

Article Title: Using spatially variable nitrogen application and crop responses to evaluate crop nitrogen use efficiency

Journal Title: Nutrient Cycling in Agroecosystems

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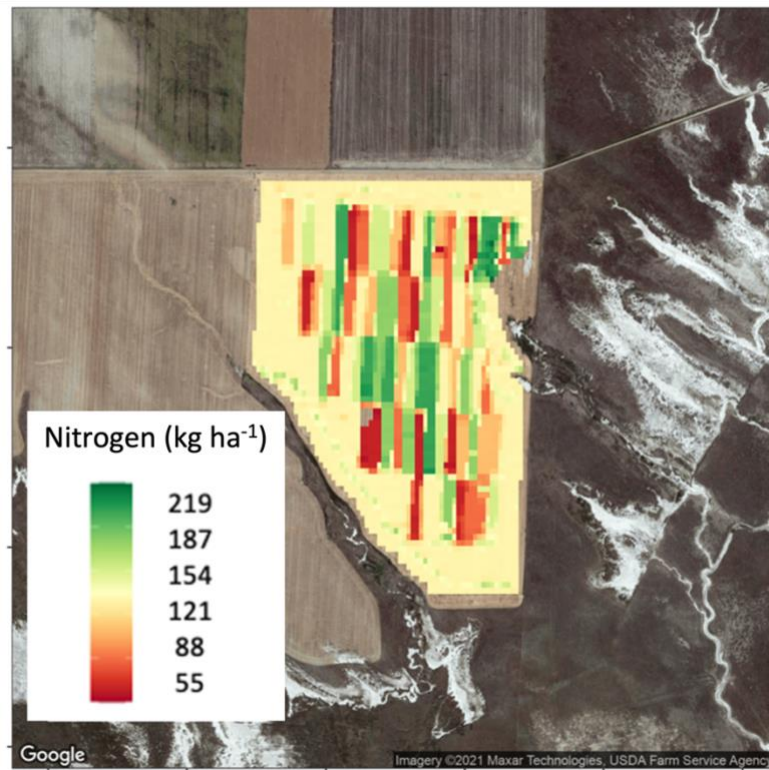
Supplementary Information

SI Table 1. Classification scheme of water holding capacity (WHC) for each pixel based on the mean and coefficient of variation (CV) of normalized difference vegetation index (NDVI). Each pixel is classified based on the mean and CV across the 20 years of data collected.

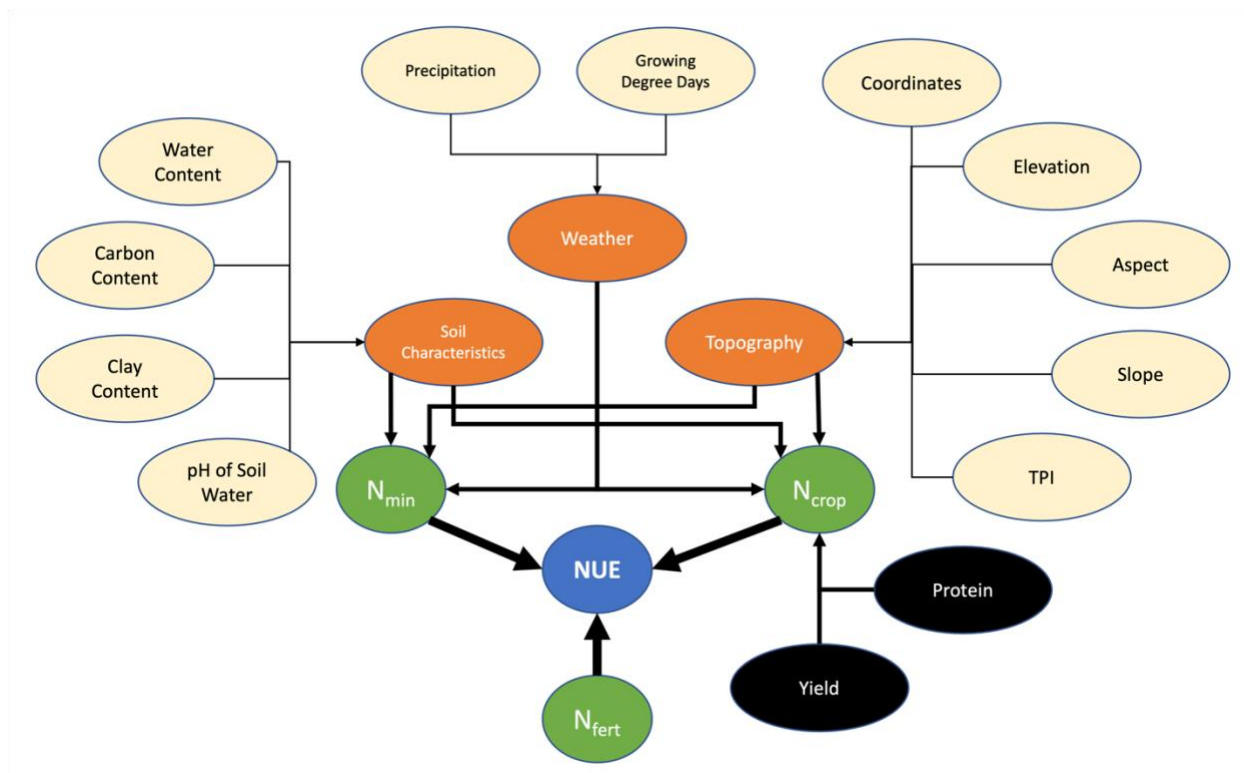
	Low Mean NDVI	Medium Mean NDVI	High Mean NDVI
High CV	Medium WHC	Medium WHC	Medium WHC
Medium CV	Low WHC	Medium WHC	High WHC
Low CV	Low WHC	Medium WHC	High WHC

