



PLANT-BASED PERFORMANCE

How INSITE® EcoComfort™ insole foams use bio-based compounds to lower your carbon footprint —while enhancing the performance of your shoe

insiteinsoles.com





INTRODUCTION

susterra
bio-based performance

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As the effects of climate change become more evident in our daily lives, the footwear industry has a clear obligation to reduce its environmental impact. That's why many brands are shifting from petrochemicals to plant-based alternatives for their material sourcing.

But do plant-based materials uphold the performance and durability standards we've come to expect in the petroleum era?

At INSITE®, we believe the answer is yes. And like everything we do, that belief is based on data.

INSITE EcoComfort™ insole foams use Susterra®, a corn-based bio-propanediol (bio-PDO), to replace a percentage of the petrochemical ingredients used for making polyurethane (PU). This does more than just reduce our carbon emissions and non-renewable energy use; the unique molecular structure of Susterra also enhances the durability, elongation, and strength of the foam.

In this paper, we will explore the science behind INSITE EcoComfort foams with Susterra bio-PDO – and how you can build a more sustainable shoe without compromising on performance.

Q: What is bio-propanediol (bio-PDO)?

A: It's a molecule that replaces one of the key petrol-based ingredients in polyurethane (PU) foam.

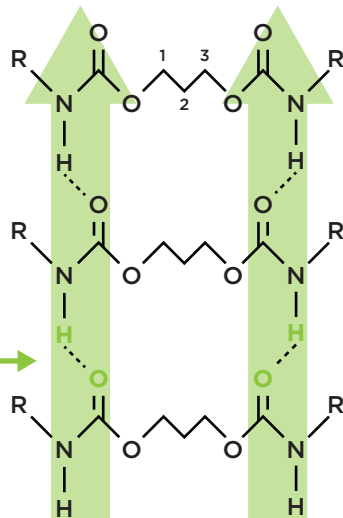


PU foams are made from a chemical reaction between an isocyanate and a polyol. These polyols – typically polyester or polyether – are often derived from petrochemical sources. This is what Susterra is made to replace.

Susterra bio-PDO is made by fermenting glucose from industrial field corn to produce 1,3-propanediol. Chemically speaking, this molecule is identical to the petrol-based 1,4-butanediol often used in PU foams. The only difference is that Susterra molecules have longer hydrogen bonds.

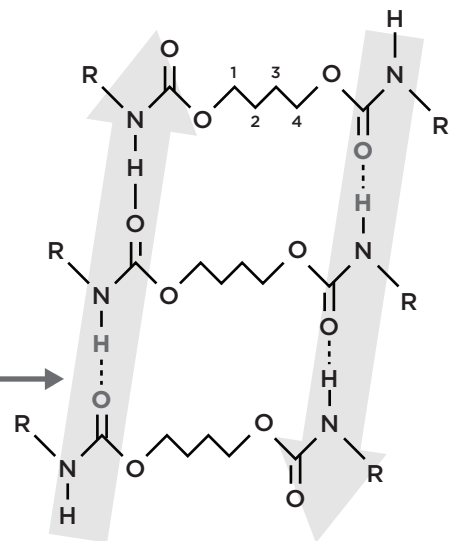
**SUSTERRA
Propanediol
(1,3-PDO)**

**Longer
hydrogen
bonds**



**1,4-Butanediol
(1,4-BDO)**

**Shorter
hydrogen
bonds**



Longer hydrogen bonds mean greater flexibility, which gives INSITE EcoComfort foams better tensile strength, elongation, and tear strength over 100% petrol-based PU.



HARVEST:

Renewably sourced feedstocks are harvested, dried, then wet-milled to create a range of carbohydrate-rich feedstocks like glucose.



FERMENTATION:

Glucose is converted into 1,3 propanediol using a patented microorganism under exact temperatures and conditions.



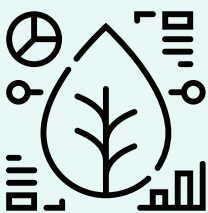
REFINING:

The 1,3-propanediol is refined to a final purity of 99.7% by deactivating and removing the microorganism, water, and other byproducts.



FOAM:

The bio-propanediol is used to create the polyurethane foam used in products like INSITE EcoComfort insoles.



PHYSICAL PROPERTIES SUMMARY:

Susterra is a plant-based PDO derived from field corn that enhances the overall performance of INSITE EcoComfort PU foams.



