



Silage Corn Product Selection and Value-Added Traits

- Silage producers have many selection considerations for corn products including conventional, herbicide-tolerant, or products with insect-protection and herbicide-tolerance. Each farmer must determine what product offers the best opportunity to help maximize profitability on his or her farm.
- Field research trials from a variety of sources show that genetically modified corn products have a number of benefits over conventional corn that help mitigate risk under variable yield conditions and protect yield potential.

Corn silage is an important source of forage in the United States. Silage provides over 40% of the forage value fed to dairy cows and is also an increasingly important feed in the beef finishing industry.



corn rotation. In 2005, the negative impact of the corn-on-corn rotation was not apparent for traited corn products, but was still a problem in conventional corn-on-corn rotation.¹

Corn Product Selection

Corn product selection is one of the most important decisions a corn silage producer can make to obtain the highest yield and quality forage for silage.² To help maximize yield potential, silage corn products should be planted early, at higher plant populations, and in narrower rows than corn grown for grain. For high quality forage, select corn products that are 5 to 10 relative maturity units higher than a product grown for grain in the same field.¹ Increasing plant populations by 10 to 20% over those recommended for grain can help maximize silage yields. In University of Wisconsin research, maximum forage yield was measured at 44,000 plants/acre and 38,000 plants/acre for grain yield, while around 30,000 plants/acre was the minimum for maximizing grain and forage yield.³ Although population recommendations are generally higher for silage products, populations should not exceed the “upper end” recommendation for any corn product, keeping in mind that this may vary due to soil, environmental conditions, and management practices.

Benefits of Biotechnology Corn

Since 1996, corn products with biotechnology traits and associated agronomic practices have contributed to the steady increase in corn production by reducing pest and environmental stresses in highly productive new corn genetics. Genetically modified (GM) corn products have helped promote yield stability and reduce production risks on a wide range of corn acres. Conventional corn products may offer lower seed costs and market premiums, but may also require more intensive weed, insect, and other management practices that can result in higher overall costs, lower stress tolerance, and lower yield potential. An analysis of 20 years of field research trials shows that GM corn has a number of benefits over conventional corn.¹ The benefits for GM corn found in this research include:

- Trait corn products provided more yield than conventional corn.
- Trait corn products responded to higher plant densities better when compared to conventional corn.
- Trait corn products helped overcome the continuous corn yield penalty conventional corn experienced during the 2000 to 2005 comparison period.

For example, University of Wisconsin research shows that farmers planting GM corn products in a corn-on-corn rotation in 2000 had a lower potential risk of low yield (175 bu/acre) than farmers using a conventional corn-on-

Weed Management Benefits

Weed competition reduces yield, digestibility, and protein content of silage.² Corn is very sensitive to early-season weed competition and loss of silage corn yield potential can begin soon after planting. The critical period of weed competition is variable. Roundup Ready[®] 2 Technology provides crop safety and flexible application timing to adjust glyphosate applications to the scope and intensity of the weed infestation in each field to reduce the risk of lost yield potential. Benefits include:

- Reduced plant stress due to weed infestations to protect yield potential and plant health.
- Reduces plant hosts for insects, diseases, and nematodes.
- Facilitates the use of reduced-tillage for soil and water conservation.
- Corn products with Roundup Ready 2 Technology contain in-plant tolerance to Roundup[®] brand glyphosate-only agricultural herbicides. This system provides proven crop safety, over-the-top application flexibility, and broad-spectrum weed control.
- A system with corn products with Roundup Ready 2 Technology can reduce potential yield loss from crop injury resulting in an average of up to 5.6 more bushels/acre than conventional corn herbicide products (433 field-trial comparisons, same Roundup Ready 2 Technology product).

Silage Corn Product Selection and Value-Added Traits

- The cornerstone of weed management in corn is the use of residual herbicides and multiple sites of herbicide action throughout the program. Roundup Ready PLUS® Crop Management Solutions provides weed management recommendations for broad-spectrum weed control, utilizing multiple application timings and herbicide sites of action.

Roundup Ready PLUS® Crop Management Solutions

- Is a centralized resource for weed and insect management that combines the knowledge of weed scientists, academics, agronomists, and industry partners.
- Provides customized recommendations for a proactive, economical approach to controlling tough-to-manage and glyphosate-resistant weeds, plus best management practices for controlling weeds and insects.
- Offers cash-back incentives for corn, soybean, and cotton acres when you use Roundup® brand glyphosate-only agricultural herbicides with Roundup Ready PLUS platform endorsed products.
- See your local retailer or visit www.roundupreadyPLUS.com for additional information, recommendations, and details.

