Economic Risk Analysis of Adopting Enhanced-Efficiency Urea Fertilizers in Winter Wheat Production of the Southern Great Plains

Yubing Fan[1]; Curtis B. Adams[1]; Santanu B. Thapa[1]; Seong C. Park[2]

1 Texas A&M AgriLife Research, Vernon, TX; 2 Tennessee Tech University, Cookeville, TN

Background and Objectives

- Urea is a common N source for winter wheat due to its low price, though potential N loss by volatilization can make urea a less effective fertilizer.
- To minimize N loss, growers may split urea applications at planting and mid-winter or use enhanced-efficiency fertilizers.
- This study investigates the performance of enhanced-efficiency urea fertilizers on dryland winter wheat in the Southern Great Plains.
- This study evaluates the risk-adjusted profitability of enhanced-efficiency urea fertilizers and application strategies in wheat production.

Data and Methods

- Locations: Two Texas A&M AgriLife properties near Vernon, TX
- Soil type: Abilene clay loam soil
- Climate and precipitation: Semi-arid, 260 mm (Nov. 2016-May 2017)
- Cropping system: Dryland no-till winter wheat
- Exp. design: Randomized complete block design with 4 replications.
- Plot size: 40 plots per location; 4.06 m wide and 9.14 m long.
- ***Ten treatments*** *(Adams et al., 2018):*

(1) Zero urea (N0)

Application at planting, 31.5 kg N ha^{-1}

(2) Untreated urea (Urea31.5)

(3) Polymer-coated urea (PCU31.5)

(4) Stabilized urea (SU31.5)

Application at planting, 70 kg N ha^{-1}

(5) Untreated urea (Urea70)

(6) Polymer-coated urea (PCU70)

(7) Stabilized urea (SU70)

Applications split at planting and mid-winter, total rate 70 kg N ha^{-1}

(8) Untreated urea (Urea70S)

(9) Polymer-coated urea (PCU70S)

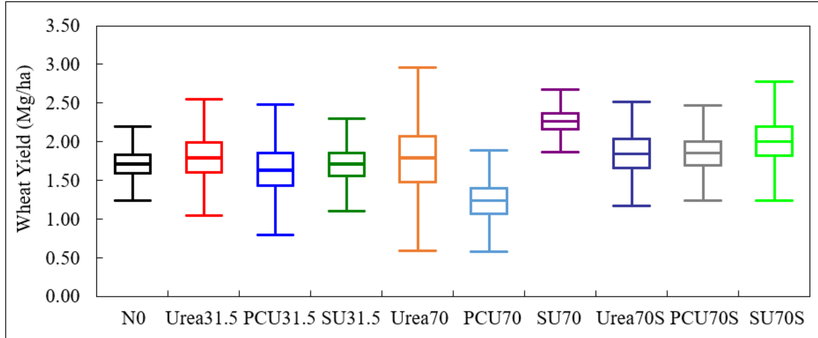
(10) Stabilized urea (SU70S)

- ***Simulation and analytical procedures*** *(Richardson et al., 2008):*
  - Simetar: Multivariate normal distribution, 500 iterations
  - Validation: Field data vs. simulated data series
  - *Net return = price × yield – total cost*
  - Stochastic Efficiency with Respect to a Function (SERF)
  - Absolute risk aversion coefficient (ARAC)
  - *Certainty equivalent (CE)*
  - *Risk premium (RP)* is the minimum payment that a decision maker will have to receive before switching from risky practices B to A under a certain risk aversion level, r_a.

    i.e., $RP_{B,A,r_a} = CE_{B,r_a} - CE_{A,r_a}$

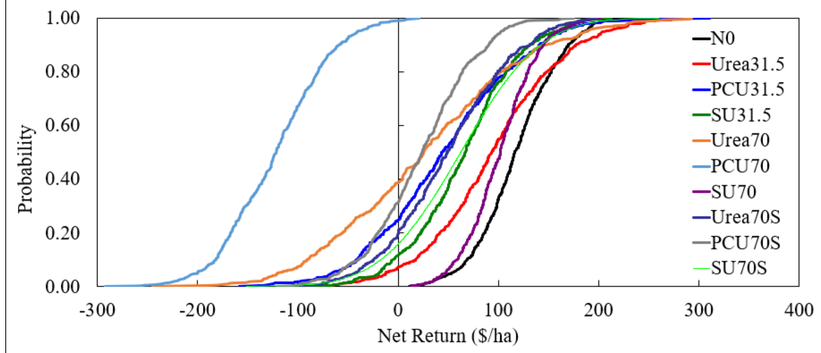
Results – Simulated Yield

- Wheat yield simulations show the largest yield variation in Urea70, followed by a moderate variation in PCU31.5, Urea31.5, and SU70S, while a smaller variation is observed for N0, SU70, and SU31.5.
- The yield is 1.72 and 1.80 Mg/ha for N0 and Urea31.5, respectively, and a greater yield is observed for SU70 and SU70S at 2.26 and 2.01 Mg/ha, resp.
- PCU70 and PCU31.5 have lowest wheat yield—1.24 and 1.64 Mg/ha, resp.



