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Executive Summary

This report combines existing research and further economic analysis to suggest that, with one notable exception, animal feed customers are unlikely to be willing to pay a premium for many of the genetic modifications that are under development in seed corn. This conclusion is based on an assessment of apparent economic barriers to adoption of new genetic modifications; barriers that are unique to the animal feed industry. The conclusion contradicts previous work by the co-author of this paper, Dermot Hayes, and others at Iowa State University.*

First, and most important, the widespread use of least-cost rations in the animal feed industry ensures that any genetic modification will be valued at the commodity cost of the modification. This makes the interests of the animal feed customer different from those of other consumers who typically demand, and are prepared to pay a premium for, a customized *bundle* of attributes.

Second, animal feeding is an old- and well-researched industry. As nutritional deficiencies have been discovered in traditional grain rations, industries have arisen to produce the missing attributes. These industries have very inelastic supply curves, and any attempt to supplant the synthetic additive will result in a price drop for that additive.

Third, U.S. grain processing and transportation systems have achieved large economies of scale in the handling and processing of undifferentiated crops. Therefore, initial attempts to market differentiated products will incur significant additional costs.

This report suggests that the most economically profitable scientific research in the seed corn business is that which increases yields (or reduces production costs) for bulk commodity corn. A second profitable avenue is one that would double the protein content of corn while maintaining yields at 80 percent or more of current levels. A third advance is one that would anticipate a federal or state mandate to reduce the phosphorus and nitrogen content of animal waste. And, a fourth possible avenue of research is to monitor developments in *new* additives (flavor enhanced milk substitutes, enzymes), and to modify the corn plant to produce these additives *before* capital-intensive production facilities are built.

*"Meeting the Challenges of Ongoing Change," by Dermot Hayes and Don Hofstrand. In *Agriculture in the 21st Century, Surviving and Thriving.* College of Agriculture, Iowa State University. March 1999.

WHAT DO LIVESTOCK FEEDERS WANT FROM SEED CORN COMPANIES?

Introduction

The vast bulk of the corn produced in the United States is fed to livestock, and the farmers who own and feed livestock compose the largest segment of seed company customers. This report describes the genetic improvements in corn for which these customers might be willing to pay.

The use of least-cost rations is widespread in the livestock industry. Lease-cost means that livestock farmers value grains for the sum of their components and will switch formulations in response to minor changes in the cost of these components.

Least-cost ration formulations allow hog, beef, and poultry producers to make use of the same two commodities, corn and soybeans, and enable them to achieve enormous economies of scale in the production and transportation of undifferentiated commodity products. What do livestock feeders want from seed corn companies? They want grain that meets the minimum quality standards at the lowest price. Seed companies have responded to customer preference by focusing on increasing yields and reducing production costs.

To date, no seed company has undertaken a commercially successful effort to produce a customized grain for a particular type of livestock because farmers are not prepared to pay a premium for a grain suited to their unique needs.[1] Contrast this situation with the differentiation in most consumer products on the market today. For example, in breakfast cereal and automobiles consumers will pay a premium for a unique combination of desired attributes, and these industries have responded with hundreds of different product lines, each with a different set of attributes.

Customized Seed: Potential Hurdles

The overarching emphasis on cost in the animal feed business has created an efficient bulk commodity production and transportation system. There are several hurdles to be addressed in introducing customized seed into the present market environment.

- The consumer will not pay any more for seed than the sum of its components.
- Any customized product will need to maintain its identity, and a system that supports identity

[1] This statement would seem to fly in the face of existing markets for high-oil corn; however, we argue that high-oil corn will not succeed in the domestic market so long as animal fat has any positive value. In other words, animal fat (which is a by-product) will fall in value as high-oil corn production grows. This will eventually reduce the commercial viability of high-oil corn.

preservation will not be able to take advantage of the present commodity transportation economy of scale.

- Farmers who grow the customized product will be concerned about yield differences and about the poor liquidity of the smaller, customized market, and they will have to be compensated for taking these additional risks.
- The seed companies will need to be compensated for the risks and research needed to bring customized products to market.
- There is the possibility that any successful customized product will upset the market for the additive that would have been used in the commodity rations.
  For example, high-oil corn displaces animal fat and high-lysine corn displaces synthetic lysine. The producers of the displaced products will lower prices when faced with new competition. A price drop may be just enough to ensure that the customized product cannot compete with the commodity product.

