CHANNELING, IDENTITY PRESERVATION AND THE VALUE CHAIN:

LESSONS FROM THE RECENT PROBLEMS WITH STARLINK CORN

Roger G. Ginder
Department of Economics Department
Iowa State University
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Biotech grains hold great promise for both producers and consumers but a thorough understanding of the value chain will be vitally important in realizing that potential. Biotech grains with input traits not approved for all uses can pose a serious problem for the grain handling and processing industry as they move through the value chain. This problem occurs because there is no premium to cover added costs of segregation and handling input trait grains after harvest. In the case of Starlink the manufacturer is currently providing a defacto premium to producers and elevators to make the channeling effort effective.

Output trait grains not approved for all uses may also create a problem if due care is not used. However the existence of a premium over the market price for commodity grain provides a positive incentive to create a separate and distinct logistics channel for these products. Experience with Starlink indicates that attempting to channel a product that is not acceptable for all uses without a premium can inflict significant uncompensated costs on the output side of the value chain. These costs may include market discounts and are typically incurred by firms who do not receive any meaningful gain from the sale of the trait.

Biotech special trait grain products promise to yield benefits for both producers and consumers in the future. Despite the current contentious debate, innovations are being introduced and some biotech grains are already being used to provide increased productivity and other consumer benefits. However for the potential benefits to be realized it is necessary to understand fully how the value chain for grain and soybeans operates and to avoid adding costs which the value of the traits do not cover. The recent experience with Starlink -- a corn hybrid not approved for all uses -- has provided some valuable (and expensive) insights into how the value chain is likely to respond to the introduction of biotech products in the future. In particular some critical differences between input trait and output trait biotech products with are now more apparent.

An attempt to channel Starlink grain into livestock uses has demonstrated the difficulty and serious problems associated with channeling certain types of biotech products. Starlink was this kind of product. The trait added value on the input side of the value chain, but was not approved for all uses and was not acceptable to significant customers on the output side of the chain. There was an unsuccessful attempt to channel this product to livestock feed uses with no premium offered on the output side of the value chain to cover the added costs or losses of market opportunity associated with grain not suitable for all uses. The result was not only inadvertent commingling with non-Starlink grain, but also a split in the market value for Starlink and grain that had been commingled with it. The known cost to the genetics developer has to date been large and the total cost externalized on the value chain has not yet been determined.

This problem indicates that channeling efforts will need to be more carefully evaluated with respect to incentives and costs at various points in the value chain if similar problems are to be avoided in the future. An understanding of the global grain marketing system is critical in developing successful channeling programs. It is especially important to understand: (1.) the interdependence among firms in the value chain (2.) the nature and economics of the bulk commodity logistics system for grain that has no specialized end use value and (3.) the importance of intermediate and final customer preferences (4.) the need to meet regulatory requirements of the U.S. and its major export customers. These characteristics combined to create the split in market price between Starlink and standard commodity grain and generated added logistics and marketing costs.

The Value Chain For Grains

The value chain begins with the genetics technology provider and ends with sale to the final consumer. The activities at each level in the chain provide or contribute to added value for the ultimate consumer. For purposes of analysis the chain is often divided into two parts with production of raw agricultural product at the center. Those activities in the chain prior to production are often termed input side activities. These are shown in Fig. 1. Activities in the chain after the production level are termed output side activities. These activities are shown in Figure 2.

Traditional hybrids have been developed for the input side of the chain and have typically addressed concerns of producers such as yield, insect resistance, disease resistance, dry-down, ability to withstand lodging, and maturity dates. The grain from these hybrids is then graded based on physical characteristics, commingled with other lots and enters the commodity grain stream. More recently hybrids have been developed using biotech techniques that have input traits such as insect resistance or resistance to specific herbicides.

These have been called input trait biotech hybrids and the farmer must pay a “technology” fee not charged for the more traditional hybrids. The technology fee is necessary to cover the huge costs involved with developing the specialized input traits. Such input trait biotech products address many of the same producer concerns as the traditional hybrids. The main difference between the two is that biotech methods are used to acquire the trait for the input trait biotech hybrids.

Both input and output trait hybrids and varieties must move through the value chain and provide added value at some point in the chain for successful commercialization. Absent some kind of added value on either the input side or the output side there is no incentive for anyone in the value chain to pay any more for seed with the trait than seed without the trait. While the trait may be commercialized under these conditions there will be no added margin (above that for standard commodity hybrids) to cover development costs. Seed retailers and farmers will not pay more for it. Others in the channel will not see any added value in the grain beyond the value of commodity so it will simply be moved into the commodity grain stream.