SI Table 2. Hold-one field out cross validation scheme where one field is held out as a test dataset while three fields are used to train models in each of the four cases.

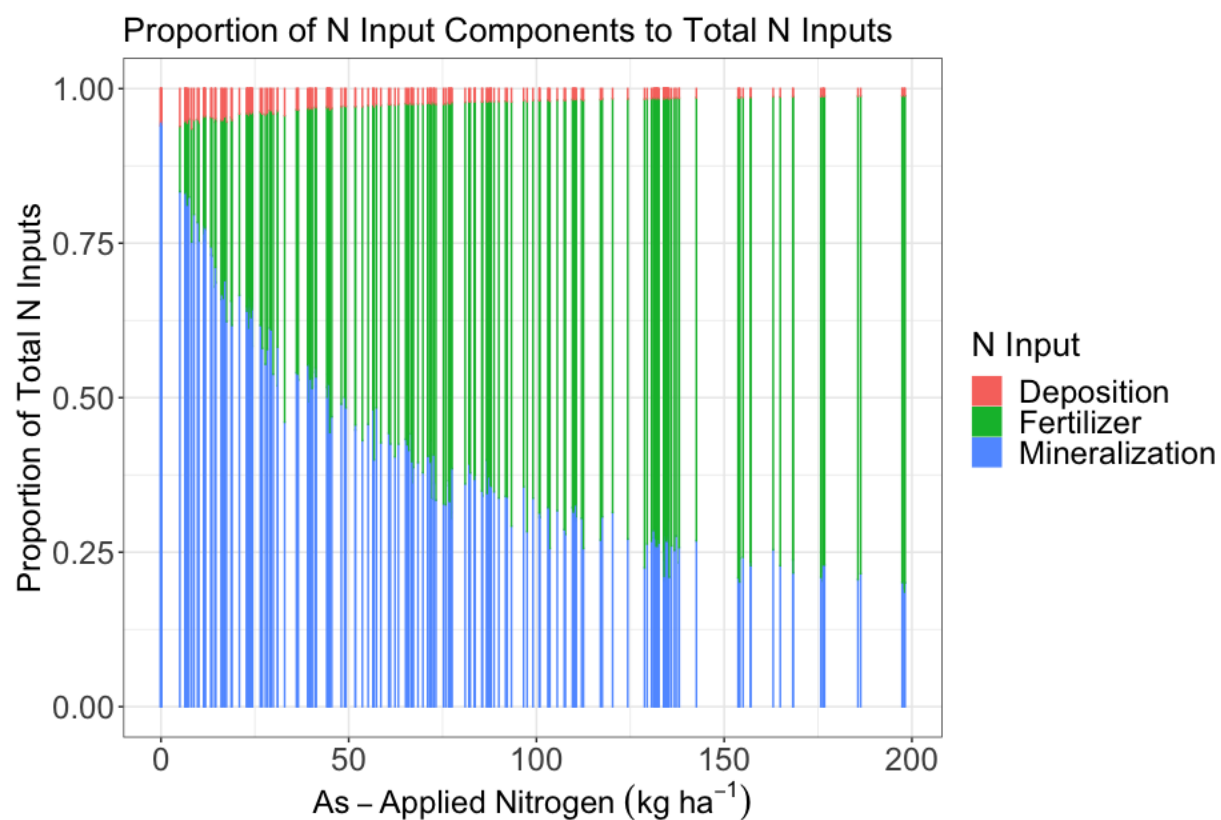
Case	Fields/Years				
A	WH 2020	BS 2020	BSE 2021	MS 2021	Train Test
B	WH 2020	BS 2020	BSE 2021	MS 2021	
C	WH 2020	BS 2020	BSE 2021	MS 2021	
D	WH 2020	BS 2020	BSE 2021	MS 2021	