Two New Studies

To date there has not been a study that considers all the potential hurdles. However, two recent Iowa State University (ISU) studies come very close. They were conducted by researchers from the departments of animal science, crop science, and economics, in collaboration with industry specialists from Optimum Quality Grains and Pioneer Hi-Bred International. The key conclusions in these studies shed light on the present barriers to increased use of modified grain in livestock feeding. Both studies use least-cost formulations to value genetic modifications in corn. One also uses least-cost formulations to find the optimum decrease in the market price of the existing synthetic additive that would force the modified grain out of the ration.

The first study was completed in November 1999 (*Identifying Valuable Corn Quality Traits for Livestock Feed,* by Lawrence A. Johnson, Connie L. Hardy, C. Phillip Baumel, Tun-Hsiang Yu, and Jerry L. Sell). The researchers analyzed the potential benefit to the animal feed industry of a list of feasible genetic improvements. Their study does not incorporate yield drag, any costs associated with identity preservation, or any price reductions in competing additives. The key results are reported in Tables 1 and 2.

Table 1 shows the increased values on a per-bushel basis. Table 2 shows the increased total value, assuming that the livestock industry purchases the modified variety and that all of the benefits of the new variety are passed back to the feed producer. For purposes of this study, per bushel premium is more important than the ultimate size of the market.

The results in Table 1 show that the most important improvement is the doubling of the grain protein content, which is worth about nine cents per bushel for each 1 percent increase in protein.[2] Other valuable improvements include

[2] This modification seems extraordinarily optimistic, especially given that the authors do not assume any yield impact from the modification. However, as was mentioned earlier, the authors of the study as well as those from industry who advised them are very well qualified. It seems unlikely that this group would have made such an assumption had they not been told that it was technically feasible.

increasing lysine, tryptophan, germ size, and oil content. One improvement that is ranked relatively low is increasing phosphorous availability. However, this analysis does not take into account any benefits from reducing the amount of phosphorous released into the environment.

In the companion study (*Impacts of Six Genetic Modifications of Corn on Feed Cost and Consumption of Traditional Feed Ingredients,* by Tun-Hsiang Yu, C. Phillip Baumel, Connie L. Hardy, Lawrence A. Johnson, Marty J. McVey, and Jerry L. Sell, 1999), ISU economists identified the sectors of the animal production business most likely to pay for each of the most promising improvements identified in the Johnson et al. report. They also analyzed whether any of the improvements would justify the costs associated with yield drag and identity preserved grain. Using actual experience with high-oil corn in Bremer County, Iowa, yield drag would add 18 cents per bushel, additional seed costs would add 12 cents per bushel, and additional handling would add 5 cents per bushel.[3] The analysis specific to livestock feeding is shown in Table 3, and the net value of the genetic modifications is presented in Table 4.

As the results in Table 4 indicate, the hog and cattle industries are not likely to be willing to pay a premium for customized, identity preserved grain.[4] But, to the contrary, the broiler and turkey industries are likely to pay a premium for corn with a high protein content and enlarged germ. These results also indicate that corn with high available phosphorous would cost an additional 33 cents per bushel if it were added to hog rations. The additional cost to producers of increasing phosphorous availability (not calculated in the study) would be slightly larger than for hogs.

In a final phase of the study, the authors estimated the level of cost reductions in the poultry feed additives that would drive out the genetically modified rations (Table 5). Reductions of 1.5 to 4.8 cents per pound in the traditional ingredients would drive the modified protein out of all the rations. Soybean meal is currently worth about 8-cents per pound; therefore, a 3-cents per pound price reduction would be very significant. This would correspond to a drop of $1.44 per bushel at the farm level (assuming that each 60-pound bushel of soybeans contains 48 pounds of meal). Under current U.S. market conditions, a drop in price of this amount would not have a major influence on soybean production because farm returns are not influenced by market prices that go below the loan rate. However, if the modified protein corn were to be commercialized under free market conditions, then there would be a significant move away from soybean production and into corn production. In other words, sales of high-protein corn seed would go up significantly.

[3] The assumption of a $0.05 additional handling charge seems low, however the yield drag value seems a little high and the total value seems to be about right.