The grain products produced from either traditional or biotech hybrids must ultimately be acceptable to intermediate users and/or the final consumer. There are three possible responses by end users or intermediate users (e.g., Final consumers, food manufacturers or processors) to grain traits. The three responses exist for traits resulting from either traditional breeding methods or biotech methods. In some cases, users may be indifferent to the genetics in the corn. In that event there is no need or incentive for channeling. The grain can be commingled and sold as suitable for all uses. Where users are indifferent to traits the grain simply moves into the commodity stream.

In other cases users may desire some trait and may be willing to pay a premium price to get it. In such cases the grain cannot move into the commodity stream without diluting the trait or in some cases losing the trait entirely. The premium however must be sufficient to cover the cost of channeling. The consumer must be willing to pay a premium sufficient to cover the added costs of channeling or there is no economic incentive and the product will not be produced.

Finally in some cases users may reject the trait and refuse to purchase it. Users may believe the trait to be unsafe or of questionable safety or regulatory authorities may make it illegal for sale to some end users. In this situation, channeling will be difficult or impossible unless someone in the value chain is willing to incur the added costs for channeling. Starlink fell into this category with some end users refusing to purchase it because it was not approved for human consumption.

The value chain for grains is a true bulk commodity system with a single commodity stream that moves into four distinct end use categories. Grain may move into livestock feed, human food products, industrial uses, or export for any or these three uses. These four categories constantly compete for grain from the commodity stream through both time (future delivery) and space (location differentials to adjust for transportation costs). The market price constantly adjusts. It adjusts instantaneously to compensate for changes in the demand for corn by each of the four major use categories. Price in any location reflects the storage costs, handling costs, interest costs (to carry the inventory) and the transportation cost to the **best** of the four alternative use categories. If corn cannot be shipped to one or two of the categories the ability to obtain the best price is almost certain to be impaired.

Output Trait Grains

Figure 3 represents the value chain for output grain products. Output trait grains incorporate characteristics developed to increase value at the end user level. The chain must channel grain with these characteristics to processors and food manufacturers while preserving the desired trait. In most (but not all) cases, the entire chain is involved from genetics supplier to food retailer. Currently, the grain without specific output trait moves through this chain as broadly defined commodity. It is handled as a bulk commodity and can be commingled; at least until it reaches the processing or food manufacturing level.

Grains with special output traits carry value to the end user beyond what is available from commodity grain. These traits are usually clearly identifiable by handlers, processors, food manufacturers or final consumers (through either visual inspection an or testing) as more valuable than commodity corn. As a consequence grain with these traits will typically command a premium price in the marketplace over commodity grain without those traits.

In order to preserve the value differences in the output trait grain it is necessary to avoid commingling it with commodity grain. The identity of individual output trait lots must be preserved as they move through the chain. Otherwise the value of the trait will be diluted through commingling and in some cases the entire value will be lost. *Firms at each level must exert extra effort and incur extra costs to transport, store, and handle the special trait grain separately from the commodity grain stream if the trait is to be preserved.*

These costs are incurred at each level in the value chain so they are additive. As a general rule the longer the chain the larger the total identity preservation cost. There are also possibilities that grain being channeled will not move through all levels in the value chain. Some levels in the chain may be bypassed as shown in Figure and the grain may move directly to some succeeding level in the chain. This direct movement eliminates some special handling costs at the levels bypassed and helps to reduce costs of trait preservation.

Whatever the path of movement, the integrity of the trait must be maintained until the point in the chain where value can be captured has been reached. This may be the final consumer or another entity in the chain (e.g., food manufacturing firm, or grain processor). There are almost always added costs generated in maintaining the trait at prior levels in the chain. There must be enough added value for the entity capturing the value from the trait to cover these costs with premiums.

It is the promise of the premium that provides incentive for incurring the added costs of trait preservation at each level in the chain. *Without a requirement that the trait be maintained and present before the premium can be obtained, there is little discipline on the firms in the chain to perform. In the absence of such a premium most firms in the chain would be unwilling to incur added costs to preserve the trait.* Even if some firms were to agree to do it without a premium their commitment would be questionable. In all likelihood, it would be a somewhat haphazard attempt with the primary focus on minimizing the added cost of I.P. and a distant secondary focus on strictly maintaining of the trait.

