Understanding the d-limonene supply squeeze
Addressing the impact on formulators
Who is Elevance Renewable Sciences?

- High-performing, novel specialty chemicals from renewable feedstocks
- Nobel Prize-winning technology
- US EPA Green Chemistry Challenge Award winner
- Crain’s Chicago Most Innovative Company Top 25 list
- 180,000 MT biorefinery in Gresik, Indonesia in operation
- Additional biorefineries in engineering
- More than 10 high-performance products commercialized in past year
- Several industry awards
Using technology to repurpose nature’s ingredients to make products better—without depleting the sources
Understanding the d-limonene supply squeeze
d-Limonene demand continues to grow

- Projections show a 70% increase in demand from 2011 to 2021
- Cleaning products account for 77% of d-limonene usage
However, d-limonene is a by-product of orange juice production...
...and orange juice consumer demand continues to decline.

- Now at a 12-year low
- 50% decline in demand
- New drink alternatives have come into the marketplace
- Higher prices for OJ adds to the reduced consumption
Worse yet, disease is systematically damaging orange groves

• Florida and Brazil orange production accounts for 75-80% of global supply
• Citrus Greening has devastated both mature trees and nursery stocks in Brazil and Florida—and there is no known cure
• Price of orange juice futures are up 43% since Sept 2015
• 2015 orange harvest will be lowest since 1964
• The impact is global with a focus in North America, South America, Europe, and Asia
The d-Limonene squeeze is a long term and growing problem
Addressing the impact on formulators
The formulator thinks about cleaning as an equilibrium

Specialty chemical providers must understand that the formulator is seeking to reduce the time, temperature and physical effort that their customer needs to use to get a job done.
The decision to formulate a cleaner that contains solvent is driven by the difficulty of the task.
Elevance Clean™ 1000 + d-Limonene

THE PERFECT COMBINATION
Elevance Clean™ 1000: Mitigating price and supply volatility of d-limonene

This high-performing, bio-based ester easily formulates with d-limonene in tar/asphalt removal and degreasing products.

• **Protects profitability** by insulating from supply shortages and price instability

• **Boosts product performance** while maintaining citrus aesthetic

• **Assimilates well** in existing d-limonene formulations; similar HLB requirement
Elevance Clean™ 1000: Protecting profitability

Elevance technology has the unique ability to upgrade any commodity feedstock to provide Elevance Clean™ 1000 extender. No citrus. No problems.

• **Offers flexibility** to reduce dependency on single feedstocks (unlike d-limonene) and to manage volatility

• **Provides ability to localize feedstocks**, shortening supply chains

- Soybean Oil
- Palm Oil
- Canola Oil
- Corn Oil
- Jatropha Oil
- Algae Oil
- Tallow
- Mustard Oil
Elevance Clean™ 1000: Boosting performance

Elevance Clean™ 1000 is more effective in the removal of persistent grease than d-limonene. The higher the proportion blended, the better the performance.

![Bar chart showing % Asphalt Removal](chart)

**ASTM D4488-95 (mod) | Testing Cleaning Performance of Products Intended for Use on Resilient Surfaces**
Driveway sealcoat tar | 3” x 3” 0.5-mm thick film centered on 3” x 6” plate | 24 h cure @ 23°C | 10 mL solvent-imbibed cellulose sponge | Gardner Scrub Apparatus | Cycled to achieve 80% removal (visual) | Image analysis quantification | Formulation: 80% solvent, 10% emulsifier, 10% rinse aid.
Elevance Clean™ 1000: Boosting performance

Elevance Clean™ 1000 is more effective in the removal of tenacious, persistent grease than d-limonene.

**ASTM D4488-95 (mod) | Testing Cleaning Performance of Products Intended for Use on Resilient Surfaces**
Cured lithium grease | 3” x 3” 0.3 mm thick film centered on 3” x 6” plate | 15 h at 160°C then 2 h at 200°C | 5.00 mL solvent-imbibed cellulose sponge | Gardner Scrub Apparatus | Formulation: 20% solvent aqueous microemulsion
Elevance Clean™ 1000: A whole better solution

Solving the d-limononene supply squeeze, while improving the safety profile of d-limononene-containing formulations.

• Large, secure supply

• Economical versus d-limononene

• Broad applicability to extend d-limononene usage across industrial cleaning applications for greases, asphalt, tar, crude oil, and fats

• Easy to formulate in existing d-limononene based formulations

• Boosts performance when used with d-limononene

• Improved EHS profile for reducing VOC, flammability, skin sensitization, aspiration toxicity
Thank You

Steve Block
Business Development Manager
Steve.Block@elevance.com

Ryan Littich, PhD
Director, Application Development
Ryan.Littich@elevance.com