[4] Although not explicitly recognized in the report, it was assumed that monogastric animals such as hogs would be able to make better use of the modifications than cattle. Therefore, the conclusion that the modifications would not be economically viable for hog producers can be extended to the cattle industry.

One important caveat not considered by the authors is that a doubling of the protein content of corn would probably be associated with a yield drag in excess of that for high-oil corn. The results in Table 5 show that after an 18 cents per bushel allowance for yield drag, the net benefit in broiler rations of high protein is 22.3 cents per bushel. Adding 22 cents net benefit to the 18 cents already subtracted by Baumel et al. provides an advantage before yield drag of 40 cents per bushel. This suggests that as long as yield drag costs less than 40 cents per bushel, the high-protein corn will be economically viable. At current prices, a yield drag of 20 percent would cost about 40 cents.

What is not yet clear is whether a doubling of the protein content would maintain yields at 80 percent of commodity corn yields. The protein modification would be worthwhile as long as yield levels can be maintained. Note, however, that the modification is not feasible in small increments. In other words, a 4 percent improvement in protein would not be economically viable.

The Impact of a Government Restriction on Phosphorus in Animal Manure

This study doesn't include the impact of a likely mandate by federal or state agencies to reduce phosphorus (or nitrogen) in livestock manure. Regulation seems likely in light of water contamination problems in the Chesapeak Bay and the Gulf of Mexico. If it were known that corn with high available phosphorus would come on the market at a competitive price, regulations would be more certain.

If regulations on total phosphorus application were put in place, the animal feeding industries would be forced to use the modified variety—or close down. The relatively low costs associated with adding these modified varieties to animal diets suggest that the industry would adopt the modified varieties quite readily. Thus, a potentially useful modification of corn for the U.S. live-stock industry is one that increases the availability of phosphorus in corn. This variety might also be exported to some other countries where phosphorus is a problem.

Exotic Modifications

In light of the somewhat pessimistic results regarding the adoption by the livestock feeding industry of modified grain, the authors interviewed additional livestock feed specialists for input on modifications not considered by the ISU team. A summary of their suggestions and discussion is presented here.

Suggestion: Introduce some non-food attributes such as anti-microbial peptides, vaccines (such as one to control TGE), and immune stimulants.
Discussion: The cost of some of these medications is currently high relative to the cost of corn, and this would suggest that these grain modifications would pass the market test. However, it seems likely that consumer advocacy groups would be concerned about this development, particularly in light of the ongoing GMO debate. The level of public concern would be large if the total intake of these medications in feed rations exceeded dosages administered on an as-needed basis. Livestock feeders would likely

respond by agreeing to avoid the modified product.

Suggestion: Genetically insert sow or cow milk into protein.
Discussion: If this were technically feasible, the modified grain would be quite useful in rations of early-weaned animals. However the sow/cow also produces antibodies unique to the local environment; and it is unlikely that these antibodies could ever be inserted into grain in an economically viable way.

Suggestion: Incorporate substances that fuel good bacteria and eliminate bad; replicate animal enzymes such as zylanaize; improve the flavor so that animals eat more; improve meat quality; and act as a growth hormone.
Discussion: These genetic products have not yet been developed. They are most likely to enter rations first as feed additives because the company that first develops such products will be interested in controlling supply and charging a premium to cover R&D expenses. There might also be a negative consumer reaction against some of these developments. Nevertheless, one might also argue that it would be less expensive to genetically modify corn than to build commercial-scale chemical production facilities. This might be the reverse of the situation that occurred with lysine where the synthetic product existed before the modified variety was commercially ready. In this particular case, the possibility of modification might deter the construction of a chemical production facility.

