Impact of Non-GM Livestock and Poultry Feed on the U.S. Feed Industry

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Institute for Feed Education & Research

Background

In recent years, food companies have increasingly offered products that are free of genetically modified (GM) ingredients. Production of these GM-free milk, meat or eggs requires that the animals in which the foods come from are fed exclusively non-GM feed. If the GM-free feed market must expand to meet an increasing production need, then it is important for the U.S. feed industry to understand the economic and environmental implications for non-GM feed production.

The Institute for Feed Education and Research (IFEEDER) sought to understand the impact that increasing GM-free feed production could have on the farm, at a grain elevator and in a feed mill. A summary of the recently completed study, "Impact of Non-GM Livestock and Poultry Feed on the U.S. Feed Industry," prepared by Iowa State University and Decision Innovation Solutions, is detailed below.

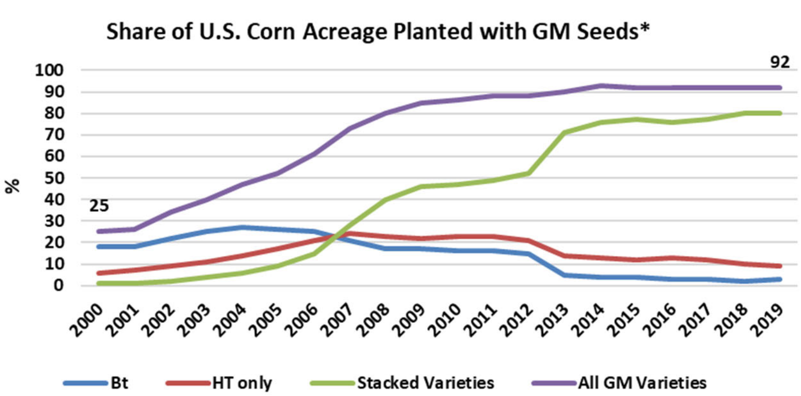
GM vs. Non-GM Corn & Soy Production

GM seeds have been widely adopted by U.S. corn and soybean farmers. Roughly 24% of U.S. corn acres planted in 2007 were herbicide tolerant (HT) seeds; while the percentage of seeds with HT declined to 9% by 2019, the prevalence of stacked trait corn hybrids, with HT and insect resistance (Bt) traits, has now reached 80%.

Overall, 92% of U.S. corn acres were planted with GM seeds in 2019 (including the combination of Bt only, HT only and stacked). In the case of soybeans, the share of U.S. soybean acres planted to HT seeds grew from 54% in 2000 to 94% in 2019, respectively.

A meta-analysis referenced within the study found strong evidence that GM corn increases yields from 5.6% to 24.5% compared with its near isogenic lines (seeds with similar genetic makeup). A 3% yield increase is referenced for GM soybeans.

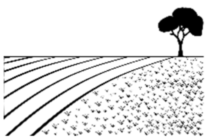
From a monetary viewpoint, GM seeds are more expensive than non-GM seeds, but herbicide costs for GM corn production can be higher or lower than non-GM herbicide costs, depending on the area of production and chemicals used. For soybeans, GM seeds are typically priced higher than non-GM seeds, but the herbicide costs are typically significantly lower than for non-GM soybean production. In most cases, the higher costs of GM seeds are offset by lower costs for herbicides, insecticides and field operations when compared to non-GM production. In addition, to the extent that higher yields are realized with GM technology, the overall costs of production on a per bushel basis can be substantially lower with GM technology than with non-GM technology. For a farmer to consider switching to non-GM farming from GM-



Source: USDA-NASS
GM= genetically modified seeds
Bt: produces a natural insecticide, HT: herbicides tolerant, Stacked includes both Bt and HT. All GM varieties include Bt, HT, and stacked.

farming, a significant premium on non-GM grains is needed to offset the production cost difference.

