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# **Impact of agricultural practices on Brazilian agriculture productivity evolution**

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## Introduction

- Agricultural activities promote changes in the biological, physical, and chemical processes of the environment.
- Implementing conservation practices such as crop rotation, green manure, and the no-till system, can help reduce or mitigate the negative effects of agricultural production.
- The adoption of these practices has the potential to improve both crop productivity and the efficient use of resources.

## Objective

• I analyze the impact of adopting agricultural practices on the evolution of productivity of Brazilian agriculture accounting for GHG emissions from agricultural and livestock activities.

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## Methods

- I use the Data Envelopment Analysis (DEA) and output-oriented Malmquist-Luenberger (ML) productivity index based on the Output Directional Distance Function (ODDF).
- Regional models.
- ML productivity index can be decomposed into two components: environmental efficiency and technical changes between two periods.
- The directional vector is defined as the observed values for desirable and undesirable outputs.
- A second-stage analysis involves running a fractional probit regression to analyze the impact of the adoption of agricultural practices on the evolution of productivity and its components.

## Data

- Panel of 588 microregional data from the 2006 and 2017 Agricultural Censuses and the Greenhouse Gas Emission Estimation System (SEEG).
- For the second stage, I selected two groups of variables. In the first group, I use the area utilized with irrigation, no-tillage, planting in contour lines, crop rotation, fallow soil, and slope protection/conservation as a proportion of the area available for agricultural and livestock activities.
- In the second group, we use internet access, higher education, energy access, storage capacity, technical assistance, credit access, pesticides, and conditions with respect to the land and association.
- Inspection and outliers: 112 DMUs were removed due to their atypical influence.

