IP-only plant may be a cost-effective oppor-

tunity for a multiplant cooperative. In addition, there are potential spillover effects for cooperatives since they now have the opportunity to team their agronomy and grain divisions to provide a greater bundle of information about the IP grains they market.

Two important areas for further research are further evaluation of all the costs associated with handling, segregating and preserving the identity of grain and expansion of the model to a profit maximization model. The best information currently available on grain handling costs is the expert opinion of industry sources and dated published research. There has been virtually no published research in the last ten years that examines costs of grain handling. In terms of the cost of segregation, the limited study that has been conducted on segregated grain handling (Herrman and Boland, 1999; Hurburgh, 1994) has focused on the direct cost of segregating grain at the elevator and not on the full cost of IP.

Expanding the model to a profit maximization model would allow examination of alternative premium structures on the IP crops. In addition, the impact of capital investments for facility upgrades for identity preservation could be evaluated.

References

Herrman, Tim and Mike Boland. 1999. Segregation strategies. *Feed and Grain* February/March: 20-24.

Hurburgh, Charles R., Jr. 1994. Identification and segregation of high-value soybeans at a country elevator. *Journal of American Oil Chemists Society* 71(10): 1073-1078.

Interstate Commerce Commission. 1990. *Movement Costing Program, Uniform Railroad Costing System Phase III.* Washington, DC.

Kilman, Scott. 1999. Seeds of doubt: Once quick converts, midwest farmers lose faith in biotech crops. *Wall Street Journal* 19 November.

Vandeburg, Jennifer M. 1999. The Cost of Handling Value-Added Grains by Multiplant Grain Marketing Cooperatives. Master of Science Thesis. West Lafayette: Purdue University, Department of Agricultural Economics.