Land Sparing



The period from 2007-16 was examined regarding land use in primary crop-producing states across the United States, revealing a net shift away from grassy habitats to crops, driven by higher net operating revenue for crops relative to grassy habitats. During this same period, GM crop technologies gained popularity. The potential for higher net operating revenues for organic crops slowed but did not stop reductions in planted acres of both total non-GM corn and total non-GM soybeans. For the time-period under examination, non-GM planted corn acres decreased while non-GM soybean planted acres remained relatively stable.

A shift away from non-GM seeds creates land sparing benefits. For example, the use of GM seed traits produced between 6.8 million to 15.9 million acres of land sparing and 35% to 65% less land conversion from grassy habitats to crop production than would have occurred otherwise.

Specifically, the researchers looked at grassy habitat conversion across the 13-state Midwest region to provide an assessment of land sparing. Along with growth in the use of GM seed traits, about 14 million acres in total were converted from grassy habitats to corn (7.5 million acres) and soy (6.9 million acres) over the period of 2007-16. This occurred as the adoption rate of GM corn rose from 73% to 92%. If a very conservative 5% yield advantage is acknowledged for GM corn over non-GM corn, grassy habitat conversion would need to have increased by 54% to 11.6 million acres; it would almost double to 13.7 million acres, a more realistic yield advantage of 15% is considered for GM corn. Similarly, grassy habitat conversion would have to increase to 9.1 million acres to overcome the 3% soy GM seed trait advantage.

Fuel Use Linked CO_2 Emissions

Environmental literature indicates low-till and no-till agriculture enabled by HT GM crops can contribute to the reduction in greenhouse gas (GHG) emissions and generate other environmental benefits. Research indicates that GM HT crop adoption reduces farmers' dependence on tillage for weed management, and by reducing tillage activities, farmers benefit in terms of fuel, equipment and labor cost savings. Researchers evaluated the impact of on-farm fuel reductions to lower carbon dioxide (CO_2) emissions to the environment.

The researchers used corn production budgets for 2020, published by the University of Nebraska-Lincoln, to estimate CO_2 emitted in diesel combusted during field operations on a metric ton per acre basis. The following table shows the four different production systems considered: GM no-till (GM-NT), GM conventional till (GM-CT), non-GM no-till (non-GM-NT) and non-GM conventional till (non-GM-CT). The fuel costs per acre varied from $10.05 for non-GM-CT to $5.75 for GM-NT. The fuel costs were greater for CT than for NT. Overall, the lowest fuel costs per acre corresponds to GM-NT.

GHG Emissions Based on Field Operation Fuel Combustion

Production System	Fuel Cost ($/acre)	Fuel Use (gallons/acre)	CO_2 Loss (metric ton/acre)
GM-NT	$5.75	2.53	0.0258
GM-CT	$9.84	4.33	0.0441
Non-GM-NT	$5.85	2.58	0.0262
Non-GM-CT	$10.05	4.43	0.0451

As more diesel is used in CT systems compared to NT systems, more CO_2 is emitted from combusted diesel in the CT system compared to the NT system. On a per acre basis, the GM-NT system emits the least CO_2 for diesel combusted in field operations (0.0258 MT/acre).

Focusing on diesel fuel combustion, the researchers evaluated the potential national GHG emissions impact of increasing non-GM corn production. The calculation was based on total national corn acres and current ratios of existing NT and CT corn production.

Based on University of Nebraska-Lincoln crop production budgets for 2020:

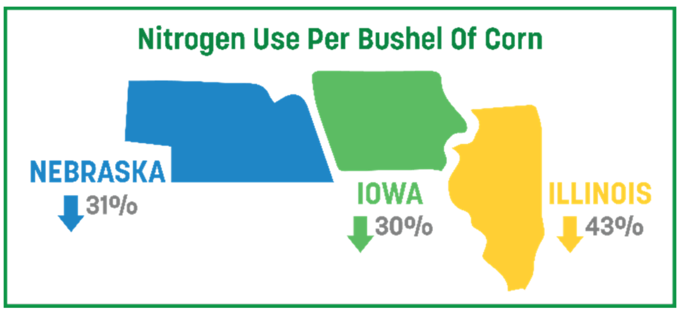
GM corn emits 0.0086 MT/acre CO_2 < non-GM
That's 21.3% less CO_2 per acre than non-GM.

