Model-based Estimation of the Number of U.S. Farms and Land in Farms from Survey and Administrative Data

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Disclaimer

The findings and conclusions in this presentation are those of the authors and should not be construed to represent any official USDA, or US Government determination or policy

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PART I

MOTIVATION

The June Area Survey (JAS)

- The June Area Survey is one of the largest surveys conducted by NASS
- Based on an area frame, conducted every year during the first two weeks of June
  - All land in all states except Alaska stratified by land use
  - Land divided into homogeneous strata (e.g., cultivated land, urban area, etc.)
  - Each of the strata is divided into several substratum containing agriculturally similar areas
  - Each substratum is then divided into primary sampling units (PSU)
  - PSUs are sampled, divided into smaller areas called segments

The June Area Survey (JAS)

- One segment is randomly selected from each PSU

- Each segment is divided into several smaller areas called tracts
- Each tract is screened: agricultural or non-agricultural
- Agricultural tracts within selected segments are enumerated

Estimation from the JAS

- Annual estimates of the number of U.S. farms and land in farms are produced by using JAS data
- A farm is any place from which $1,000 or more of agricultural products were produced and sold or normally would have been sold during the year.
- Studies have shown that the number of U.S. farms derived from the JAS are underestimated, mainly due to misclassification during screening
  - A capture-recapture approach is employed to make estimation
  - NASS's list frame used as the second sample
  - JAS and list frame records are linked by using probabilistic record linkage
  - Different adjustment weights are estimated by using the matched dataset

Estimation of the number of farms and land in farms

For a farm tract i, the capture-recapture weight is estimated by

$$w_i = \frac{t_i}{\pi_i} \frac{Pr(F_i|S_iA_iR_iJ_i)}{Pr(J_i|S_iA_iR_iF_i)Pr(R_i|S_iA_iF_i)Pr(A_i|S_iF_i)},$$

where,

i = Tract on the JAS,
t_i = Proportion of a farm represented by tract
π_i = Sample inclusion probability
S_i = Tract is in the sample
A_i = Tract passed Agricultural screening process
R_i = Tract responds
J_i = Tract is recorded as a farm on the JAS
F_i = Tract is truly a farm

The Number of farms estimates are obtained by summing the capture-recapture weights over farm tracts

Estimation of the number of farms and land in farms

- A total of five logistic regression models
- Matched JAS & list-frame records are used
- Both agricultural & non-agricultural tracts used in the analysis
- Model covariates
  - JAS data available for agricultural tracts
  - JAS data not collected for non-agricultural tracts, challenging to get model covariates

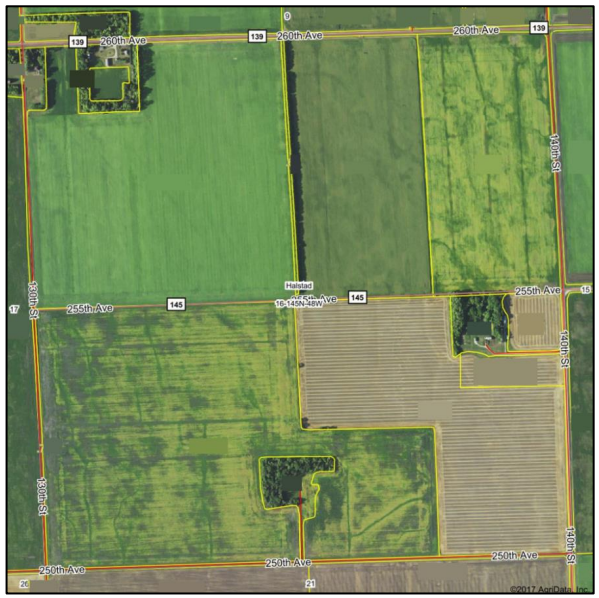
Goal: Using adminstrative & remote sensing data to create model covariates

