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Cover Cropping and Yield Variability

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Motivation and Objectives

• Existing literature has illustrated that cover crops can improve soil health, provide pest and weed control, and reduce nutrient runoff and erosion (Wood and Bowman, 2021; Qin et al., 2021). There are conflicting hypotheses around the relationship between cover cropping and both average crop yields and crop yield variability, including their influence in mitigating – or exacerbating – the negative consequences of adverse weather events (Isik and Devadoss, 2006; Marcillo and Miguez, 2017).

How does cover crop adoption impact average crop yields?

How does cover crop adoption impact crop yield variability?

Approach

 In order to answer these questions, we primarily rely on the estimation of a model that includes a specified form of heteroskedasticity, following Harvey (1976) and Just and Pope (1978):

(1) $y_{ut} = \chi CoverCrop_{ut} + X_{ut}B + \omega_u + \tau_t + \epsilon_{ut}$

(2) $Var(\epsilon_{ut}) = exp(\xi CoverCrop_{ut} + X_{ut}S + \mu_u + \pi_t + \eta_{ut})$

- y_{ut} is yield of unit u during year t.
- $Var(\epsilon_{ut})$ specifies the form of the variance of the residual of the yield equation.
- X_{ut}, are unit-specific controls including precipitation, temperature, and non-cover-crop EQIP enrollment. Unit fixed effects are included in each equation.
- Regressions are estimated separately for each crop-practice combination (e.g., nonirrigated corn for grain).
- Cover cropping impacts the expected yield by $\hat{\chi}$ and the variance of the residual in a multiplicative way by exp(ξ). These effects are estimated either simultaneously, through a maximum likelihood (ML) procedure, or in two steps, with ordinary least squares (OLS).
- For some specifications, we leverage a Mundlak approach to capturing unit-specific differences, following Wooldridge (2019). For others, we use a more conventional fixed effects construction, as in Noack and Larsen (2019).





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Data

- This research leverages and connects multiple datasets:
- Policy-level yields and plantings reported for crop insurance (USDA-RMA)
- Field-level cover cropping and other planting information reported to Farm Service Agency through mandatory operator filings (USDA-FSA)
- Field-level cover cropping through Environmental Quality Incentives Program (EQIP) voluntary contracts (USDA-NRCS)
- All information is associated with 'policy field sets,' the most spatially disaggregated level for which yields are known, and these policy field sets are panelized on the basis of having common component fields (spatially) over time.

Figure 1 Sample States 2013-2021



Source: US Census Bureau 2010 TIGER Shapefiles.



Results

Figure 2

- Impacts on mean yields
- FSA-reported cover crops associated with higher yields on corn fields, statistically insignificant impacts on yields for soybean.
- Cover crops receiving EQIP assistance have no significant impact on yields for corn or soybeans fields.
- Impacts on yield variability
- FSA-reported cover crops associated with lower yield variability on corn and soybean fields.
- No detected impact of EQIP-funded cover crops on yield variability.



Source: USDA RMA Producer History and Claims Data, USDA FSA Crop Acreage Reporting Data, USDA FSA Common Land Units.

Discussion and Conclusions

- This is the first study to utilize USDA administrative data records on yields and plantings at the field level to measure the effect of cover crops on yield risk.
- We find little evidence supporting the existence of a "yield penalty" resulting from cover crop adoption, a common finding in previous work that utilizes experimental plots (Abdalla et al., 2019)
- FSA-reported cover crops are observed to decrease yield variability in both corn and soy, while EQIP-funded cover crops are associated with a small (yet mostly insignificant) increase in yield variability for both crops.
- Cover cropping through EQIP contracts is often undertaken with particular seed mixes and termination methods, which varies by the state and EQIP funding pool. These systems may differ from typical systems implemented by non-funded cover croppers.





Figure 3 **Results for Soy Plantings**

Source: USDA RMA Producer History and Claims Data, USDA FSA Crop Acreage Reporting Data, USDA **FSA Common Land Units.**

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