NT corn emits 0.0185 MT/acre CO_2 < CT corn
That's 41.7% less CO_2 per acre than CT.

A 5% increase in non-GM corn acres would increase GHG emissions by 7% (196,151MT) CO_2 annually.

Nitrogen Loss

Percentages of corn planted acres treated with nitrogen (N) have remained steady from 1995 (97%) to 2018 (98%). However, the rate of nitrogen efficiency has improved with the expansion of GM seed use and other technologies. Average N use per bushel declined 26% from 1.2 pounds per bushel of corn in 1995 to 0.90 lb. in 2018 among all 12-leading corn states. Among the top three states – Iowa, Illinois and Nebraska – N use declined even further during that period. For Iowa and Illinois, N use per bushel fell 30% and 43%, respectively, and for Nebraska use declined 31%. GM crops with enhanced N use efficiency could help reduce nitrate runoff, while contributing to increased yields. On average, among the selected states, corn yields increased from 109 bushels per acre in 1995 to 172 bushels per acre in 2018.



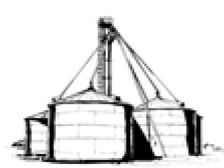
Three primary N loss pathways in crop production systems included N volatilization at application, N leaching through the soil profile and N releases through denitrification. The researchers evaluated N loss considerations if all produced corn was from non-GM seed with a 5% yield disadvantage.

Through literature, researchers identified volatilization losses for three application rates in corn-soybean rotations in Iowa with 2.4 lb N volatilized when the application rate was 123 lb N applied per acre; 2.6 lb N volatilized at 135 lb N per acre; and 2.8 lb N volatilized at 147 lb per acre. Using an assumption that farmers planting non-GM corn that has a 5% yield disadvantage to GM corn would apply approximately 5% less N per acre of corn planted, it should be expected that N volatilization would be about 2.1% less per acre than would be expected in GM corn. However, if it takes 4.9% more corn acres to yield the same level of production with non-GM corn as would be expected with GM corn, then total N volatilization under all non-GM corn production would be expected to be 2.7% higher than with all GM corn production.

Similarly, through literature, researchers noted N leaching losses of 20 lb N per acre at application rates of 123 lb N per acre, 21 lb of N leaching at 135 lb per acre, and 28 lb of N leaching at 147 lb N per acre. Again, using the assumption that farmers planting non-GM corn that has a 5% yield disadvantage to GM corn would apply approximately 5% less N per acre of corn planted, it should be expected that N leaching would be about 0.56% less per acre than would be expected in GM corn. If, however, it takes 4.9% more corn acres to yield the same level of production with non-GM corn as would be expected with GM corn, then total N volatilization under all non-GM corn production would be expected to be 4.3% higher than with all GM corn production.

Finally, researchers used literature to note N denitrification losses for the corn phase of a corn soybean rotation in Iowa of 5.9 lb N per acre per year for N application rates of 123 lb N per acre; 6.5 lb N per acre per year loss at 135 lb N per acre, and 7.1 lb N loss per acre per year at 147 lb N per acre. Assuming that farmers planting non-GM corn, which has a 5% yield disadvantage to GM corn, would apply approximately 5% less N per acre of corn planted, it should be expected that N losses from denitrification would be about 5.2% less per acre than would be expected in GM corn. If, however, it takes 4.9% more corn acres to yield the same level of production with non-GM corn as would be expected with GM corn, then total N denitrification losses under all non-GM corn production would be expected to be 0.55% less than with all GM corn production.