PART II

PROPOSED METHODOLOGY

Farm Service Agency (FSA) data

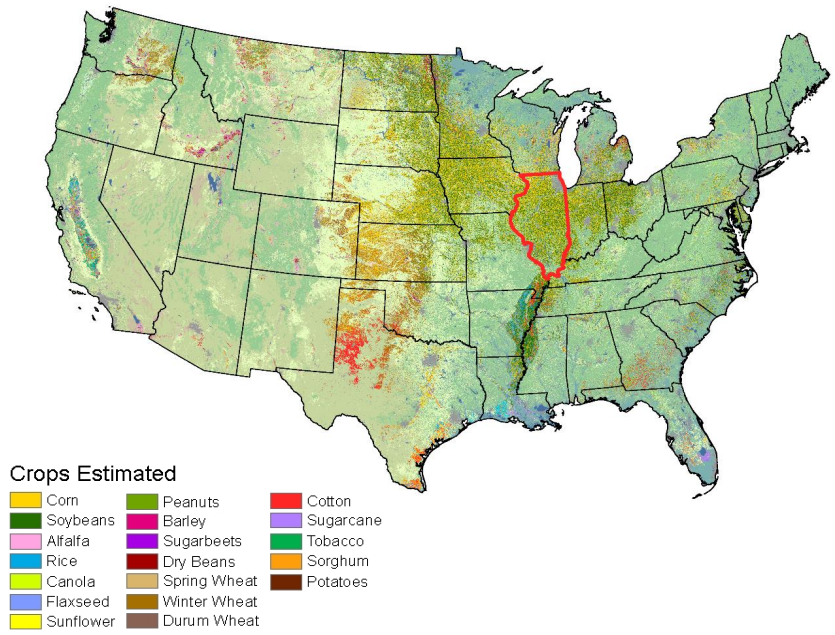
- FSA Common Land Units (CLUs)
  - The smallest unit of land that has a permanent contiguous boundary, a common land cover and land management, a common owner, and a common producer
- FSA-578 Form
  - Available for all land associated with a USDA program in a calendar year
  - Provides crop information



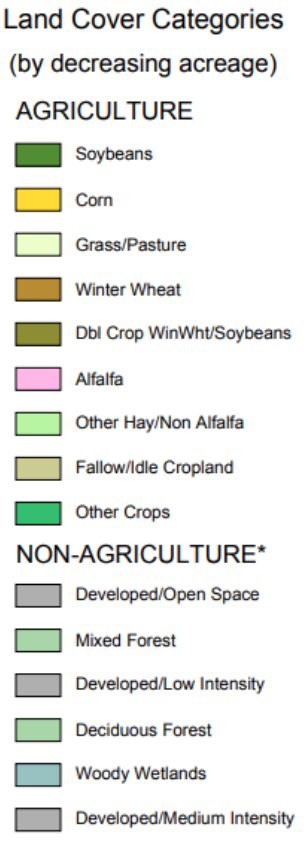
https://www.agridatainc.com/Home/Products/Mapping%20Features/Land%20Resource%20Intelligence/FSA%20Field%20Boundaries%20(CLU)

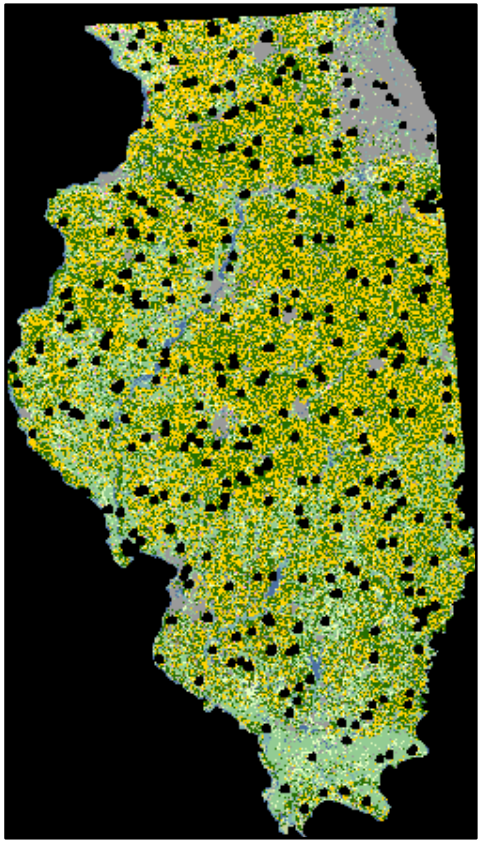
Cropland Data Layer (CDL)