Insect Management Benefits

European corn borer, corn earworm, western bean cutworm, fall armyworm, and corn rootworm feeding can cause stress and injury to plant tissues. This damage can reduce yield potential or allow fungi to infect, proliferate, and produce mycotoxins which have the potential to cause health problems in animals and humans.^{4,5,6} Insect protection in GM corn products protects the plant parts these insects feed on, which can help reduce the risks of lost yield potential and lower grain quality. Conversely, insecticide applications require precise application timing, rates, and coverage, and may affect non-target organisms.

- European corn borer (ECB) populations still threaten non-Bacillus thuringiensis (B.t.) corn products. An analysis of historical ECB damage in Minnesota estimated that B.t. corn for ECB protection provided an average benefit of \$17.24/acre.¹⁴
- GM corn rootworm protection can have agronomic benefits in addition to insect management. Improved root growth and activity can allow plants to utilize nitrogen more effectively after flowering to promote higher kernel weight and yield potential.⁷
- Higher corn plant densities can support maximum grain yield potential. Genetic improvements, including new GM traits such as insect protection from the B.t. gene, help support higher plant populations.¹⁰

Summary

Farmers planting corn products with herbicide resistance and insect protection traits with multiple modes of action can realize higher yield potential through:

- Reduced plant stress from corn borers, ear-feeding insects, stalk boring insects, and rootworm root damage.^{11,12,13}
- Planting corn-intensive crop rotations with more successful outcomes.
- Maintaining higher plant densities to help maximize corn production.
- Harvesting better quality grain by preventing insect damage that can lead to stalk and ear rot diseases. Mycotoxins produced by these

diseases have the potential to cause health problems in animals and humans.

- Reap the economic benefits of higher yield potential in feedstuffs for cattle.⁸

GM products protect corn yield potential and provide other benefits. The PG Economics annual report on the impact of GM crops shows that GM crops are credited with decreasing pesticide and fuel use, facilitating conservation tillage practices that reduce soil erosion, improving carbon retention, and lowering greenhouse gas emissions.⁹

Sources

¹ Chavas, J., Shi, G., and Lauer, J. 2014. The effects of GM technology on maize yield. *Crop Sci.* 54:1331-335. ² Lauer, J. Keys to higher corn forage yields. University of Wisconsin. <http://www.uwex.edu>. ³ Lauer, J. 2009. Corn plant density for maximum grain and silage production. *Agronomy Advice*. University of Wisconsin. ⁴ National Research Council. 2010. The impact of genetically engineered crops on farm sustainability in the United States. National Academies Press. ⁵ Folcher, L., Delos, M., Marengue, E., Jarry, M., Weissenberger, A., Eyche, N., and Regnault-Roger, C. 2010. Lower mycotoxin levels in Bt maize grain. *Agron. Sustain. Dev.* 30: 711-719. ⁶ Hutchison, W.D. 2010. Areawide suppression of European corn borer with Bt maize reaps savings to non-Bt maize growers. *Science* 330:222-225. ⁷ Haegerle, J.W. and Below, F.E. 2013. Transgenic corn rootworm protection increases grain yield and nitrogen use of maize. *Crop Science* 53:585-594. ⁸ Hartnell, G.F. 2010. Feeding transgenic feedstuffs to cattle. *Proc. 21st Florida Ruminant Nutr. Symp.*, University of Florida, Gainesville, FL. ⁹ Brookes, G. and Barfoot, P. 2014. GM crops: global socio-economic and environmental impacts 1996-2012. PG Economics Ltd, Dorchester, UK. ¹⁰ Mitchell, P. 2009. Information and the use of new technology: evidence from seeding density decisions of U.S. corn farmers. *UW AAE Applied Economics Workshop*, University of Wisconsin. ¹¹ Wu, F. 2006. Mycotoxin reduction in Bt corn: Potential economic, health, and regulatory impacts. *Transgenic Research*:15 277-279. ¹² Castillo-Lopez, E., Clark, K.J., Paz, Ramirez, H.A., Klusmeyer, T.H., Hartnell, G.F., and Kononoff, P.J. 2014. Performance of dairy cows fed silage and grain produced from second-generation insect-protected (*Bacillus thuringiensis*) corn (MON 89034), compared with parental line corn or reference corn. *J. Dairy Sci.* 97 :3832-3837. ¹³ Munkvold, G.P. and Hellmich, R.L. 1999. Genetically modified insect resistant corn: Implications for disease management. *APSnet*. ¹⁴ Ostlie, K.R., Hutchison, W.D., and Hellmich, R.L. Bt corn and European corn borer, long-term success through resistance management. University of Minnesota. Web sources verified 11/17/15. 140915143014

For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology Development & Agronomy by Monsanto.

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