Grain Handling: Farm, Elevator & Feed Mill



The research found that fairly large-scale, systemic changes would be needed to accommodate increasing production of non-GM grain in grain handling, as handling two differentiated product streams deviates from the high-volume commodity system that has developed in the United States. The current study modeled these costs under a variety of feed supply chain scenarios as they would fall to farmers, grain elevators and feed mills.

Impact for Farmers

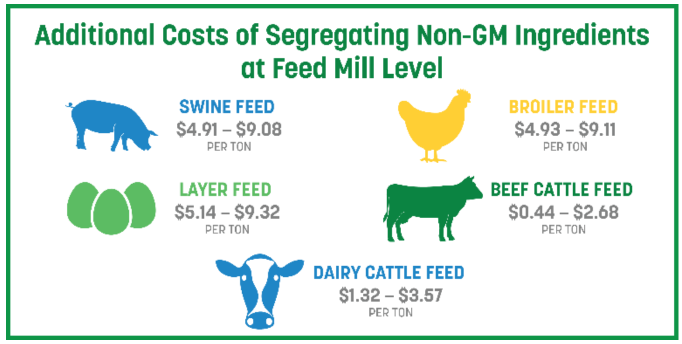
The study found that all participants in the non-GM feed production supply chain would be subject to additional costs related to segregation and isolation of GM and non-GM ingredients. The costs of segregation on the farm are the smallest. With the largest isolation range considered, the cost of on-farm segregation is less than $0.05 per bushel. The costs of operationalizing segregation on the farm will likely not be a major factor guiding the decision to produce or not produce non-GM grain. It is expected that farmers will continue to reconcile productivity and final pricing as a key part of their decision.

Impact for Grain Elevators

As an intermediary, the grain elevator not only buys non-GM grain at a premium price but also sells it at a higher price. Therefore, clarity and transparency on costs of segregation and isolation are critical for grain elevator decisions on whether to handle non-GM grain. Depending on the sale date to a feed mill, the grain elevator can negotiate a better value for its grain, but it is always conditioned to the market value. The elevator will spend an additional $0.05 to $0.07 per bushel to handle and segregate non-GM soybeans, compared with regular soybeans, and $0.07 to $0.09 per bushel for non-GM corn.