Q: What are the environmental benefits of Susterra?

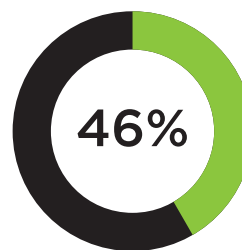
A: Susterra significantly reduces carbon emissions and non-renewable energy use compared to petrol-based PDO.



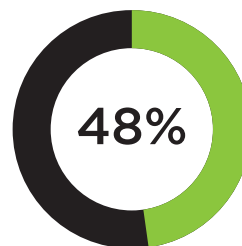
Susterra bio-PDO offers a twofold approach to reducing CO₂ emissions.

First, by replacing a portion of the petrol-based ingredients in PU, it keeps one of the main contributors to climate change in the ground and out of the atmosphere.

Second, plant-based feedstocks absorb CO₂ to help sequester carbon that is already in the atmosphere.

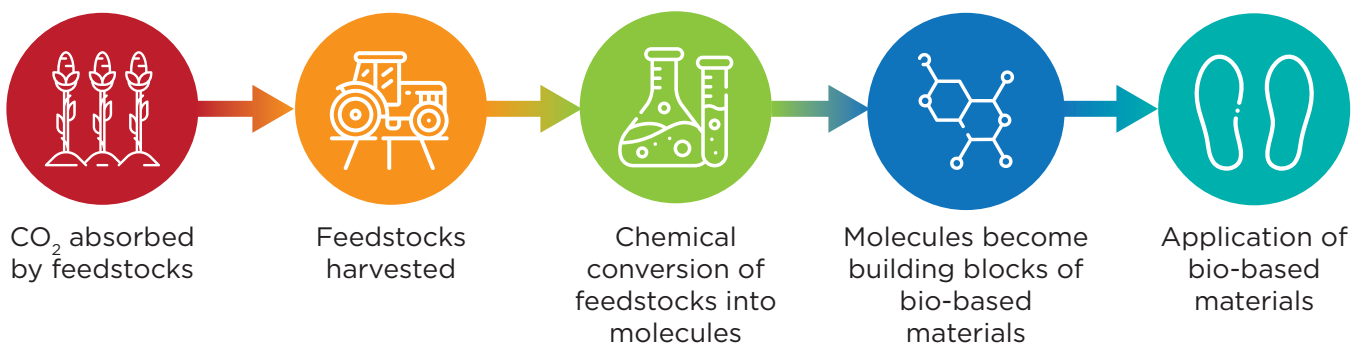


Reduction in greenhouse gas emissions*



Reduction in non-renewable energy use*

*Based on a 2019 cradle-to-gate life cycle assessment study comparing Susterra bio-PDO to petrochemical alternatives. See next page for LCA summary.



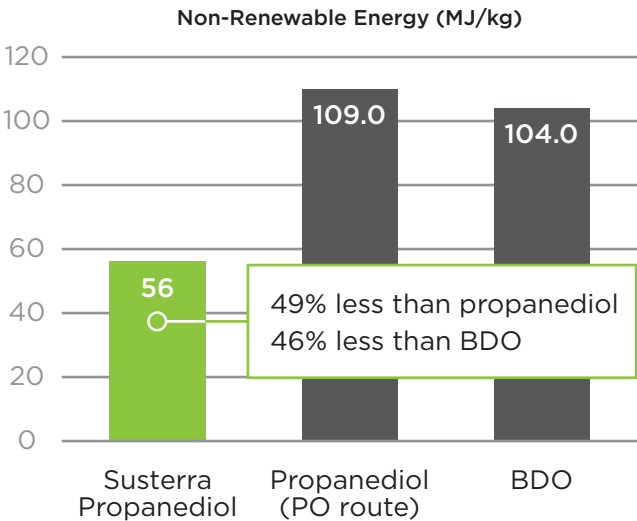
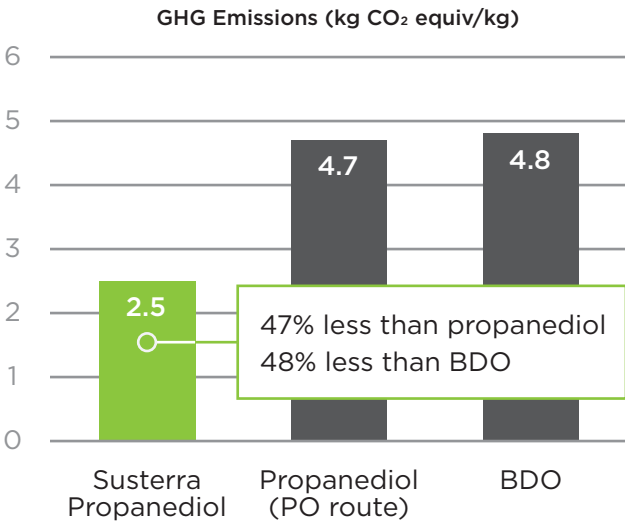
Susterra Life Cycle Assessment Summary