Table 1. Benefits and values of corn modifications to improve feed

Modification	**Benefits**	**Content of Normal Corn**	**Estimated Gross Added Value (cents/bu/unit of trait)**	**Gross Added Value (cents/bu)**
Increase protein content	Replaces soybean meal and some amino acids in the diet	8.7% db	9.0¢/bu per percentage point of additional protein	78.3¢/bu if protein content is doubled
Increase protein digestibility	More efficient use of protein	80%[a]	1.1¢/bu [a] per percentage point of additional digestibility	11.1¢/bu if starch digestibility is increased to 100% digestible
Increase lysine content	More lysine and protein	0.3% db	3.8¢/bu per 0.1 percentage point of additional lysine	11.5¢/bu if lysine content of corn is doubled
Increase lysine only	More lysine without total protein increase	0.3% db	6.5¢/bu per percentage point of additional lysine	19.5¢/bu if lysine content of protein is doubled
Increase methionine content	More methionine and protein	0.2% db	1.8¢/bu per 0.1 percentage point of additional methionine	3.6¢/bu if methionine content of corn is doubled
Increase methionine only	More methionine	0.2% db	3.7¢/bu per 0.1 percentage point additional methionine	7.4¢/bu if methionine content of protein is doubled
Increase total sulfur-containing amino acids (TSAA) only	More methionine and cystine	0.4% db	2.1¢/bu per 0.1 percentage point additional	8.4¢/bu if TSAA content of protein is doubled
Increase total sulfur-containing amino acids (TSAA)	More methionine, cystine, and protein	0.4% db	1.5¢/bu per 0.1 percentage point of additional TSAA	6.3¢/bu if TSAA content of corn is doubled
Increase tryptophan[b]	More protein and tryptophan	0.07% db	1.8¢/bu per 0.1 percentage point of additional tryptophan	2.2¢/bu if tryptophan content of corn is doubled
Increase tryptophan only[b]	More tryptophan	0.07% db	8.2¢/bu per 0.1 percentage point of additional tryptophan	9.9¢/bu if tryptophan content of protein is doubled
Increase threonine[b]	More threonine and protein	0.35% db	0.25¢/bu per 0.1 percentage point of additional threonine	0.9¢/bu if threonine content of corn is doubled
Increase threonine only[b]	More threonine	0.35% db	0.25¢/bu per 0.1 percentage point of additional threonine	0.9¢/bu if threonine content of protein is doubled

Table 1. (continued)

Modification	Benefits	Content of Normal Corn	Estimated Gross Added Value (cents/bu/unit of trait)	Gross Added Value (cents/bu)
Increase albumin protein content	More germ proteins, lysine, methionine, cystine	7% of protein	1.1¢/bu per percentage point of additional albumin	7.9¢/bu if albumin content of corn is doubled
Increase glutelin content	More protein, lysine, methionine, cystine, threonine	25% of protein	1.1¢/bu per percentage point of additional glutelin	27.3¢/bu if glutelin content of protein is doubled
Increase C-zein protein content	More protein lysine, methionine, cystine	3.3% of protein	0.9¢/bu per percentage point of additional C-zein protein	2.7¢/bu if C-zein content of corn is doubled
Enlarge germ for oil	More energy and protein, better amino acid composition	4.1% oil db	5.8¢/bu per percentage point of additional oil	23.8¢/bu if oil content is doubled
Enlarge germ for protein	More energy and protein, better amino acid composition	8.7% protein db	3.6¢/bu for each percentage point of additional protein	30.6¢/bu if protein content is doubled
Enlarge germ size	More energy and protein, better amino acid composition	11% of kernel weight db	0.2¢/bu for each percentage point of additional germ size	19.9¢/bu if germ size is doubled
Increase oil content	More energy	4.1%	3.5¢/bu per percentage point of additional oil	14.0¢/bu if oil content is doubled
Increased starch content	More energy but decreases other nutrients	71%	0.02¢/bu per percentage point of additional starch	0.1¢/bu if starch content is increased 5 percentage points
Increase starch digestibility	More energy without decreasing other nutrients	90%[c]	2.1¢/bu per percentage point of additional starch digestibility	21.5¢/bu if starch digestibility is increased to 100% digestible
Increase availability of phosphorus	More utilizable phosphorus	20% of total phosphorus is available	2.9¢/bu per 10 percentage points of additional phosphorus availability	5.8¢/bu if phosphorus availability is doubled
Increase phosphorus (total and available)	More utilizable phosphorus	0.06% of kernel weight is available phosphorus	1.9¢/bu per 0.06 percentage point of additional available phosphorus	3.8¢/bu if available phosphorus is doubled

[a] Protein digestibility was assumed to be 82 percent for swine, 84 percent for poultry, and 73 percent for beef cattle.

[b] Swine diets only.

[c] Average digestibility was assumed to be 99 percent for swine, 90 percent for poultry, and 89 percent for beef cattle.

