

# Seeds of Disparity: the Gender Land Divide from Brazil's Agricultural Transition

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## This Paper: Motivation

- Land is a fundamental form of wealth and power.
- Women have less access to land (**15%**) ([Fisher and Naidoo, 2016](#)).
- In low- and middle-income countries, women often lack rights such as property, inheritance, and credit access. ([Duflo, 2012](#)).

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- Adoption of agricultural technology can . . .
  - ↓ gender inequality → economic development ([Duflo, 2012](#); [Jayachandran, 2015](#)).
  - ↑ gender inequality → male specialization due to gender norms ([Alesina et al., 2013, 2018](#)) and fewer incentives to invest in land ([Goldstein and Udry, 2008](#); [Ali et al., 2014](#); [Dillon and Voena, 2018](#); [Genicot and Hernandez-de Benito, 2022](#)); access to credit ([Reboul et al., 2021](#); [De Andrés et al., 2021](#)); risk-aversion ([Eckel and Grossman, 2008](#); [Croson and Gneezy, 2009](#))

# This Paper

- How does **agricultural technology** impact gender inequality in **land ownership**?
- We exploit the transition spurred by adopting genetically engineered (**GE**) soy seeds.

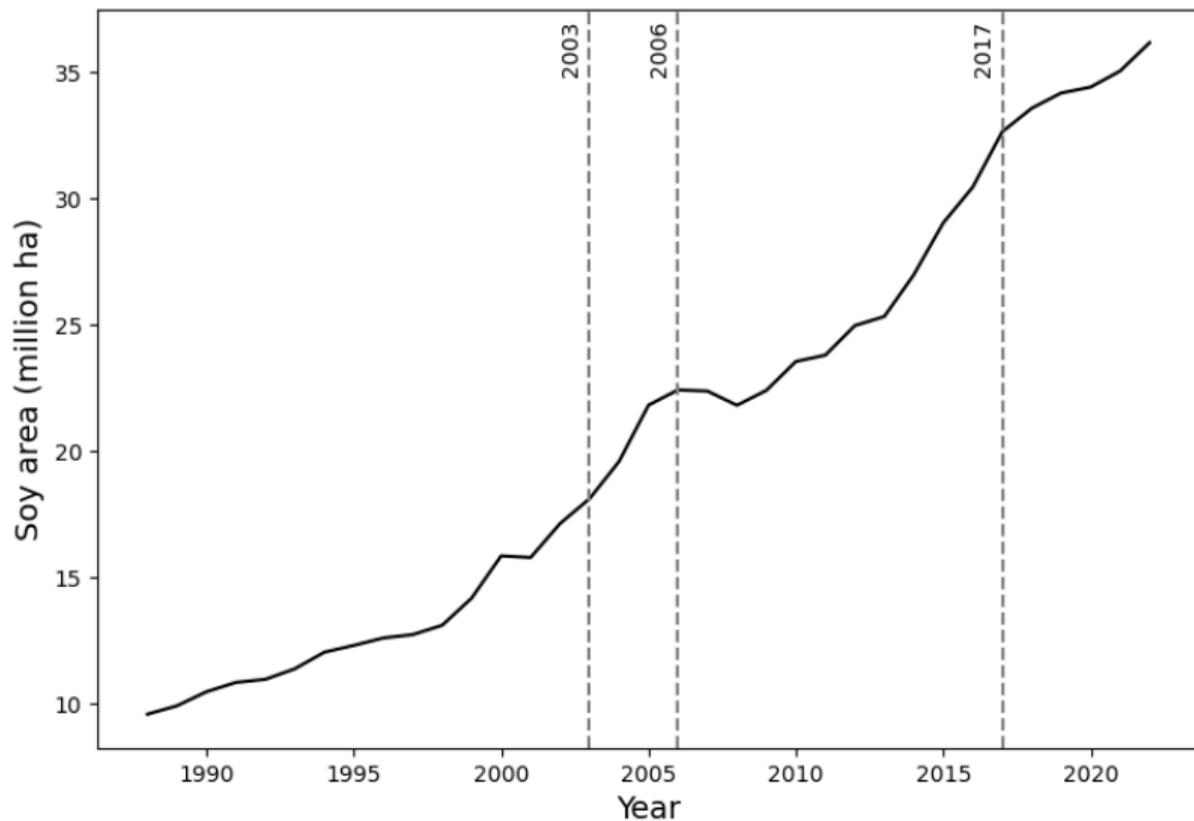
# Results

- Reduction of the number of female-owned rural properties and areas owned by women. [Table](#)
- Larger reductions in women's land in municipalities with ... [Table](#)
  - ... lower access of women to credit.
  - ... stronger property rights.
  - ... salient local gender norms (measured by gender wage gaps and labor force participation gaps).

# Background

- Brazil is one of the world's largest soybean producers.
- Women comprise 18.7% of landowners and 13.9% of land area.
- Female-owned properties are less capital-intensive, have fewer workers, and have limited access to credit.
- **Agricultural Transition:** In 2003, the government approved the cultivation and sale of GE soy seeds.