- Georeferenced, crop-specific land cover raster dataset
- Captures planted acres
- National scale, 30m, 9 billion+ pixels
- Annually produced since 2008
- 85%-95% accuracy for major crops
- Freely available and open to the public

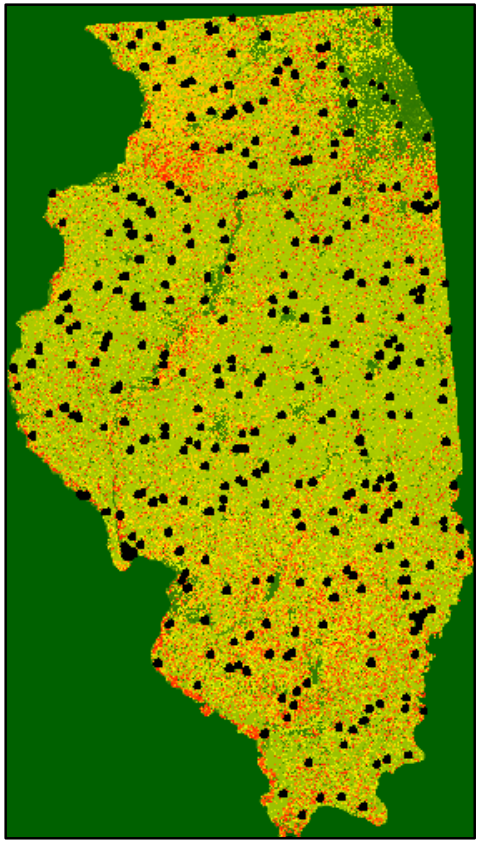


Predictive Cropland Data Layer (PCDL)

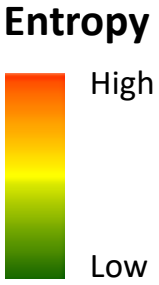




Illinois (2021)
PCDL and Segments



Illinois (2021)
Entropy Layer



PART III

APPLICATION

Case study

- Data available for 2021 have been considered in this study
- The JAS & digitized tracts data merged by using state, segment and tract identification numbers
- Tract-level PCDL data are used to create covariates for four models ($Pr(J_i|S_iA_iR_iF_i)$, $Pr(R_i|S_iA_iF_i)$, $Pr(A_i|S_iF_i)$, and farm status)
  - Predicted CDL for corn, cotton and rice
- Estimates of the number of farms and land in farms produced based on the capture-recapture model
  - State & U.S. level estimates produced without accounting for Alaska & Hawaii