Channeling output traits is successfully accomplished on a regular basis when the value of the trait is sufficiently high to cover the cost of keeping grain with the desired trait segregated as it moves through the chain. Where there is not sufficient premium to cover the costs of identity preservation the output trait grain is produced in very low quantities or not at all. Examples of successful channeled output trait grains include high oil corn, high protein corn, white corn, waxy maize, and high lysine corn. There are likely to be even more of these specialty crops in the future where there is sufficient added value to an end user to cover the cost of identity preserved handling.

Input Trait Grains

Input trait grains are in some ways similar to output trait grains, but their relationship to the output side of the value chain is radically different. The value of input trait grains is captured at the production level**.** Producers are willing to pay extra for these traits because they add value in production of the grain. Generally they increase the harvested yield or reduce the average cost of production in other ways. *Beyond that input trait grains usually add no value in the chain and if fully approved for all uses would simply enter the commodity grain stream.*

Yield, insect resistance, ear-drop drought resistance and other input traits have not been of importance to consumers or firms on the output side of the chain. The value in these traits is usually captured early in the production process before the grain is actually harvested. The grain produced by hybrids with these traits is typically commingled and moves through the chain as commodity grain suitable for use as human food, animal feed, industrial products, or export for any of these uses.

In most cases the output side of the value chain is indifferent to input traits in grains. If there has been any value of input traits to the final consumer or the firms on the output side of the chain it has been the reduction in cost and the higher levels of grain production these traits have provided. Thus there has been no real incentive for identity preservation for these traits once the grain is harvested. Rather than being channeled to some specific end use, grain with input traits typically moves through the chain as grain suitable for all uses with no attempt to segregate and no premium to provide an incentive to segregate**.** For the most part this continues to be the case for input traits. However for some traits developed through biotechnology this is clearly not the case.

For some biotech traits certain end users find the trait is actually a market negative and of less value than standard commodity corn. Some of these buyers totally reject grain containing even minute quantities of the input trait and apply pressure on food manufacturers and retailers to avoid using it. In other cases regulatory authorities may not approve it due to consumer pressure or questions of safety. These situations make grain with the trait unsuitable for all uses. Some of the traits in Starlink are an example. Starlink could not be used in food products because it did not have regulatory approval for human consumption. Input traits that make grain unsuitable for some uses can create serious problems in the chain for undifferentiated bulk commodity grain. Because some end users find the trait to be of negative value a market discount is a real possibility.

The Starlink hybrids provided producers with insect resistance and herbicide resistance. However; the grain was not approved by U.S. (and many foreign countries) regulatory authorities for use in human food. As a compromise the vendors of this seed agreed to channel the grain produced from these hybrids to U.S. approved uses -- domestic livestock feeding and certain domestic industrial uses.

This restriction created costs on the output side of the value chain as the grain moved through the channe; just as would be the case for an output trait. However, there were no premiums (or benefits) beyond the gains at the production level to offset these added costs. The benefits at the production level were gained before the grain was harvested and apparently proved inadequate to induce some producers to strictly isolate and segregate it effectively from standard hybrids.

This result may have occurred in part because producers are unaccustomed to segregating grain with input traits. And since there was no rigorous check for purity required before the benefit could be obtained, as would be the case when there was an output trait premium, farmers had neither an incentive nor a rigorous check for purity at the time of sale. *Even where the Starlink grain was segregated strictly, few producers realized that there might be a discounted price due to the market limitations imposed on grain not approved for all uses. Few people fully understood that commodity grain is priced based on the best price in the four alternative markets that undifferentiated commodity grain is suitable to fill.*

The impact on firms at all levels on the output side of the value chain has also been serious. The failure to strictly segregate at the production level and the subsequent commingling has resulted in significant costs and risks to firms at all levels in the chain from elevators to food retailers. At the core of the problem was the failure to understand that channeling input trait grain to a specific end use is substantially different from channeling output trait grain to an end user who will gain added value and pay a premium for it.

In the case of Starlink the technology provider Aventis provided what was essentially an" *ex-post* premium." Payments were made after the fact in the form of compensation to farmers, dealers, manufacturers, and food manufacturers for added costs associated with Starlink. Only after the technology supplier provided payments to cover the added costs of channeling was the effort to move the grain into proper channels moderately successful. Moreover, the costs of the channeling effort were much larger since widespread commingling with non-Starlink commodity grain had occurred.