Table 2. Gross values of selected levels of corn modifications in feed rations (ranked in order of annual market impact)

MODIFICATION	Gross Values (billion $/yr)	Average Gross Added Value (cents/bu)[a]	Quantity of Corn Affected by Modification (billion bu/yr)
Add 8% points of protein	3.45	72.2	4.8
Add 8 points of oil by enlarging germ for oil	2.51	44.8	5.6
Increase size of germ to 27% of dry matter	2.06	28.7	7.2
Add 7% points of protein by enlarging germ for protein	2.04	24.6	8.3
Add 10% points. of starch digestibility	1.44	21.5	6.7
Double glutelin protein content	1.18	27.3	4.3
Add 10% points of protein digestibility	0.88	11.1	7.9
Double oil content	0.74	14.0	5.3
Double lysine content and increase protein content	0.48	11.5	4.8
Triple C-zein and D-zein protein cotents	0.38	9.8	3.8
Double lysine content only	0.36	19.5	1.8
Double albumin protein	0.33	7.9	4.2
Triple phosphorus availability	0.26	11.7	2.2
Double TSAA content and increase protein content	0.25	6.3	4.0
Double methionine content and increase protein content	0.14	3.6	4.1
Double C-zein protein	0.12	2.9	4.1
Triple total/available phosphorus contents	0.09	3.8	2.3
Double TSAA content	0.08	9.0	0.9
Double methionine content	0.07	7.4	0.9
Double tryptophan content and increase protein content[b]	0.04	2.2	1.7
Double tryptophan content[b]	0.03	9.9	0.3
Double threonine only[b]	0.01	0.9	0.1
Double threonine content and increase protein content[b]	< 0.01	0.9	0.1
Add 5% points of starch content	< 0.01	0.1	0.4

[a] Distributes gross value ($) over estimated bushels used.
[b] Swine diets only.

Table 3. Added value (cents per bushel) of six genetic modifications of corn in swine and poultry rations

	Swine		Poultry		
Modification	**Piglets 8-13 lb**	**Finishers 233-238 lb**	**Broiler**	**Tom turkeys**	**Layer**
High Protein	29.4	15.6	57.4	45.0	27.1
Enlarged-germ	0.0	10.3	48.0	44.2	36.3
High starch digestibility	—	—	39.8	33.4	5.7
High methionine	—	—	7.4	4.1	5.7
High lysine	0.0	5.2	—	—	—
High available phosphorus	1.7	1.7	—	—	—

— Indicates that estimates were not calculated in these diets.

Table 4. Net value (cents per bushel) of the six genetic modifications of corn in swine and poultry rations

	Swine		Poultry		
Modification	**8-13 lb Piglets**	**Finishers**	**Broiler**	**Tom turkeys**	**Layer**
High Protein	-5.6	-19.5	22.3	10.0	-8.0
Enlarged-germ	-35.0	-24.8	12.9	9.2	1.2
High starch	—	—	4.8	-1.6	-3.9
High methionine	—	—	-27.6	-31.0	-29.3
High lysine	-35.0	-29.8	—	—	—
High available phosphorus	-33.3	-33.4	—	—	—

Table 5. Estimated reductions in traditional ingredient prices needed to drive modified corn varieties out of poultry rations in dollars per hundredweight

		Price reductions in cents per hundredweight		
Modification	**Traditional ingredient**	**Broilers**	**Tom turkeys**	**Layers**
High protein	Soybean meal	$ 0.60	$ 1.40	--
	Feed fat 3.10	11.80		--
	Methionine	127.70	128.90	--
Enlarged germ	Soybean meal	0.20	2.20	$ 4.80
	Feed fat	0.20	1.60	3.30
High starch digestibility	Soybean meal	0.10	—	—
	Feed fat	0.02	—	—

References

Yu, Tun-Hsiang, Phillip C. Baumel, Connie L. Hardy, Lawrence A. Johnson, Marty J. McVey, and Jerry L. Sell. *Impacts of Six Genetic Modifications of Corn on Feed Cost and the Consumption of Traditional Feed Ingredients*. Iowa State University Extension. 1999.

Johnson, Lawrence A., Connie L. Hardy, C. Phillip Baumel, Tun-Hsiang Yu, and Jerry L. Sell. *Identifying Valuable Corn Quality Traits for Livestock Feed*. Iowa Grain Quality Initiative Traits Task Team Project. Iowa State University. November 1999.

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