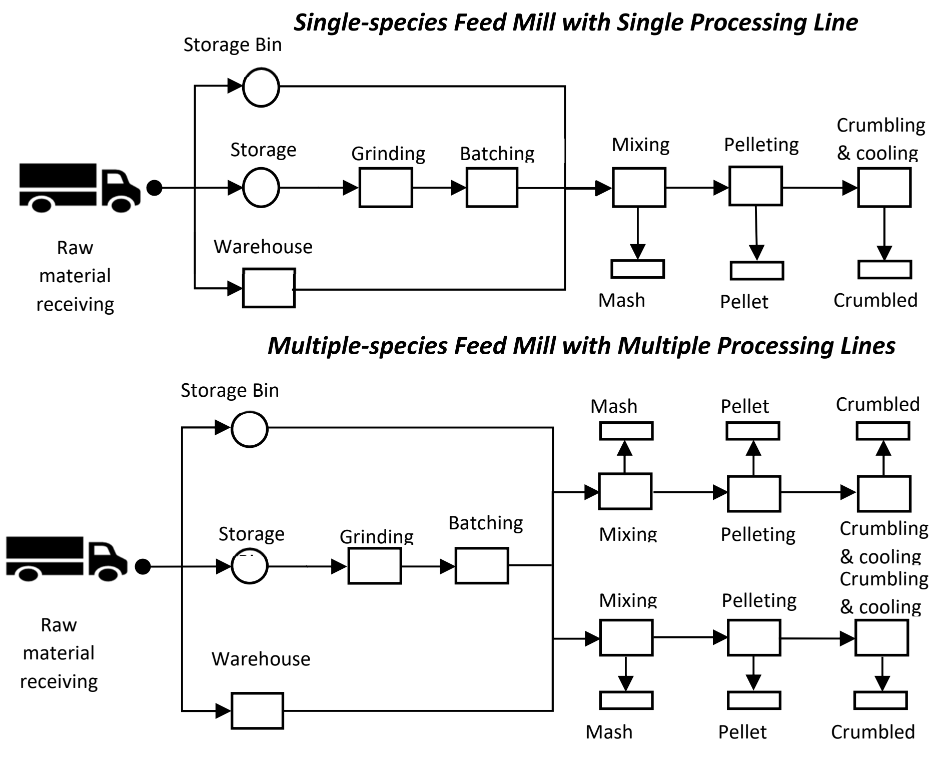
Impact for Feed Mills

The feed mill, at the end of the feed production chain, marks the largest increase in the price of the final product, which has direct bearing on the price of meat, milk and egg products derived from animals fed with non-GM feed. The additional costs of segregating non-GM ingredients ranges from $4.91 to $9.08 per ton for swine feed, $4.93 to $9.11 per ton for broiler feed, $5.14 to $9.32 per ton for layer feed, $0.44 to $2.68 per ton for beef cattle feed, and $1.32 to $3.57 for dairy cattle feed. For the feed mill, the choice of the segregation strategy has greater weight in the final additional costs. Spatial segregation entails higher costs, especially for smaller facilities, relative to temporal segregation or dedication.



When calculating the final costs for beef and dairy cattle, it is worth remembering that these animals consume a significant fraction of their diets from on-farm (and not elevator or feed mill) produced ingredients.

Modeling Feed Mill Capability to Manufacture Non-GM Feed at 0.9%, 3% & 5% AP Tolerance



The model included two feed mill configurations, a single species mill with one processing line and a multi-species mill with multiple processing lines.

Parameters potentially contributing to AP included ingredient impurity, receiving and conveying system, processing line and handling error. The model assessed facility capability to segregate non-GM feed by facility dedication for non-GM feed or segregating spatially and temporally while handling both GM and non-GM in the same facility.

For a mill with a single processing line, dedication and temporal segregation was an effective strategy to meet 0.9% tolerance. For a mill with multiple processing lines, dedicating the processing line could not guarantee meeting 0.9% AP. A group of robust segregation strategies beginning with the receiving of raw materials till feed production is necessary to achieve 0.9% AP tolerance.

Achieving Adventitious Presence

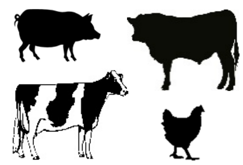
The aforementioned calculations and research did not consider levels of non-GM purity in the final products. Different countries and third-party certification bodies recognize varying levels of adventitious presence (i.e., the unintended presence of low levels of transgenic material in non-GM ingredients or products) as "acceptable" for a product to be considered non-GM. The smaller the acceptable level of AP, the more expensive it is to achieve. The costs shown above are for standard segregation and isolation operations. In the future, this work may serve as a basis for determining segregation costs by the degree of AP.

However, the researchers created a second probabilistic model in parallel with the economic model described above to inform the extent of segregation strategies needed at the farm, elevator and feed mill levels to have a high probability of achieving three common trade tolerances for AP of GM in non-GM grains (0.9%, 3% and 5%). Scenarios were developed representing a variety of supply chain strategies useful for achieving segregation in the feed supply chain and then analyzed to determine the feasibility of meeting either a 0.9%, 3% or 5% tolerance level under that scenario.

Incoming grain impurity has a strong influence on the level of adventitious presence. For the segregation scenarios modeled, a 5% tolerance was achievable. Elevator configuration plays a significant role in determining segregation capability, with increased flexibility leading to a higher probability of achieving the lower tolerances for AP. A key finding is that even facilities that may not be ideally configured can still implement combinations of strategies and achieve AP goals with reasonable confidence.