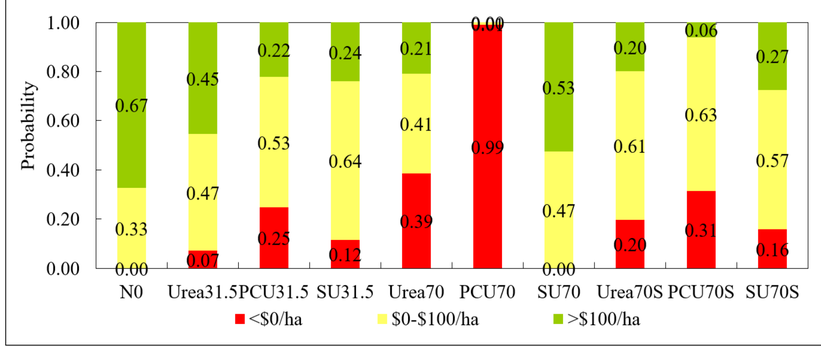
Net Return

- The cumulative distribution functions (CDF) of net returns show N0 has a distribution further to the right, indicating a higher chance of getting a higher net return, followed by Urea31.5 and SU70.
- The CDF distributions of SU31.5 and SU70S are in the middle of the graph and are tighter than other distributions, while PCU70 is further to the left, followed by Urea70 and PCU70S, indicating less farm income.



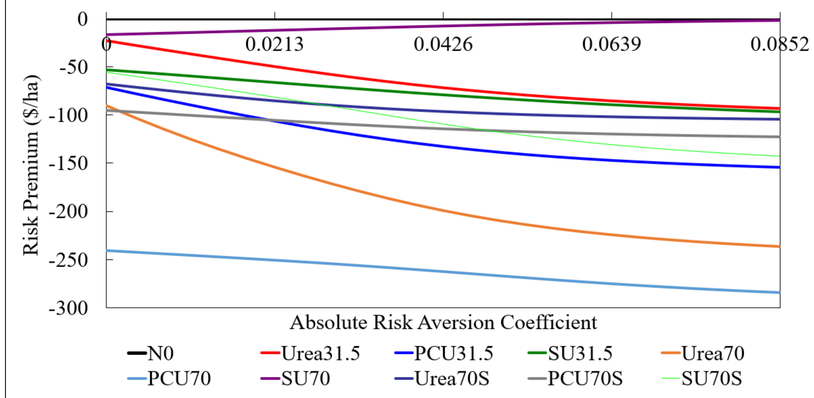
Stoplight Chart

- The probability of average net return >$100/ha is highest for N0 (0.67), followed by SU70 (0.53), and Urea31.5 (0.45).
- For the middle-income category ($0-$100/ha), SU31.5, PCU70S, Urea70S, SU70S, and PCU31.5 have a higher probability, about 0.53-0.64.
- PCU70 is 99% likely to have a negative net return on average .



SERF Results

- N0 is most preferred by risk-neutral, somewhat risk-averse, and rather risk-averse producers, while very and extremely risk-averse producers may not be different with N0 and SU70.
- Risk-neutral producers are not really different with SU70 and Urea31.5, while the more risk-averse he gets, the more likely he becomes more preferred to SU70.
- PCU70 is the least preferred strategy regardless of risk aversion levels.
- Slight differences are observed for risk-neutral producers, while as producers become more risk-averse, Urea70 and PCU31.5 get less and less preferred.



Summary

- Greatest yield variation is found for wheat managed under Urea70, while less variation for N0 and SU70.
- N0 has the highest probability of obtaining an average net return greater than $100/ha. SU70 has the highest probability among urea applications.
- Very and extremely risk-averse producers would be indifferent between N0 and SU70. However, the N0 treatment would not allow sustainable production due to soil nitrogen depletion.
- Though almost no difference between SU70 and Urea31.5 for risk-neutral producers, they would get much more preferred to SU70 as they become more and more risk-averse.

References

Adams, C.B., Thapa, S.B., Fan, Y., & Park, S. (2018). Agronomic and economic effects of two enhanced-efficiency urea fertilizer technologies on Southern Great Plains winter wheat. *Agronomy Journal*, 110(3), 1097-1102.

Richardson, J.W., Schumann, K., & Feldman, P. (2008). Simetar: Simulation for excel to analyze risk. Department of Agricultural Economics, Texas A&M University. College Station, TX.

Acknowledgements

Supported by the USDA Agricultural Research Service Initiative-Ogallala Aquifer Program (FY2018-2020) and Texas Wheat Producers Board. Yubing Fan is grateful to support from Center Director Dr. Richard Vierling.

Contact information: yubing.fan@ag.tamu.edu