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**Evaluating planting date recommendation effects on soybean yield using causal inference**

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Selecting the appropriate planting date is a crucial decision for soybean farmers aiming to optimize yield. Planting date recommendations are usually made through several years of field research data and models. We introduce an observational causal inference framework to assess the impact of adhering to the recommended early planting date on soybean yield improvement. We used farmer field survey data collected from approximately 5000 farms in North Central United States over three growing seasons 2014, 2015 and 2016. We applied our knowledge in agronomy and crop production to develop a causal graph of the soybean farming system. Based on early planting recommendations made by a group of soybean researchers, from 11 different universities in North Central US, we classified the observed planting date of the survey data into optimal or non-optimal planting. Using the backdoor criterion, we identified the minimal sufficient adjustment set and subsequently estimated the average treatment effect using adjusted linear regression, propensity score matching, parametric G-computation, and inverse probability weighting. The results showed that field planted according to the researcher recommended early planting date exhibited a statistically significant yield increase that ranged from 109 to 222 kg/ha depending on the method. The robustness of these effect estimates was supported by their consistency across various estimation methods. Overall, this study presents a comprehensive observational causal inference framework that is beyond the scope of predictive accuracy. This approach is applicable to decision support systems of other fields.