### Table 1. Summary statistics of the variable for microregions in 2006 and 2017

		20	06			20	17															
-	Mean	Std. Dev	Min.	Max	Mean	Std. Dev	Min.	Max				<del>л · 4</del>		<b>P</b> · <b>P</b>	N (1)		T 1		The impact of the	adontion of agric	ultural practices	
Output Livestock's VP (Mi									Region	Federation Unity	Min	Moon	Mar	Effvir. E	II. Unan	ige Aar N	Tech.	Change	The impact of the	adoption of agric	unular practices	
US\$)* Agriculture's VP (Mi	50.13	64.41	0.04	560.81	85.27	102.06	0.04	754.09			0.000	1 100	Max						• Among the eval	lated practices of	nly irrigation and no	till showed positive
US\$)*	119.25	155.58	0.19	1252.85	165.07	294.23	0.26	3138.18	North		0.893	1.100	1.057	0.674 0.	994 I.	.522 0.	.939 1.	.112 1.388	• Allong the eval	affects, when con	night in the level of	adoption in 2017
GHG Emission (Mi ton CO2e)	0.89	1.17	0.00	8.17	0.97	1.32	0.00	8.04		Acre	1.00	1.01	1.06	1.00	1.03	1.13 (	0.94 (	0.99 1.00		· ci i i i		
Input	110.70	510.00	0.00	4720.40	440.00	670.60	0.00	1005.01		Amapá	1.00	1.00	1.00	1.00	1.00	1.00	1.00 1	1.00 1.00	However, they	influence only t	the productivity inde	x and the change
Land (1,000 hectare) Capital (1,000 units)	418.79	518.99 1.86	0.08	4/30.40 12.00	440.03 2.20	2.71	0.02	4225.81 16.01		Amazonas	0.90	1.11	1.66	0.81	1.02	1.52	1.00 1	1.09 1.18	component of en	vironmental effici	ency.	
Labor (1,000 people) Expenditure (Mi	29.69	25.14	0.07	162.95	27.07	21.83	0.03	140.21		Pará	0.90	0.98	1.04	0.67 (	).95	1.09 (	0.96 1	1.05 1.39	• In relation to n	o-tillage, in 2017	7, 553,382 producers	declared that they
US\$)*	72.72	138.33	0.07	1416.53	115.13	182.82	0.06	1885.33		Rondônia	0.96	1.24	1.49	0.92	1.04	1.32	1.04 1	1.19 1.26	proceeded with	no-till, with a tot	tal of 33,052,969 hec	tares. Compared to
Notes: * Monetary v	alues were	e convertea	l from Re	eal (R\$) of 2	2017 to U	S Dollars (	US\$) cons	idering an		Roraima	0.89	1.16	1.49	0.68	1.00	1.28	1.09 1	1.17 1.31	2006. this modal	ity had an increas	se of 9% in the number	er of establishments
exchange rate of 3.31	K\$/US\$.									Tocantins	1.02	1.17	1.27	0.82 (	).95	1.00 1	1.14 1	1.24 1.35	and an increase of	of $85\%$ in the area	with no-tillage	
									Northeast		0.541	0.920	1.513	0.549 1.	041 1.	.720 0.	.662 0.	.895 1.250		1 05 /0 in the area	100/ C	1 •
Resulte							Alagoas	0.66	0.83	1.16	0.64 (	).90	1.36 (	0.77 (	0.95 1.25	• Regarding irrigation, in 2017, 10% of establishments used irrigation techniques (flood, infiltration, sprinkler, or similar). The irrigated area						
<b>NCSUITS</b>								Bahia	0.64	0.88	1.51	0.66	1.03	1.52 (	0.67 (					0.88 1.20		
										Ceará	0.67	0.90	1.21	0.74	1.04	1.46 (	0.72 (	0.87 1.03	comprised 6.7 m	illion hectares or	10% of the total area	with temporary and
gure 1. Evolution of Value of Production, Number of establishments with area, and Area of ablishments (Land) in Brazil and Regions						Maranhão	0.69	0.94	1.28	0.84	.11	1.64 (	0.70 (	0.85 1.00	permanent crops	, corresponding to	an increase of 48% co	ompared to 2006.				
						Paraíba	0.70	0.93	1.26	0.68 (	).98	1.37 (	0.76 (	0.95 1.18	• When considering	g the speed of cha	ange in adoption, irrig	ation had a negative				
						Pernambuco	0.75	0.94	1.12	0.82	00.1	1.29 (	0.74 (	0.95 1.10	effect on the pro	ductivity index an	d on the environment	al efficiency change				
										Piauí	0.54	0.93	1.51	0.55	1.15	1.72 (	0.67 (	0.81 0.99	component.	5		
								126.11%		Rio Grande do Norte	0.73	1.01	1.30	0.77	1.08	1.37 (	0.73 (	0.94 1.09	• The offect was n	acitiva for no tilla	~~	
	76.92%	/0			89.62%					Sergipe	0.73	0.93	1.18	0.75	1.06	1.60 (	0.66 (	0.90 1.13	• The effect was p	DSILIVE IOI IIO-UIIA	ge.	
						Southeast		0.794	1.030	1.516	0.719 1.	045 1.	.593 0.	.617 0.	.993 1.254	• The speed of change in the adoption of the counter lines practice had						
47.69%						Espírito Santo	0.83	0.99	1.20	0.87	.12	1.56 (	0.62 (	0.90 1.10	positive impact of	on the productivity	v index and the technol	ogical change.				
28.56%	7.43%	-0.50% -6.	81% -4.56%	)	-1	13.74%				Minas Gerais	0.87	1.07	1.50	0.83	1.07	1.59 (	0.80	1.01 1.25				
6.99%       9.77%         2.62%       10.34%       6.32%						Rio de Janeiro	0.79	1.01	1.47	0.74	1.02	1.37 (	0.84 (	0.99 1.23	Table 3. Margins effects of agricultural practices' adoption							
BR	N		NE	SE	1	S	I	MW		São Paulo	0.79	1.00	1.52	0.72	.01	1.44 (	0.71 1	1.00 1.25		8	<b>I</b>	
Number of	of establishi	ments with	an area		nd	Value o	f Productio	n	South		0.759	1.035	1.360	0.759 1.	045 1.	.362 0.	.855 0.	.993 1.157	Variable	ML index	Env. Eff. Change	Tech. Change
						Paraná	0.81	1.05	1.28	0.87	1.07	1.36 (	0.85 (	0.99 1.08	Irrigation	0.0718	0.0926					
										Rio Grande do Sul	0.88	1.07	1.36	0.90	1.08	1.29 (	0.88 (	0.99 1.09	No-tillage	0.1126	0.101	
The value of Production (VP) in 2006 was US\$95.14 billion, while in								Santa Catarina	0.76	0.95	1.12	0.76 (	).94	1.19 (	0.93 1	1.01 1.16	∆ Irrigation	-0.0156	-0.0126			
2017, it was US\$140.52 billion, showing a growth of 47 .69%. The						Midwest		0.843	1.092	1.509	0.711 0.	986 1.	.343 0.	.986 1.	.111 1.392	∆ No-tillage	0.0054	0.0177				
variation of the VP does not follow a pattern.							Distrito Federal	1.00	1.00	1.00	1.00	1.00	1.00	1.00 1	1.00 1.00	∆ Contour lines	0.1236		0.069			
Variations in the number and area of establishments can provide us some							Goiás	0.95	1.09	1.30	0.81	1.00	1.18 (	0.99 1	1.09 1.31							
initial insights into the possible causes and magnitudes of variations in						Mato Grosso	0.84	1.12	1.51	0.71	.01	1.34	1.00 1	1.11 1.20								
						Mato Grosso do Sul	0.89	1.07	1.19	0.77	0.91	1.00	1.00 1	1.18 1.39								
the VP.										Brazil	0.541	1.006	1.657	0.549 1.	034 1.	.720 0.	.617 0.	.982 1.392				
The growth in VP in Brazil ( $\pm 17.60\%$ ) is not fully evolvined by the																						



