Transforming brick manufacturing in Bangladesh to promote clean air and better health

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Research Team

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- In Bangladesh - 7,000 brick kilns produce 27 billion bricks each year, generating 11% of PM, 22% of black carbon, and 17% of total annual CO_2 emissions (World Bank 2020)
- Air pollution generated by brick kilns results in over 6,000 premature adult deaths annually in Bangladesh and 24,000 excess deaths in India (World Bank 2020)

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» We address these barriers through a randomized intervention

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3. Inventing a new device to reduce pollution

Experimental Design

Experimental Design

- RCT in seven districts in Khulna division in 320 kilns
- Technical - technical knowledge and training. Receives information, training, and encouragement to adopt the suite of technical and behavioral recommendations
- Incentive - technical knowledge and training + worker incentives. Receives everything that the TKT Group receives plus additional information and encouragement targeted toward owners to address the workers' misaligned incentives
- Control

Technical intervention - brick settings

Figure 1: Double/Triple Zigzag brick stacking

Technical intervention - coal feeding

Figure 2: Continuous Coal Feeding

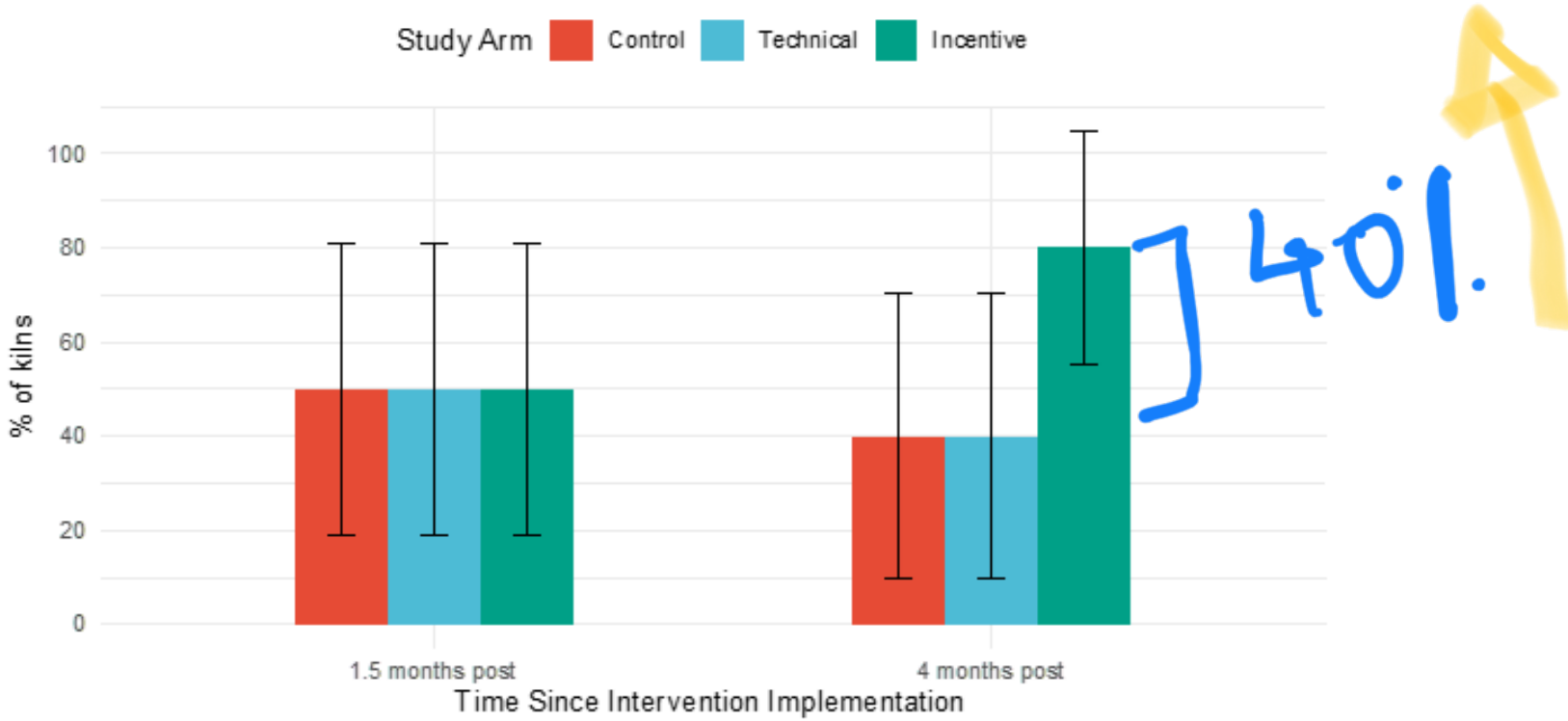
Incentive intervention

- Recommend providing economic incentives to works to adopt.
