The Hidden Cost of Bananas: The Effects of Pesticides on Newborns' Health

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- Increasing demand for agricultural productions, combined with land restrictions and changing weather has contribuited to the extensive use of agrochemicals
- Issue:This use of chemicals has severe negative effects on the populations living close to the farms or working on them
- But, still there are few studies analyzing the effects of enviromental pollution on health outcomes
    1. very few that leverage quasi-experimental variation to estimate the health effects of the use of pesticides in agriculture
- Goal of this paper: examine the effects of pesticides used in banana plantations in Ecuardor on newborn's health outcomes

Why Ecuador?

- Provides an excellent context for analysing the effects of pesticides use in agriculture
- Ecuador is the world's fifth largest banana producer and the largest exporter
- In the early 1970s, started to use aerial fumigations to treat fungal disease affecting banana fruit plants
- raised major concerns about their environmental and health implications

Empirical Strategy

- DiD approach that exploits the seasonal changes in the fumigation of banana plantations as an identification strategy
- 4 newborn's health outcomes: weight at birth, gestational length, low birth weight, and preterm
- Use of mother's address durirng pregancy and precise information on the perimeter of the plantations to compute measures of exposure to air pollution
  1. compute the mother's distance from the plantation and the area of fumigated plantations near their place of residence

- the newborns potentially most affected by pesticides were those born to mothers living within 150 meters of fumigated plantations
- The paper use this result to construct a geographical exposure dummy variable (**Banana Exposure**) that defines the group of treated and control newborns
- Challenge: households living close to the plantations present different characteristics from those living further way
- Approach: exploits the seasonal changes in the intensity of fumigations. Fumigations are more intense during rainy season, which is when the fungus propagates more easily.

- They compute a seasonal exposure dummy (**Intensive Fumigations**)
  1. create a grid of 5x5 km cells
  2. the seasonal exposure variable takes the value 1 for newborns who during their gestation were for at least three months in a grid cell with more than four gallons of peticides per hectare.
- DiD strategy is based on the seasonality of the fumigations of the plantations surronding the mother's residence
- DiD approach compares:
  1. the difference between newborns born to mothers living in geographically exposed areas who were gestated during intensive and nonintensive fumigation seasons
     relative to
  2. the difference between newborns born to mothers living in geographically nonexposed areas who were gestated during the same two seasons

$$Y_{ijmy} = \beta_0 + \beta_1 \text{Banana Exposure}_{ijmy} + \beta_2 \text{Intensive Fumigations}_{ijmy} +$$

$$\theta \text{Banana Exposure}_{ijmy} \times \text{Intensive Fumigations}_{ijmy} +$$

$$\delta X_i + \mu_j + \psi_m + \pi_y + \epsilon_{ijmy} (1)$$

$$Y_{ijmy} = \beta_0 + \beta_1 \text{Banana Exposure}_{ijmy} + \sum_{z=1}^{3} \beta_z Z^{th} \text{Intensive Fumigations}_{ijmy} +$$

$$\sum_{z=1}^{3} \theta_z Z^{th} \text{Banana Exposure}_{ijmy} \times Z^{th} \text{Intensive Fumigations}_{ijmy} +$$

$$\delta X_i + \mu_j + \psi_m + \pi_y + \epsilon_{ijmy} (2)$$

- Y_{ijmy}: birth outcomes of newborn i, in a grid cell j, month m and year
- Banana Exposure$_{ijmy}$: is a dummy variable that takes the value 1 for newborns from mothers geographically exposed to pesticides
- Intensive Fumigations$_{ijmy}$: is a dummy variable that takes the value 1 for newbornds that were affected by intensive fumigations for at least theree months during gestation
- Z^{th}Intensive Fumigations$_{ijmy}$: is a dummy variable that takes the value 1 for the newbornds that were affected by intensive fumigations during the three months of the Z^{th} gestation trimester.
- X: vector of controls

Data

Newborn's health:

- dataset from the National Register of Live Births for the period 2015-17 (information on the mother's residential addresses during pregancy)
- data set includes information on several observable characteristics of children and mothers

Ecuador's banana plantations:

- 2013 agricultural census
- 2016-18 register of aerial fumigations (geocoded data on the application of the pesticide)