The growth in VP in Brazil (+47.69%) is not fully explained by the increases in the number of establishments with an area (+1.54%) and in the total area of establishments (+5.28%). The result suggests that this increase may be linked to the productivity gains of agricultural activities and the improvement in the prices of agribusiness products.

Recent works point to an increase in the productivity of Brazilian agriculture.

• Despite their productivity gains in the period and their importance to the economy in general, whether through income and employment generation, agricultural and livestock activities are subject to negative externalities, such as the emission of GHGs.

• In 2017, emissions from the agriculture sector totaled 561.76 million tons of CO<sub>2</sub> equivalent, an increase of 8.54% compared to 2006.

### **Productivity analysis**

• Based on the ODFF, the average productivity in agriculture and livestock remains almost unchanged over 2006-2017 (1.006), mainly influenced by the opposite results presented by its components.

• The decomposition results show that although average environmental efficiency (MLEEC) increased (3.4%) over the period, technical changes (MLTC) fell (1.8%).

• The values of the productivity indexes by regions indicate that all Brazilian regions, on average, presented TFP expansion, except for the Northeast region. For the North and Mid-West regions, the engine of growth was the technological progress since that was a regress in environmental efficiency. On the other hand, for the Southeast and South regions, the growth driver was the expansion of environmental efficiency since, on average, a technical regress was observed.

### Table 2. The ML productivity index and its components by Regions and Federal units

### Figure 2. Geographic Distribution of the ML productivity index and its components



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## Conclusion

present study found that agricultural productivity showed modest growth between 2006 and 2017, reflecting the behavior of its components—environmental efficiency and technological changes. In essence, most of the analyzed micro-regions showed advances in environmental efficiency, while most showed technological regression.

• When evaluating the impact of adopting agricultural practices, in general, there were positive impacts of adopting irrigation, no-tillage, and Contour lines practices. Only the speed of adoption of the agricultural practice evidenced a negative impact on the productivity index and on the component of technological change.

### Contact