Analyzing higher moments of nitrogen response for risk efficient fertilizer application in wheat and corn production

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Background

- The question of optimal fertilizer intensity has a long history and is still relevant from several perspectives.
- While it is obvious that the optimal input use contributes to economic benefits for the farmer, understanding the economically optimal use of nitrogen fertilizer may help to address environmental policies more efficiently.
- Literature shows that nitrogen (N) fertilizer applications to agricultural crops often exceed the rate recommended by officials or advisors. One possible explanation is farmers' response to uncertainty.
- This study contributes to this question based on long term crop response data in Canada and Germany.

Problem Statement and Objective

- To what extent may risk aversion determine optimal fertilizer rates?
- What impact can be expected from higher moments (skewness, kurtosis) of the distributions of expected returns?

Data

- Data were taken from long term nitrogen response field experiments in Germany and Canada over a period of 9 and 27 years, respectively.
- Trend corrected response data were analyzed for their moments of distribution.

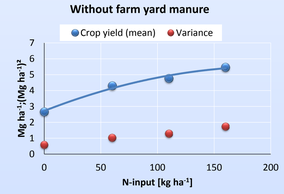
Experimental site	Number of N-treatments	Crop	Duration	Additional factors
Dahlem (Germany) Köhn et al. 2000	4	Wheat	27 years	Manure management
Ontario (Canada) Rajsic et al. 2009	6	Corn	9 years	-

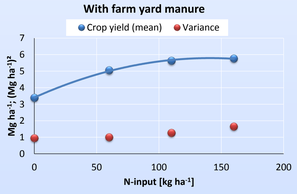
Methods

- The predominant paradigm for analyzing the impact of uncertainties on agricultural decisions is the expected utility framework (Anderson et al., 1977).
- A measure to indicate the risk efficiency of a monetary yield from a risky production option is the certainty equivalent (CE).
- We compare CE maximizing N-rates (Nopt) derived from the mean-variance approach (see Robison and Barry, 1987) and CE maximizing N-rates derived from the risk efficiency approach proposed by Hardacker et al. (2004) for different levels of risk aversion.
- While the mean-variance approach does not take into account the higher moments of the distributions of the variable outcome. The approach by Hardacker et al. (2004) calculates the utility of each observation and calculates the certainty equivalent, taking into account the higher moments of the distributions.

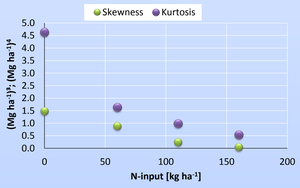
Results

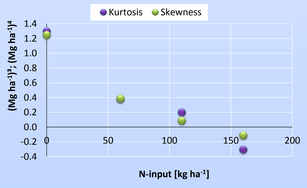
Dahlem (Germany)



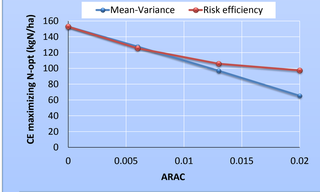


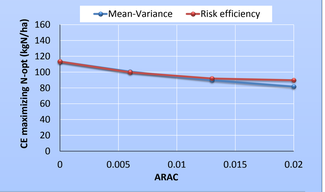
- Variance increases with N rate for both treatments
- In the narrow sense, this implies that N is a risk-increasing input





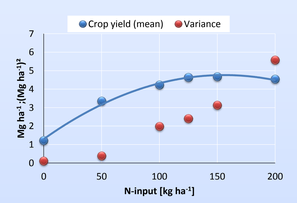
- Skewness and kurtosis decline with increasing N-rates
- => N is to some extent a downside risk- decreasing input



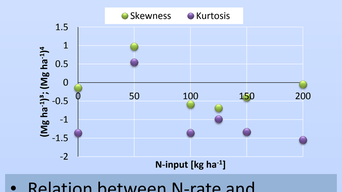


- Under consideration of risk aversion Nopt is reduced
- Mean-Variance approach over-estimates the impact of risk aversion at high levels of risk aversion.

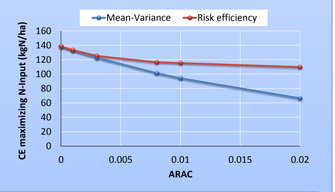
Ontario (Canada)



- Variance increases with N-rate but
- by a greater extent than in Dahlem



- Relation between N-rate and skewness/kurtosis not as clear as in Dahlem



- Similar patterns as in Dahlem, with more pronounced differences

Conclusions

- Nitrogen fertilizer showed to be variance increasing for corn and wheat production in Canada and Germany.
- Even though skewness and kurtosis showed to mitigate the downside risk to some extent the overall marginal effect of risk aversion showed a nitrogen fertilizer reducing rather than a nitrogen fertilizer increasing effect.
- The mean-variance approach to calculate the certainty equivalent showed to produce similar optimal N rates compared to the risk efficiency approach proposed by Hardacker et al. (2004) for low levels of risk aversion.
- With higher levels of risk aversion the mean-variance approach may overestimate the impact of risk aversion on risk efficient N levels.
- This effect is limited in Canada and Germany, where levels of absolute risk aversion only in exceptional cases exceed values of 0.01. In developing countries the deviation of the two methods may have a greater impact.

References

Anderson, J.R., Dillon, J.L., Harddakker, B. (1977) Agricultural Decision Analysis. Iowa Sate University Press.

Hardaker, J. B., Richardson, J. W., Lien, G., Schumann, K. D. (2004) Stochastic efficiency analysis with risk aversion bounds: a simplified approach. Australian Journal of Agricultural and Resource Economics, 48: 253–270.

Köhn, W., Ellmer, F., Peschke H, Chmielewski F-M, Erekul O (2000) Dauerdüngungsversuch (IOSDV) Berlin-Dahlem Deutschland. UFZ Bericht 15/2000, pp. 25–35.

Rajsic, P., Weersink, A., Gandorfer, M. (2009) Risk and nitrogen application levels. Canadian Journal of Agricultural Economics, 57: 223–239.

Robison, L.J., Barry, P.J. (1987) The competitive firm's response to risk. Macmillian Publ. Co., New York.

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