In 2019, Dupont Tate & Lyle, the parent company of Susterra, conducted a cradle-to-gate lifecycle assessment study on Susterra. The study was performed by Dupont engineers and reviewed by a third-party review panel. Raw materials, utilities, and process outputs including emissions were tracked from the farming process to the production of the Susterra Bio-PDO.

All materials contributing more than 1% of the mass of the Bio-PDO were reviewed in the study. The processes modeled in the assessment included:

- Corn grain production
- Corn wet milling
- Processes at the Dupont Tate & Lyle facility
- Energy models

Impact category	Units (per kg)	Susterra propanediol	Petroleum-based 1,3-propanediol	Propylene glycol	1,4-butanediol
Non-renewable energy use	MJ	56.1	108.8	95	103.8
Climate change potential	kg CO ₂ eq	2.51	4.7	4.25	4.77
Water use	liters	117	Not calc.	19.5	55.1
Agricultural land use	m ²	2.01	0	0	0



Petrochemical materials are responsible for 4% of all CO₂ emissions, nearly 2 times that of the aviation industry. The Lifecycle Assessment found that Susterra Bio-PDO produces 48% less carbon emissions than petrol-based PDO. The same assessment also found that Susterra uses 46% less non-renewable energy. For a full LCA findings report, contact your INSITE sales rep.

Q: How does Susterra compare to castor oil?

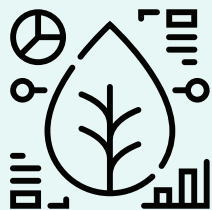
A: Susterra offers better physical properties for better performing ergonomic foams.



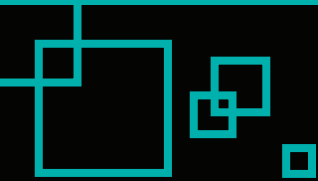
Castor oil is another popular feedstock for producing bio-PDO for PU foams. Like Susterra, it can be an effective means for carbon emissions reduction. However, Susterra’s physical properties allow for better ergonomic performance — which is why INSITE uses it as our primary sustainable foam solution.

Physical property	Units (per kg)	Susterra	Castor oil
Density	g/cm ³	0.22	0.22
Tensile strength	Mpa	0.6097	0.2173
Elongation	%	189.1607	39.1396
Tear strength	KN/m	3.6388	2.43265

In 2019, a study compared 11% castor oil derived PU insoles to ones made with 25% Susterra. While both Susterra and castor oil achieved similar density, Susterra outperformed castor oil for tensile strength, elongation, and tear strength.



SUSTERRA VS. CASTOR OIL SUMMARY:
Susterra has greater physical properties for ergonomic foam than castor oil derived PDO, which is why INSITE uses it as the primary ingredient in our sustainable foam blends.



CONCLUSION

INSITE's mission is the wellness of your footwear customers. It's what motivates our data-driven approach to underfoot comfort. It's also the foundation of our commitment to sustainability.

There is no denying the damaging effects that climate change has on the health and safety of the world. Petrochemical materials account for roughly 4% of all carbon emissions – twice that of the aviation industry. We believe the footwear industry must dramatically reduce its fossil fuel dependency to address this problem.

The good news is, thanks to innovations like Susterra, we can make this transition while delivering a product with even better ergonomic benefits than before. INSITE is committed to helping you bridge the gaps between performance, sustainability, and cost – so you can build a shoe that's better for your customers, and better for the planet.





IT'S WHAT'S INSIDE THAT COUNTS.

Build insoles with data-driven comfort, performance, and support — using plant-based materials that are helping to build a better world.



ONE STEP FURTHER.

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