Only where there is a premium guiding the grain though the system will firms at each level have a positive incentive to incur the extra costs involved in strict identity preservation**.** Where obtaining the premium is contingent upon effectively segregating grain with the trait at each level in the chain and where there is verification at each level, it is possible to channel input trait grain effectively**.** These conditions at a minimum assure that there is an incentive and compensation for added cost identity preservation at each level where the grain must be segregated.

Conversely the absence of a premium to guide the grain not approved for all uses through the system provides inadequate incentive for strict segregation (even at the producer level) and inflicts extra costs on the output side firms in the value chain. Placing a market restriction on what is actually nothing more than commodity grain leaves no possibility for the producer to receive above the market price for commodity grain. Instead it creates a substantial probability that the producer will receive a price lower than the price received for commodity grain due to the restrictions on use**.** Furthermore; the producer does not know the magnitude of the discount that could be incurred prior to planting the grain. To assure that there will be no discount the producer must price the grain before planting.

This latter set of conditions leaves the producer and others on the output side of the chain with a perverse set of incentives and rewards. Without a premium there is no real economic incentive for segregation beyond harvest. There may, in fact, be a disincentive to carefully channel the input trait grain to restricted uses if the price is discounted from the price of grain suitable for all uses (the equivalent of a negative output premium)**.** To make matters worse there is no positive incentive for testing and verification to assure that conditions are being met.

In reality a negative incentive exists for testing and verification on the output side of the value chain because the firms there will lose substantial value if their inventory becomes commingled with grain not approved for all uses. While it is true that a negative incentive exists for verification on the output side of the channel, there is no added value to fund the verification costs. *Instead the entire cost of verification is externalized to firms and consumers on the output side of the channel who receive none of the benefit from either the production of the trait or the* *use of the trait. Under these circumstances there is an incentive for output side firms to try to "slip it through" to the next level in the chain in order to minimize their losses rather than absorb those costs.*

Conclusions

Several insights gained from the Starlink situation can be of value in the future as more biotech products are brought to market in the future. Among them are the following:

Consumer reaction to genetic modifications is important and may differ in important ways for output traits and input traits. Where consumers either demand a trait or are indifferent to a trait, there is less difficulty associated with channeling efforts. In the first case, consumers are willing to pay a premium to keep the trait separate. In the latter case, the grain can simply enter the commodity stream of grain suitable for all uses

Traits consumers reject or those regulators refuse to approve for all uses can create serious problems for firms on the output side of the value chain. The absence of a premium to cover the costs of channeling the grain produced from these hybrids creates uncompensated costs on the output side of the value chain. In the case of Starlink what amounts to an *ex-poste* premium has been paid in the form of compensation to farmers, handlers, processors, and food manufacturers.

Failure to isolate and segregate effectively can result in large quantities of grain without the trait becoming commingled with the trait. Thus relatively few acres of seed with the trait can affect a large fraction of the total crop. Isolation is especially difficult to achieve in crops that can easily cross-pollinate such as corn.

Grain with input traits not approved for all uses can face discounted prices when farmers attempt to sell them. At best the grain will be sold at the commodity market price, and there is a substantial probability that there will be a discount. This creates a negative incentive for channeling and can result in failure to segregate effectively. To avoid this added price risk the grain must be priced or a commodity reference price must be established prior to planting.

Where input trait grain in the commodity stream is rejected by customers who consume a significant volume of grain or where the trait is not fully approved for use by regulators (domestic or foreign) where grain will be consumed there is potential for significant losses by firms on the output side of the chain. Efforts to channel input trait grains in markets where significant customers have not approved them for uses carries this risk.

Biotech traits are relatively new and their introduction has been a learning experience. The outcomes from Starlink were almost certainly not anticipated when the trait was introduced. If there is a positive side of the experience with Starlink it must come from the knowledge gained in the process. Lessons about how channeling works and about how the introduction of input traits not approved for all uses affects the commodity stream on the output side of the value chain have been expensive, but they provide valuable knowledge for the future.