Results

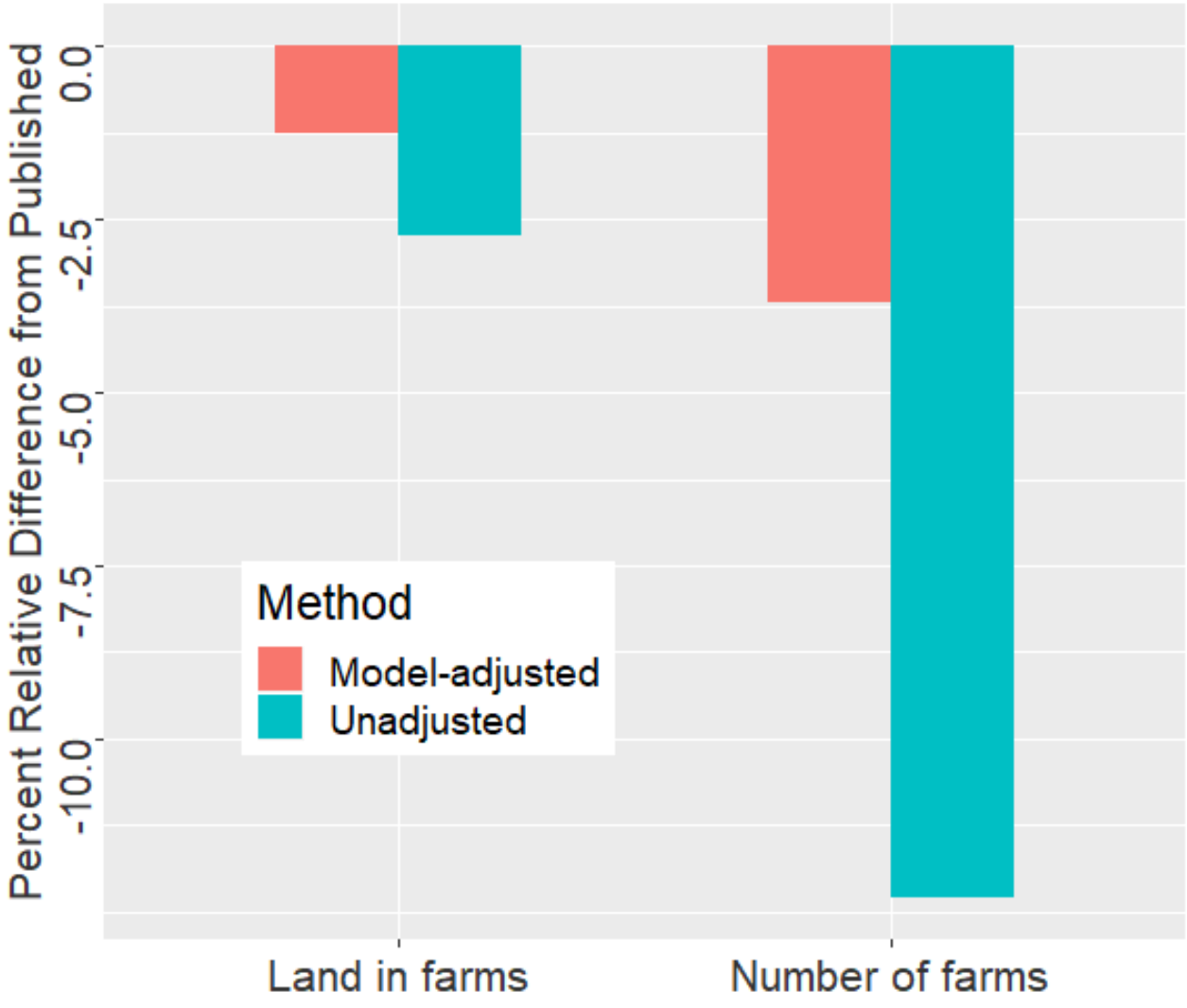


Figure: Percent relative differences of unadjusted and adjusted number of farms and land in farms against published (Year 2021)

PART IV

CONCLUSION

Final remarks

- The model-based adjustment improved state and national estimates
- Tract-level administrative and remote sensing data enabled to obtain more accurate adjustment weights
- Digitized tracts data can be used to obtain information on non-agricultural JAS tracts
- Challenges:
  - Complete digitized tracts data available only for 2021
  - Digitized tracts data not available for some of the JAS tracts
- Future research opportunities:
  - Summarizing the entropy layer at the tract level to be used as a covariate
  - Testing generalized additive models or other non-parametric models to better account for nonlinear effects

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Thank you!

Questions?

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