The Nitrogen-Corn Silage Response Function Using Dairy Effluent: Evidence from California Central Valley Dairies

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Introduction:

- California Dairies are required to self-report N-P-K application and crop yield data
- A 2026 Stanford Study exposes the overapplication of Nitrogen across dairies in the Central Valley(CV)

Research Questions:

- What does the N production function look like for corn silage?
- Does N from dairy effluent have a significant effect on the yield?

Objectives:

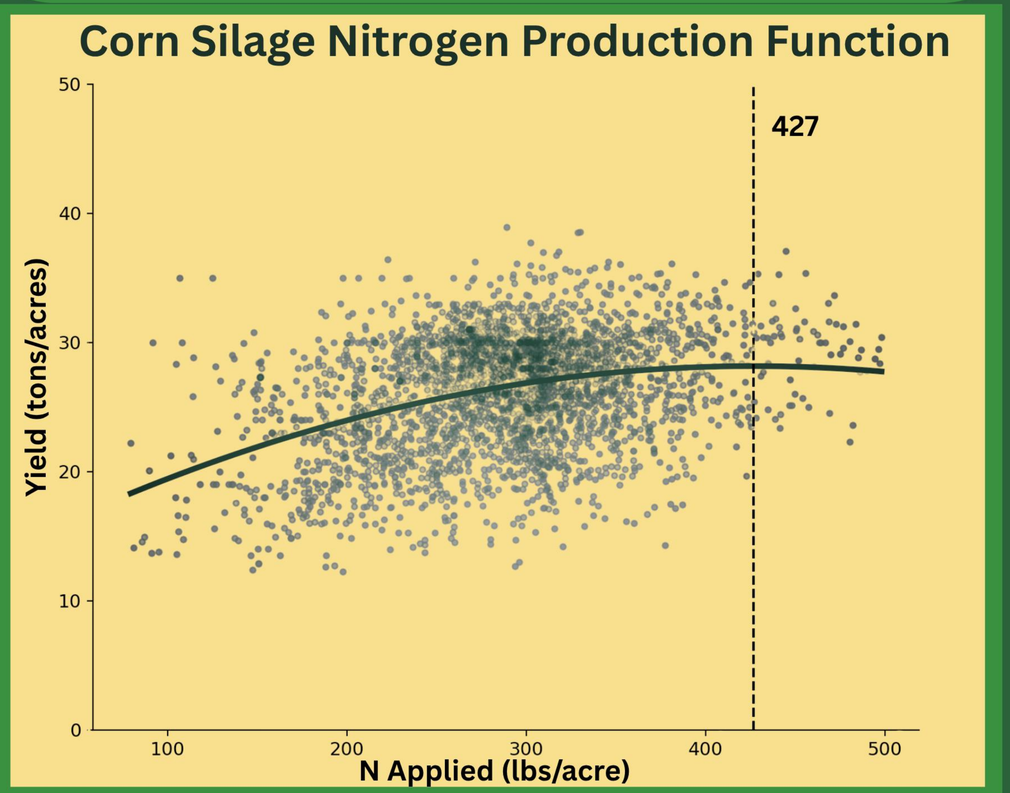
- Construct a dataset that links crop yield to the actual amount of applied N per field, per dairy
- Determine the N application rate that maximizes corn silage yield by estimating an N production function

Acknowledgements:

- Dr. Sean Hurley
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Methodology:

- Extracted data from 595 CV dairies' Annual Reports in PDF format using Python, built with AI assistance
- Validated extraction against source PDFs, then used Python to remove values beyond 3 standard deviations from the mean
- Utilized AI prompt engineering to build a Python script to extract records into modeling variables to run multiple regressions
- Fit a quadratic regression for nitrogen
- $Yield = \beta_0 + \beta_1 \cdot N + \beta_2 \cdot N^2$ to estimate corn's yield response to N
- Estimated a production function to find yield based on N application
- Estimated a quadratic relationship between N and corn



Results:

- Yield-maximizing rate: 427 lbs N/acre. ($R^2 = 0.12$)
- Average: 289 lbs/acre
- $Yield = 13.28 + 0.070(N) - 0.00008(N^2)$, $t = 5.10(N)$ and $t = -3.61\ (N^2)$

Conclusion:

- 427 lbs/acre is over double UC Davis's guideline of 180 lbs/acre
- 87% of fields exceed UC Davis's regulatory-adjusted guideline of 1.4x N application
- $R^2 = 0.12$ explains a minor share of yield variation
- If N application is under-reported in these findings, the true gap could be larger than what this model captures.

References:

- Stanford Law School Environmental and Natural Resources Law & Policy
- UC Davis