# Enogen Corn for Feed
# Surviving or Thriving in the Future of Dairy Production?
## How to be Both Sustainable and Profitable

*September 14, 2022*

Profitability and sustainability are two of the key challenges facing dairy producers and the dairy industry today. Increasing feed efficiency is generally recognized as one of the best approaches to address both of these challenges, as reducing inputs required to produce a unit of milk can be expected to ease environmental impacts while saving on production costs. Enogen® trait technology is a relatively new tool that producers can easily adopt to enhance their businesses with only a simple change of corn hybrids.

Enogen corn hybrids were initially launched in 2011 for use in ethanol production, where the robust alpha amylase enzyme embedded in the starchy endosperm of Enogen corn kernels is released to provide multiple benefits, including more efficient conversion of starch to sugars for better ethanol yield, reducing energy and water use, eliminating the need for some other inputs, and producing higher quality byproducts compared with commercial amylase additives. Potential value for animal feeders was recognized soon after the technology was commercialized, and Enogen hybrid seed was sold for use in production of animal feed for beef and dairy cattle for the first time in 2016-2017.

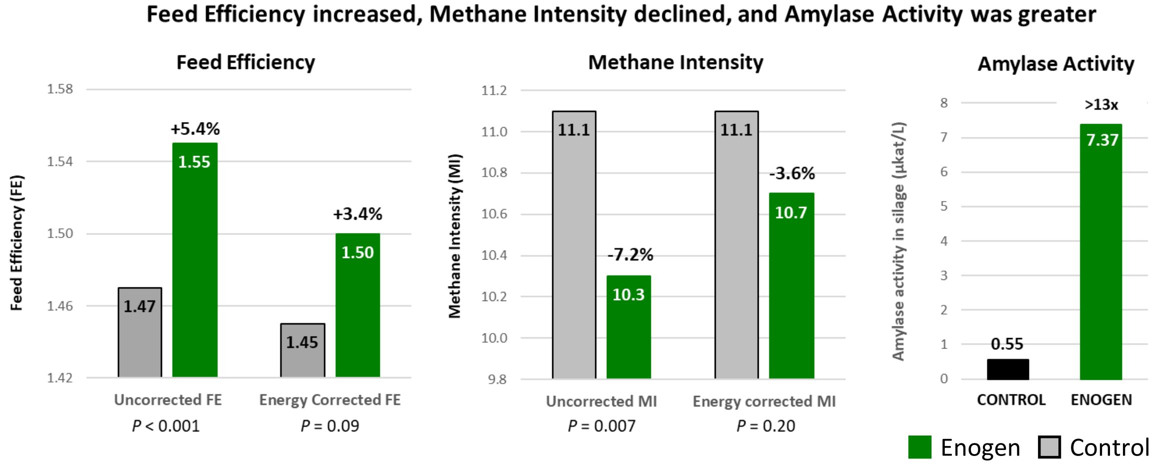
Over the intervening years, we've learned more about the benefits Enogen technology can offer to dairy producers through the potential for increased feed efficiency, reduced environmental impacts, and improved profit potential. A great example comes from a dairy performance study conducted at Penn State University by the nutrition team led by Dr. Alex Hristov[1], coupled with additional analysis based on the same core data set to assess:

- environmental benefits through Life Cycle Assessment (LCA) modeling, and
- economic benefits through financial return modeling.

**The performance study** conducted at Penn State (Figure 1) showed that feed efficiency (FE) and energy-corrected milk (ECM) feed efficiency (ECMFE) for lactating cows fed a diet containing Enogen silage were improved by 5.4% and 3.4%, respectively, versus cows fed a diet with conventional isoline corn silage*, with no difference in feed intake and no negative impacts on milk components or body condition scores.  Enteric methane emissions were monitored during the study and methane intensity (methane emitted per unit of yield) was reduced for the cows fed Enogen silage by 7.2% for actual-milk yield and 3.6% for ECM yield, respectively. Amylase activity in Enogen silage was more than 13-fold greater after 220 to 300 days of fermentation time than in the control silage, confirming the robustness of the enzyme in Enogen hybrids.