Table 2. Descriptive Statistics: Means (standard deviations) of Selected Variables

Variable	All Newborns (1)	Not Geographically Exposed to Banana Plantations (2)	Geographically Exposed to Banana Plantations (3)	Not Seasonally Exposed to Intensive Use of Pesticides (4)	Seasonally Exposed to Intensive Use of Pesticides (5)
Birth weight	3,127.8	3,119.1	3,151.8	3,113.8	3,143.2
	(3.53)	(4.11)	(6.88)	(4.94)	(5.04)
Gestation weeks	38.44	38.42	38.52	38.41	38.48
	(.01)	(.01)	(.02)	(.02)	(.02)
Low birth weight	.08	.08	.08	.09	.08
	(.00)	(.00)	(.00)	(.00)	(.00)
Preterm	.06	.06	.06	.07	.06
	(.00)	(.00)	(.00)	(.00)	(.00)
Mother's age	24.53	24.59	24.36	24.57	24.48
	(.04)	(.05)	(.09)	(.06)	(.07)
Male newborn	.51	.51	.52	.52	.51
	(.00)	(.00)	(.01)	(.00)	(.00)
Mother's education					
< high school	.43	.41	.49	.42	.44
	(.00)	(.00)	(.01)	(.00)	(.00)
Mestizo ethnicity	.96	.96	.97	.96	.96
	.01	(.00)	(.00)	(.00)	(.00)
Normal birth	.53	.52	.57	.53	.53
	(.00)	(.00)	(.01)	(.00)	(.00)
Nonmarital union	.40	.4	.39	.4	.39
	(.00)	(.00)	(.01)	(.00)	(.00)
Single	.42	.42	.44	.42	.43
	(.00)	(.00)	(.01)	(.00)	(.00)
Married	.14	.14	.13	.13	.14
	(.00)	(.00)	(.00)	(.00)	(.00)
Public hospital	.83	.81	.89	.85	.82
	(.00)	(.00)	(.00)	(.00)	(.00)
Number of births	2.28	2.27	2.34	2.29	2.28
	(.01)	(.01)	(.02)	(.01)	(.01)
Number of children	2.32	2.3	2.38	2.33	2.32
	(.01)	(.01)	(.02)	(.01)	(.01)
Prenatal control	6.03	6.05	5.98	6.03	6.02
	(.02)	(.02)	(.03)	(.02)	(.02)
Single birth	.99	.99	.98	.98	.99
	(.00)	(.00)	(.00)	(.00)	(.00)
Observations	21,393	15,686	5,707	11,182	10,211

Figure: Table 2 from Calzada, Gisbert, and Moscoso (2023)

Figure: Table 2 from Replication

Preview of the results

- pesticides have a statistically significant impact on newborns' birth weigth
- pesticides have a greater impact when intensive fumigations coincide with the first two trimesters of gestation
- exposure to pesticides reduces the number of gestations weeks and increases the odds of being born with low birth weight and of preterm delivery

Results

Table 3. Effects of the Seasonal Intensification of Fumigations on Birth Weight

	Birth Weight					
	(1)	(2)	(3)	(4)	(5)	(6)
Banana Exposure	−48.58	.998	−37.59	−33.93	−49.38	−5.965
	(39.57)	(50.21)	(47.72)	(43.96)	(51.55)	(47.67)
Intensive Fumigation		29.64***				
		(10.09)				
Banana Exposure × Intensive Fumigation		−80.02***				
		(30.81)				
Intensive Fumigation during first trimester			17.58			24.19*
			(14.23)			(14.03)
Intensive Fumigation during second trimester				14.34		20.09
				(15.04)		(15.65)
Intensive Fumigation during third trimester					8.135	18.26
					(17.88)	(16.27)
Banana Exposure × Intensive Fumigation during first trimester			−47.44**			−74.29**
			(20.58)			(32.61)
Banana Exposure × Intensive Fumigation during second trimester				−63.09***		−75.40***
				(20.40)		(24.44)
Banana Exposure × Intensive Fumigation during third trimester					4.933	−43.17
					(23.54)	(37.84)
Mother's controls	X	X	X	X	X	X
Month × year fixed effects	X	X	X	X	X	X
Grid fixed effects	X	X	X	X	X	X
Observations	21,393	21,393	21,393	21,393	21,393	21,393
R^2	.1096	.1102	.1098	.1100	.1096	.1104
Number of clusters	151	151	151	151	151	151