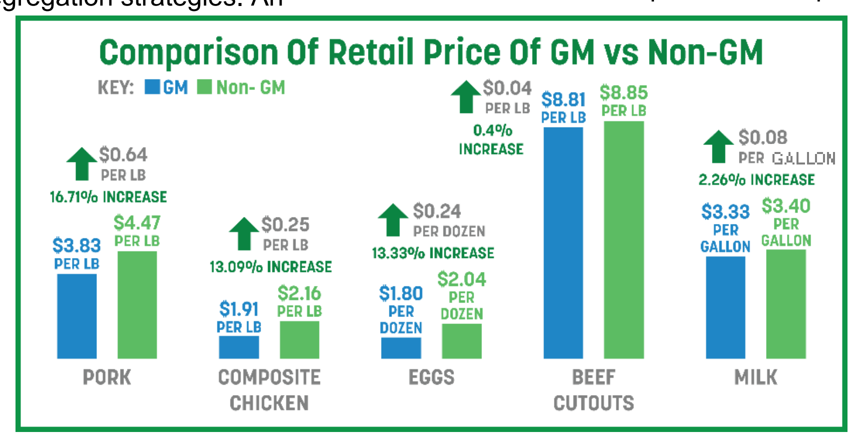
At the feed mill, a similar trend was generally true: the greater the flexibility, the more likely one could achieve lower tolerance levels for AP. But, for a feed mill with a single processing line, 0.9% AP was achievable with a robust combination of segregation strategies. An ongoing effort is underway to merge the modeling of economic costs and segregation implementation strategies, with an end goal of determining how much it costs to achieve compliance with a given tolerance level for AP under select supply chain scenarios.

Impact on Protein Production Costs



Armed with the knowledge generated on production costs, segregation costs, premiums, etc. associated with non-GM grains and feeds produced with non-GM grains, and in tandem with data from the Livestock Marketing Information Center database, the researchers provided estimates of the costs to consumers of their pork, chicken, eggs, beef and milk based on 2014 to 2019 data.

The cost of pork is estimated to increase by $0.64 per pound, which is a 16.71% increase. The retail price of pork produced with GM feed is $3.83 per pound whereas the estimated non-GM pork retail price is $4.47 per pound. For retail composite chicken, the price per pound increases by $0.25 per pound, which is a 13.09% increase. The retail price of composite chicken produced with GM feed is $1.91 per pound whereas the estimated non-GM composite chicken retail price is $2.16 per pound. The cost of eggs produced with GM feed is $1.80 per dozen. However, the estimated non-GM eggs would be $2.04 per dozen. So, there is an increase of $0.24 per dozen for GM eggs retail to non-GM eggs retail, which is a 13.33% increase. For retail beef cutouts, the price per pound increases by $0.04 per pound, which is a 0.40% increase. The retail price of beef produced with GM feed is $8.81 per pound, whereas the estimated non-GM beef retail price is $8.85 per pound. For retail milk, the price increases by $0.08 per gallon, which is a 2.26% increase. The retail price of milk produced with GM feed is $3.33 per gallon, whereas the estimated non-GM milk retail price is $3.40 per gallon.



Key Conclusions

The yield advantage offered by GM seed technology creates environmental and economic benefits on the farm. Until non-GM seeds achieve similar yields, those advantages will continue to exist. Additionally, because GM seed traits improve the feasibility for reduced tillage, and therefore fuel use, reduced CO_2 emissions from combustion will remain an advantage.

For feed production, the ability to be part of a potentially expanding GM-free feed market has capital and operating cost considerations. The ability to segregate to achieved desired AP tolerance levels is feasible, but the management requirements add a higher level of complexity unless the facility is solely dedicated to non-GM feed.

As the animal sector pursues sustainability targets, feed implications will need be considered. For example, feed is a significant component of an animal's carbon footprint. The scope of the GHG impact linked to GM vs. non-GM feed will need to be considered as the animal sector explores pathways to meeting their evolving targets.

Acknowledgements

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The full report is available at:
https://ifeeder.org/research/gmfree-feed-report/