*Conventional silage was produced from a Syngenta hybrid genetically similar to the Enogen hybrid but without the amylase-expression trait (an "isoline" hybrid).

**Figure 1. Results of Penn State dairy study[1] comparing Enogen silage vs conventional silage**




**Design: RCB with 48 cows, free stall w/ Calan gates**

- Ten-week study, sampling in last 6 weeks
- TMR 40% corn silage (DM basis) – Enogen or Control
- Methane emissions measured with GreenFeed units

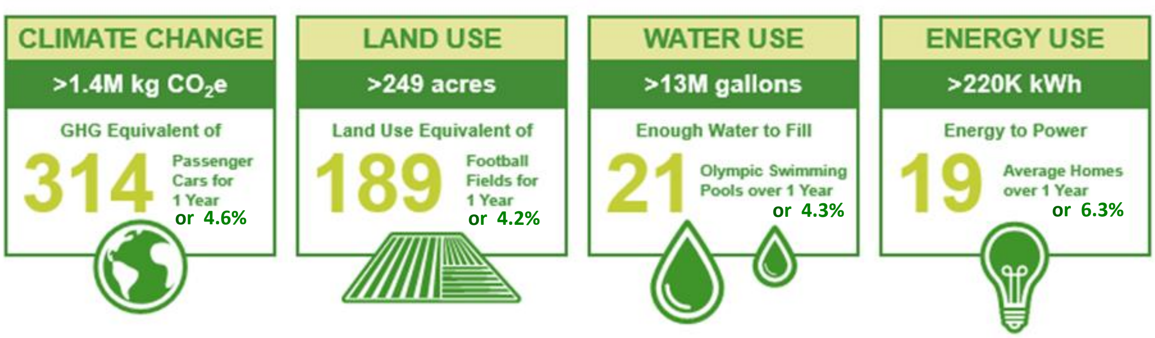
**Total Mixed Ration composition (%DM):**

| | CP | NDF | Starch |
|---|---|---|---|
| Control | 16.7 | 33.9 | 24.0 |
| Enogen | 16.5 | 33.6 | 25.2 |

**The Life Cycle Assessment (LCA)**[2], based on the Penn State study, modeled the environmental impacts of the Enogen silage diet vs the conventional silage diet for key impact criteria, using widely accepted models and resources, and was validated by an independent review panel of experts to ensure compliance with ISO standards for LCA.

The LCA results (Figure 2) show that the environmental impacts from the Enogen diet were 4% to 6% lower than the conventional silage diet across the four key impact categories. Impact reductions are directly related to reduced enteric methane emission intensity and increased feed efficiency because less Enogen silage is needed per unit of ECM yield. Real-world equivalencies were calculated from the LCA results using publicly available tools offered by the US EPA and EIA.

**Figure 2. Results of dairy LCA[2]; reduction in key environmental impacts per kg ECM yield for cows fed diets with Enogen silage vs conventional silage for a herd with 1,000 lactating cows**




**The economic analysis** was based on the results from the Penn State lactation performance study utilizing a calculator developed by the University of Wisconsin Madison[3]. The economic calculator, originally developed to assess potential agronomic yield versus silage quality/animal performance trade-offs for some hybrid types, was adapted to perform this analysis.

The key inputs are lactation performance and yield per acre data for control and test hybrids. Other important input variables include current Federal Milk Marketing Order (FMMO) milk component prices, the proportion of corn silage used in the rations, current pricing for non-corn silage feed ingredients used in the rations, and an estimate of the per acre cost of corn silage production. Diet composition and lactation performance data were from the Penn State study. Agronomic yield data were estimated from typical local yields and set to parity based on field hybrid evaluation trials conducted over multiple years, showing no yield impact of the amylase-expression trait.[4]

Income, feed cost, and income over feed cost (IOFC) results are presented in Figure 3 for a simulated dairy herd with 1,000 lactating cows (850 in milk and 150 dry cows). When IOFC for cows fed the Enogen silage diet was compared with IOFC for the conventional diet, the model estimated an economic benefit of $132 to $208 per cow and $112,403 to $176,490 for the herd per year using monthly FMMO component prices for the first 8 months of 2022, averaging $174 per cow and $148,118 for the herd over that time. Results will vary with FMMO (Figure 4) and feed ingredient prices, diet composition, and corn silage production cost, but sensitivity analysis indicates that corn silage production cost and cost of the non-corn silage portion of the diet have minimal impact on the results. The model indicates that substantial benefits in IOFC are possible with Enogen silage.

