Computing Uncertainty in the Optimum Nitrogen Rate Using a Generalized Cost Function

An overview of the EONR Python package

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2019 NUE Workshop
Columbia, MO
6 August, 2019

#WickedNitrogen
Economic optimum nitrogen rate (EONR)
Have you ever...

• Calculated (and reported) the uncertainty associated with the EONR?

• Calculated the EONR from a N response trial?

• Considered costs other than N fertilizer costs?
1) Uncertainty:

It is not intuitive to calculate uncertainty about the ONR.
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2) Generalized cost function: The traditional MRTN approach does not extend past the cost of $N$ and the price of grain.
Uncertainty

It is widely recognized that large uncertainties exist around the estimated ONR computed from yield data and that it is essential to report CIs.
...yet there are only a few reports where CIs are actually calculated
Methods to compute uncertainty

Wald-type (+/- 1 SE)

- Poor performance with small sample sizes and nonlinear models
- \( \hat{\theta} \pm Q(t_d, 1 - \alpha/2) SE(\hat{\theta}) \)

Bootstrapping

- Sampling residuals of the original data with replacement
- Worthy alternative, but not always perfect

Profile-likelihood

- Most accurate of any of the approaches
- \( \tau(\hat{\theta}_2) = \frac{(SSE(\bar{\theta}_2) - SSE(\hat{\theta}_2))/q}{SSE(\bar{\theta}_2)/(n - p)} \)

+/- $1
per acre return
No statistical basis!
1) Uncertainty:
It is not intuitive to calculate uncertainty about the ONR

2) Generalized cost function:
The traditional MRTN approach does not extend past the cost of N and the price of grain
In addition to the cost of N and price of grain, we want to consider costs that:

Increase proportionally to the quantity of residual/excess nitrogen
How do we place a value on pollution and other damages caused by nitrogen fertilizer application?
The present value of monetary damages caused by an incremental increase in nitrogen

Keeler et al. (2016)
a Python package

https://eonr.readthedocs.io
A Python package to compute the optimum nitrogen rate and its confidence intervals

..using a generalized cost function

Full documentation at:
https://eonr.readthedocs.io

• Installation instructions
• Tutorials
• Full description of features and API

*Quadratic-plateau is the only model currently supported
Economic optimum nitrogen rate (EONR)

2012 Minnesota - Pre N Fertilizer Timing

- Gross return to N
- Net return to N
- N fertilizer cost
- Confidence (0.90)

Grain price: $0.16
N fertilizer cost: $0.88
Price ratio: 5.61
Base zero: $1214.51

EONR: 162 kg per ha
MRTN: $767.93

Return to N ($ per ha)
N Rate (kg per ha)
“Socially” optimum nitrogen rate (SONR)
“Socially” optimum nitrogen rate (SONR)
makes it easy to report uncertainty... and possible to consider externalities.
Thank-you!

Please get in touch!

Financial support provided by:

• MnDRIVE

• Minnesota Corn Promotion and1592.458


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