  - The adoption of GE soy likely is Brazil's fastest and largest agricultural transition ([Bustos et al., 2016](#)).

# Soy Planted Area Over Time



# Data

- **2006 and 2017 Agricultural Censuses:** number of women landowners and land area owned by women.
- **FAO data** on potential soy yield (to measure exposure to GE soy).
- **Credit data** (share of rural credit to women).
- **Atlas** of land property rights.
- **National Census:** proxies for gender norms (wage and labor participation gaps).

## Differences Between Male and Female Properties - 2006

	Male	Female	Difference	p-values
<b>Number of properties</b>	686.1	77.5	608.6	0.000
<b>Area owned (ha)</b>	70,483.7	3,578.3	66,905.4	0.000
<b>Avg property size (ha)</b>	134.9	67.7	67.2	0.000
<b>Family farm (%)</b>	74.3	82.6	-8.3	0.000
<b>Hired workers</b>	3.8	3.0	0.8	0.000
<b>Mechanical traction (%)</b>	31.6	25.9	5.7	0.000
<b>Fertilizer use (%)</b>	49.7	40.8	8.9	0.000
<b>Rural credit (\$)</b>	13.9	4.2	9.7	0.000
<b>Planted Forest Area (ha)</b>	91.8	3,231.2	-3,139.4	0.000
<b>Native Forest Area (ha)</b>	106.2	2,182.3	-2,076.1	0.000

# Empirical Method I

$$\Delta y_i = \alpha + \beta A_i + W_i' \gamma + \varepsilon_i.$$

$\Delta y_i$ : change in the outcome between 2006 and 2017.

1. number of women landowners;
2. land area owned by women.

$W_i$ : baseline controls (literacy rates, the share of rural populations, population density, and income per capita).

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$A_i$ : difference between yields with low and high potential productivity as reported in the FAO-GAEZ dataset ([Bustos et al., 2016](#)).

## Empirical Method II

Due to the presence of zeros and the count nature of our dependent variables, we also use a Poisson estimator:

$$y_{it} = \exp [\alpha_0 + \beta_0 A_i + W_i' \gamma_0 + \mathbf{1}\{t = 2017\} \times (\alpha_1 + \beta_1 A_i + W_i' \gamma_1) + \varepsilon_{it}]$$

$\beta_1$ : proportional average impact of GE soy suitability  $A_i$  on the change in land ownership between 2006 and 2017.