**Figure 3. Results of dairy economic calculation[3] for cows fed diets with Enogen silage vs conventional silage for a herd with 1,000 lactating cows**

Professor Randy Shaver, UW Madison Animal & Dairy Sciences Dept; Dr. John Goeser, Rock River Laboratory, Inc., Cows Agree Consulting LLC, Adjunct Assistant Professor, UW Madison Animal & Dairy Sciences Dept; Professor Joe Lauer, UW Madison Agronomy Dept; and Emeritus Professor Bruce Jones, UW Madison Animal & Dairy Sciences Dept.

| Enter # Milking Cows in Herd | 850 |
|---|---|

Legend: Data Input; Calculated Output

| COW | Control | Enogen |
|---|---|---|
| DMI, lb/d | 58.4 | 58.0 |
| Milk, lb/d | 85.5 | 89.9 |
| Fat % | 4.00 | 3.82 |
| Protein % | 3.11 | 3.07 |
| Other solids, % | 4.86 | 4.92 |
| SCC | 72,000 | 135,400 |
| Fat, lb/d | 3.40 | 3.42 |
| Protein, lb/d | 2.65 | 2.76 |
| Other Solids, lb/d | 4.17 | 4.41 |
| Fat, $/lb* | 3.1770 | 3.1770 |
| Protein, $/lb* | 2.8944 | 2.8944 |
| Other Solids, $/lb* | 0.4853 | 0.4853 |
| SCC Adjust $/1000 cells* | 0.00107 | 0.00107 |
| SCC Premium, $/cwt* | 0.00129 | 0.00129 |
| Milk Revenue, $/cwt | $ 24.37 | $ 23.64 |
| Milk revenue, $/head/d | $ 20.84 | $ 21.26 |
| Revenue difference $/head/d | | $ 0.42 |
| Revenue difference $/herd/d | | $ 357.84 |
| Revenue difference $/herd/year | | $ 130,612.64 |

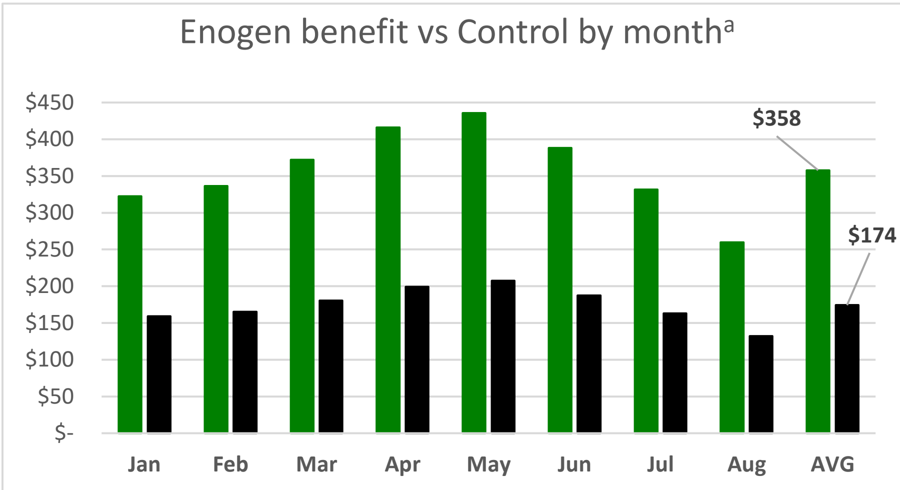
| CORN SILAGE | Control | Enogen |
|---|---|---|
| % in TMR DM | 40 | 40 |
| 35%-DM Tons Harvested/Acre | 24.0 | 24.0 |
| Storage DM Loss, % | 12 | 12 |
| Bunk Feed Refusal Target, % | 3 | 3 |
| Acres for Milking Herd for Year | 431.6 | 428.3 |
| Corn Silage Production Cost per Acre | $ 850 | $ 850 |
| Corn Silage Production Cost per 35%-DM Ton | $ 35 | $ 35 |
| Corn Silage Production Cost for Milking Herd for Year | $ 366,824 | $ 364,061 |
| Non Corn Silage TMR DM, $/lb | $ 0.180 | $ 0.180 |
| Income for Milking Herd for Year | $ 6,466,278 | $ 6,596,891 |
| Feed Cost for Milking Herd for Year | $ 2,324,370 | $ 2,306,864 |
| IOFC for Milking Herd for Year | $ 4,141,908 | $ 4,290,027 |
| IOFC Difference for Milking Herd for Year | | $ 148,118 |
| IOFC Difference per Cow per Year | | $ 174 |

