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Can optimization associated with on-farm experimentation using site-specific technologies improve producer management decisions?

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Crop production input decisions have become increasingly difficult due to uncertainty in global markets, input costs, commodity prices, and price premiums. We hypothesize that if producers had better knowledge of market prices, spatial variability in crop response, and weather conditions that drive crop response to inputs, they could more cost-effectively make profit-maximizing input decisions. Understanding the drivers of variability in crop response and designing accompanying management strategies would hence allow increased resilience to economic or climatic perturbations or system stress. We have developed an on-farm precision experiment (OFPE) framework drawing on site-specific agriculture technologies to provide the best estimate of field-specific, site-specific profit-maximizing input application. Our test of the on-farm precision experiment framework was to site-specifically optimize nitrogen fertilizer application rates on 12 dryland winter wheat fields on wheat farms in Montana. After two years of implementing the on-farm precision experiment framework, we demonstrated that nitrogen rate experiments could be applied using a previous year’s yield stratification with standard variable rate fertilizer applicators. In addition, using these empirical results with four different optimization approaches (non-linear regression, Bayesian estimation, random forest and stacked encoder machine learning) we demonstrate that producers could increase net returns in some cases using on-farm experimentation to parametrize optimization models.