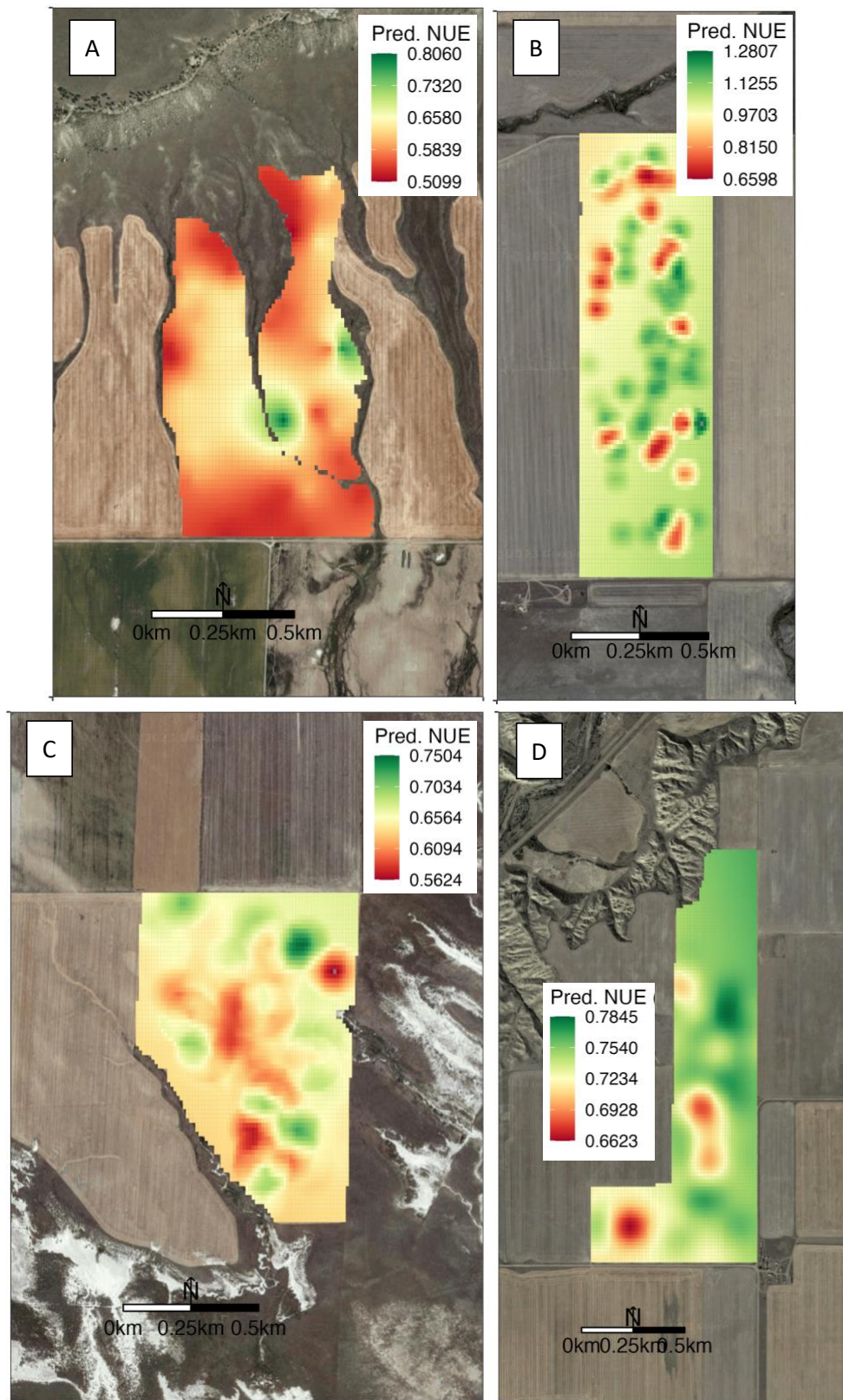
SI Fig. 1. Example of a nitrogen fertilizer experiment applied by the OFPE project on field B1 in 2021, mapped as as-applied nitrogen fertilizer (kg ha⁻¹) rates from farmer B's applying equipment.



SI Fig. 2. Conceptual model of the development of a general nitrogen use efficiency (NUE) model for Montana dryland agroecosystems. Green circles are variables that are used to directly calculate NUE (N_{min} = mineralized N, N_{crop} = N taken up by the crop, N_{fert} = N from fertilizer), thus measuring these variables would provide the best characterization of true NUE. Orange circles are general data types that influence the components used to calculate NUE (green). Yellow circles are data types organized by general data type (orange), that are measured from remote sensing sources. The thickness of connecting arrows represents the strength of the relationship between the variable and NUE, where a variable is more directly related to NUE with thick arrows and more indirectly related with a thin arrow. The strength of a relationship between data and NUE decreases as distance between data and the blue NUE circle increases. Yield and protein would be beneficial data types for predicting crop N uptake and subsequent NUE but are not available data when a farmer models NUE to derive optimal N fertilizer rates.



SI Fig. 3. The proportion of each component of N inputs to the total N inputs across N fertilizer rates. Bars are from observations across all fields. Note that deposition (2.92 kg ha^{-2}) is shown here yet not included in NUE calculations.



SI Fig. 4. Geographically smoothed NUE predictions from the random forest regression (RF). A = BS2020, B = MS2021, C = BSE2021, D = WH2020.