Data in columns C and D, rows 6-14 and columns H and I, row 6 are published PSU values or calculated from published values

DMI, milk fat % and yield, protein % and SCC did not differ significantly ($P \geq 0.17$) while MY, protein yield, OS % and yield were significantly greater for cows fed Enogen silage vs control silage($P < 0.05$)

*FMMO published monthly component values: 2022 Average

**Figure 4. Effect of changes in monthly FMMO component prices on model results**




[a] Calculated using 2022 published monthly FMMO component prices
[b] Herd of 850 milking cows
[c] Feed cost, $/head/day   Enogen diet: $7.44, Control diet: $7.49

**Enogen revenue advantage vs Control**

**$ / herd[b] / day**

Average    $358
Range    $260 - $436

Equates to average annual benefit of $130,629 (range $94,897 to $158,984)

**Enogen IOFC advantage vs Control**

**$ / cow / year[c]**

Average    $174
Range    $132 - $208

Equates to annual benefit of $148,118 for the herd[b] (range $112,403 to $176,490)

Similar results were found for beef cattle, where a feed efficiency improvement of 5.7% observed in finishing cattle fed rations containing Enogen as dry-rolled corn translated to environmental savings in the finishing feedyard of 5.6 to 6.1% for the four key impact categories.[5] This also translated to 12 fewer days on feed to reach target weight** and economic benefits of approximately $39,000 per 1000 head ($39/head) under current conditions (unpublished). Simply replacing their current hybrids with Enogen hybrids could allow producers to reap meaningful economic benefits while simultaneously reducing environmental impacts from beef and dairy production.

**Days on feed to reach 1300 lb target average live weight from beginning average live weight of 648 lb.

[1]Cueva et al. 2021. Lactational performance, rumen fermentation, and enteric methane emission of dairy cows fed an amylase-enabled corn silage. J. Dairy Sci. 104, vol 9, 9827-9841 https://doi.org/10.3168/jds.2021-20251

[2]Based on LCA conducted by the Sustainable Solutions Corp. 2021, for 1000 lactating cow dairy herd annual ECM production, using these experimental data and resources: Cueva et al.. 2021. J. Dairy Sci. 104, vol 9, 9827-9841 https://doi.org/10.3168/jds.2021-20251; 39.5 kg average ECM/cow/day basis; equivalencies calculated using these calculators: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator; and https://www.eia.gov/energyexplained/units-and-calculators/energy-conversion-calculators.php

[3]Source: J.G. Lauer, 2019, https://ipcm.wisc.edu/blog/2019/04/brown-midrib-and-leafy-corn-silage-performance-a-new-bmr-economics-calculator/

[4]R.D Shaver. 2019. Enogen corn silage research summary. Proc. 4-State Appl. Nutr. & Mgmt. Conf. Dubuque, IA.

[5]Matlock et al. Analysis of life cycle environmental impacts of using Enogen corn in beef cattle rations. Animals 2021, 11, 2916. https://doi.org/10.3390/ani11102916