## Pre-Trends – Growth in the Number of Woman Farm Managers 2000-1991

Dep. Var.: $\Delta$ Women Farm Managers 2000-1991			
OLS			
	(1)	(2)	(3)
GE Soy ( $\beta$ )	0.121 (0.156)	0.234 (0.248)	0.231 (0.270)
State FE		Y	Y
Controls			Y
Observations	2,154	2,154	2,154

## First Stage

	Share of GE soy production (Census)			Total Soy Area (MapBiomass)
	(1)	(2)	(3)	(4)
GE Soy ( $\beta$ )	0.08*** (0.01)	0.07*** (0.01)	0.07*** (0.01)	3,811.52*** ( 607.14)
Dep. Mean	0.09	0.09	0.09	4,092.95
State FE		Y	Y	Y
Controls			Y	Y
Observations	1,776	1,776	1,776	2,779

## Results on Women Landownership

	OLS			Poisson
	(1)	(2)	(3)	(4)
<b>Panel A. <math>\Delta</math> Number of women-owned rural properties 2017-2006</b>				
GE Soy ( $\beta$ )	-21.46*** ( 3.78)	-14.59*** (4.41)	-13.40*** ( 4.32)	-0.055** (0.022)
<b>Panel B. <math>\Delta</math> Land area owned by women 2017-2006</b>				
GE Soy ( $\beta$ )	-4,417.66*** ( 674.65)	-2,283.20** (1,081.55)	-2,032.73* (1,085.10)	-0.100* (0.054)
State FE		Y	Y	Y
Controls			Y	Y
Year FE				Y
Observations	2779	2779	2779	5558

# Heterogeneous Results

	Heterogeneity by ( $H_i$ )				
	Total Rural Credit (1)	Women's Rural Credit (2)	Strong Property Right (3)	Gender Wage Gap (4)	Gender Labor Force Participation Gap (5)
<b>Panel A. <math>\Delta</math> Number of women-owned rural properties 2017-2006</b>					
GE Soy $\times H_i$ ( $\delta$ )	0.05*** (0.02)	0.06* (0.03)	-0.02 (0.04)	0.04 (0.03)	0.01 (0.03)
<b>Panel B. <math>\Delta</math> Land area owned by women 2017-2006</b>					
GE Soy $\times H_i$ ( $\delta$ )	-102.46*** (23.80)	8.70** (3.65)	-34.73*** (11.19)	-27.16** (13.77)	-18.59*** (3.68)
State FE	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y
Observations	2779	2740	2779	2779	2779

# Takeaways

- Places highly exposed to GE soy gains saw a significant decline in women owning land.
- New technologies in farming favor production methods traditionally associated with men - particularly in low- and middle-income countries.
- **Why would we care?**
  - Balanced wealth distribution and bargaining power.
  - Environmental concerns.

Thank you!

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## Exposure to Productivity Gains and Migration

	Inflows		Outflows	
	All	Farm Manager	All	Farm Manager
	(1)	(2)	(3)	(4)
<b>Panel A. <math>\Delta</math> Female Migration 2010-2000</b>				
GE Soy ( $\beta$ )	-27.14 ( 81.12)	0.04 (0.05)	-91.42 ( 105.05)	0.03 (0.03)
<b>Panel B. <math>\Delta</math> Male Migration 2010-2000</b>				
GE Soy ( $\beta$ )	-9.64 ( 80.58)	-0.12 (0.38)	-101.14 ( 108.22)	-0.24 (0.44)
State FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Observations	2779	2779	2779	2779

# Contribution

- Gender inequality across various dimensions in rural areas (Goldstein and Udry, 2008; Alesina et al., 2013; Ali et al., 2014; Bose and Das, 2017; Dillon and Voena, 2018; Alesina et al., 2018; Almond et al., 2019; Bhalotra et al., 2019; Teklewold et al., 2020)
- Technological changes and gender gap in the labor market (Galor and Weil, 1996; Goldin, 2006; Munshi and Rosenzweig, 2006; Black and Spitz-Oener, 2010; Juhn et al., 2014; Blau and Kahn, 2017; Moorthy, 2022; Mehraban et al., 2022; Estefan, 2023; Afridi et al., 2023).
- Climate change and new technologies (Smith et al., 2007; Mbow et al., 2019).