Figure 1. Input Side of the Value Chain

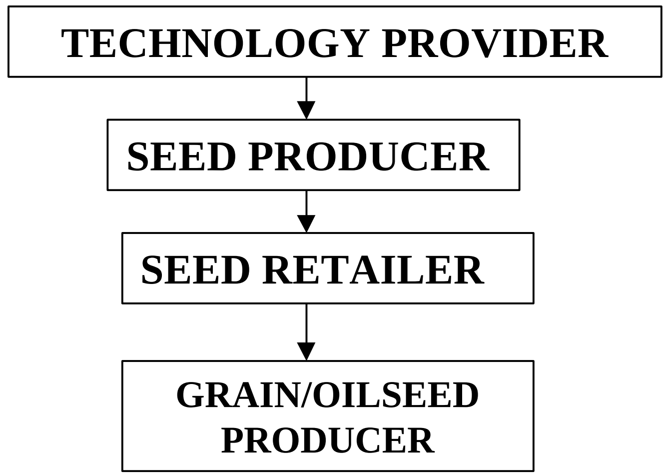

Figure 2. Output Side of the Value Chain

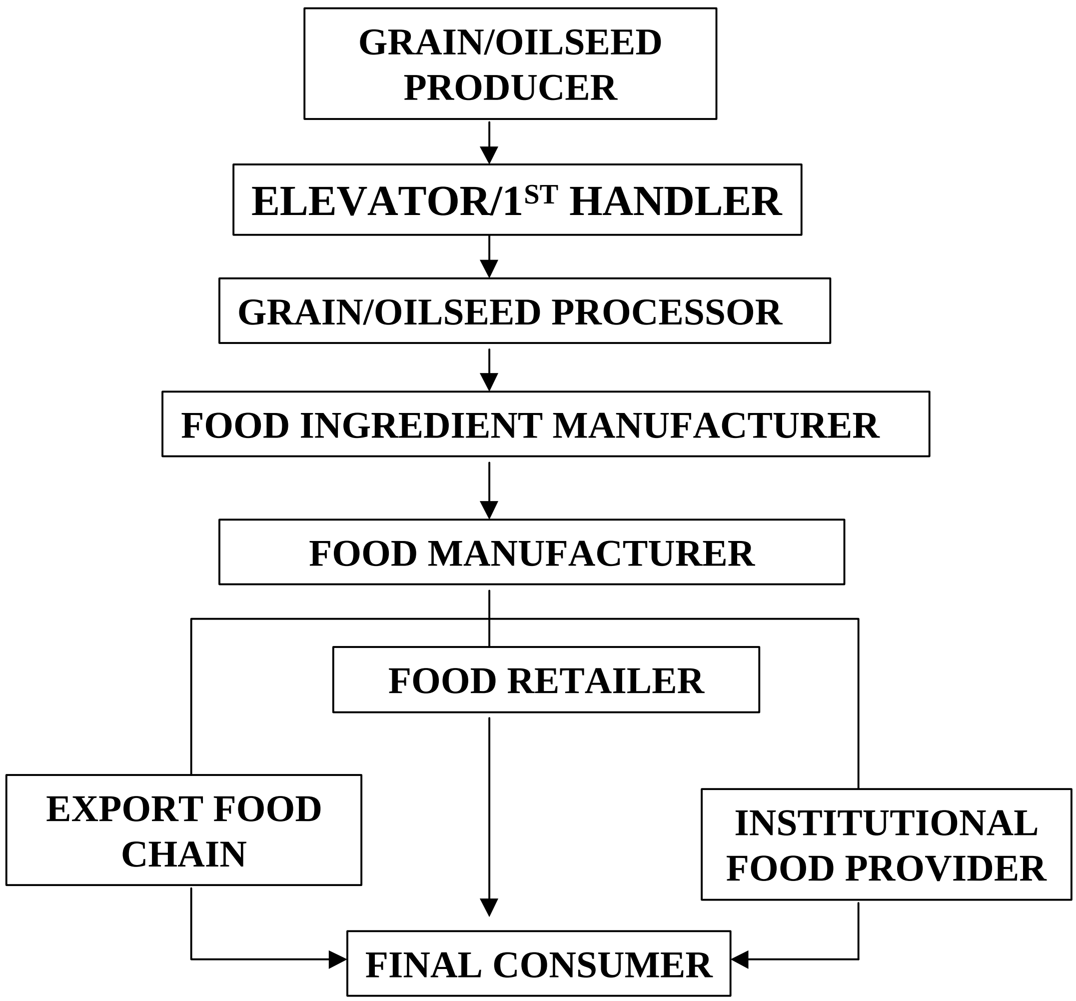

Figure 3. Output Trait Grain Value Chain