Figure: Table 3 from Calzada, Gisbert, and Moscoso (2023)

Figure: Table 3 from replication

Table 4. Effects of the Seasonal Intensification of Fumigations on Gestation Weeks, Preterm, and Low Birth Weight

	OLS Fixed Effects		Logit Fixed Effects			
	Gestation Weeks		Preterm Birth		Low Birth Weight	
	(1)	(2)	(3)	(4)	(5)	(6)
Banana Exposure	.0482	.106	1.250	1.252	1.304	1.249
	(.153)	(.154)	(.360)	(.281)	(.287)	(.248)
Intensive Fumigation	.0125		.829**		.791***	
	(.0385)		(.0710)		(.0648)	
Banana Exposure × Intensive Fumigation	−.0183		1.426		1.429**	
	(.105)		(.400)		(.259)	
Intensive Fumigation during first trimester		.0631*		.747**		.714***
		(.0366)		(.106)		(.0902)
Intensive Fumigation during second trimester		−.0417		1.029		.849*
		(.0580)		(.155)		(.0822)
Intensive Fumigation during third trimester		−.00557		.989		.869*
		(.0375)		(.103)		(.0668)
Banana Exposure × Intensive Fumigation during first trimester		−.142**		1.470**		1.568***
		(.0677)		(.269)		(.221)
Banana Exposure × Intensive Fumigation during second trimester		−.121*		1.461*		1.799***
		(.0728)		(.293)		(.246)
Banana Exposure × Intensive Fumigation during third trimester		−.0594		1.319		1.204
		(.0686)		(.229)		(.176)
Mother's controls	X	X	X	X	X	X
Month × year fixed effects	X	X	X	X	X	X
Grid fixed effects	X	X	X	X	X	X
Observations	21,393	21,393	20,871	20,871	21,086	21,086
R^2	.0842	.0850	. . .	. . .	. . .	. . .
Pseudo-R^2	. . .	. . .	.1161	.1170	.1170	.1180
Number of clusters	151	151	91	91	99	99

Figure: Table 4 from replication

Table 5. Effects of the Seasonal Intensification of Fumigations on Birth Weight and Gestation Weeks: Maternal Fixed Effects

	Birth Weight				Gestation Weeks			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Banana Exposure	38.04	77.94	109.5		−.711	−.643	−.346	
	(154.9)	(176.5)	(186.2)		(.679)	(.727)	(.815)	
Intensive Fumigation		13.04				.535**		
		(66.84)				(.252)		
Banana Exposure × Intensive Fumigation		−122.4				−.268		
		(129.1)				(.438)		
Intensive Fumigation during first trimester			121.2	90.25			.574	.396
			(97.20)	(101.2)			(.365)	(.323)
Intensive Fumigation during second trimester			−94.10	−130.5			.146	.322
			(111.2)	(100.6)			(.429)	(.545)
Intensive Fumigation during third trimester			64.10	74.84			.702*	.674*
			(103.7)	(121.5)			(.399)	(.398)
Banana Exposure × Intensive Fumigation during first trimester			−327.0*	−319.0***			−1.539*	−1.614***
			(175.2)	(108.2)			(.795)	(.406)
Banana Exposure × Intensive Fumigation during second trimester			92.60	163.8			−.156	−.439
			(135.0)	(141.4)			(.540)	(.492)
Banana Exposure × Intensive Fumigation during third trimester			−246.2	−239.3			−1.407**	−1.508***
			(179.4)	(147.6)			(.647)	(.511)
Mother's controls	X	X	X	X	X	X	X	X
Month × year fixed effects	X	X	X	X	X	X	X	X
Maternal to grid fixed effects	X	X	X	X	X	X	X	X
Observations	1,961	1,961	1,961	1,567	1,961	1,961	1,961	1,567
R^2	.861	.861	.862	.873	.848	.849	.850	.879
Number of mothers	970	970	970	777	970	970	970	777

Figure: Table 5 from Calzada, Gisbert, and Moscoso (2023)

Figure: Table 5 from replication