  - Bonuses
  - Profit sharing
- Improved working environment
  - Resting area, proper accommodation, medical facilities, education for children
  - Providing extra meals
  - Protective equipment
  - Extra days off

Incentive intervention - poster

Results

Providing workers' incentives



Notes: This figure compares the percent of kilns assigned to each treatment ar m that adopted any type of worker incentives. The left figure presents results for 1.5 months after the technical inter vention was implemented and the right figure presents results 4 months a fter the technical inter vention was implemented. The black lines indicate 95% confidence intervals around the mean.

Figure 4: Use of any worker incentives by treatment arm

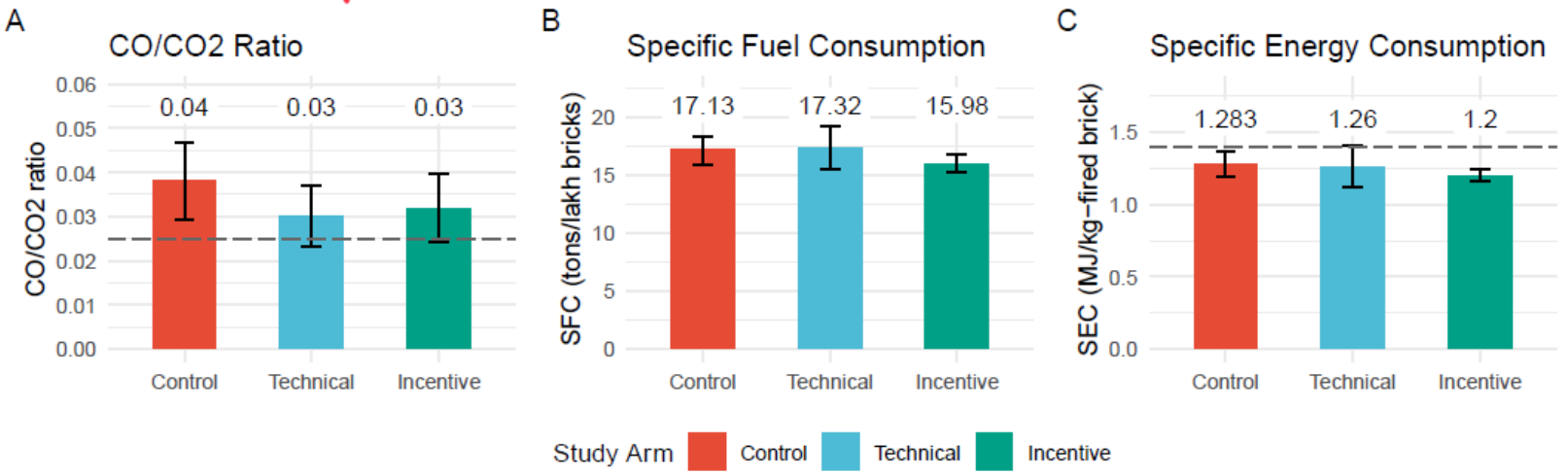
Effect on working conditions

	Provides Meals	Number of Meals	Rest Area Capacity
Technical Group	0.000	0.000	0.100
	(0.204) [1.000]	(0.436) [1.000]	(2.648) [0.970]
Incentive Group	0.400	0.667	5.200
	(0.204) [0.060]	(0.356) [0.104]	(2.648) [0.060]
Control Mean	0.200	2.000	6.800
	(0.144) [0.176]	(0.309) [0.000]	(1.872) [0.001]
Num.Obs.	30	10	30

Notes: Standard errors in parentheses. Exact p-values in square brackets. All three columns present results for the ITT specification. Column 1 presents results for whether the owner provides meals. Column 2 presents results for the number of meals provided. Column 3 presents results for the number of workers that can be accommodated in a rest area.

Figure 5: ITT Effect of Intervention on Working Conditions

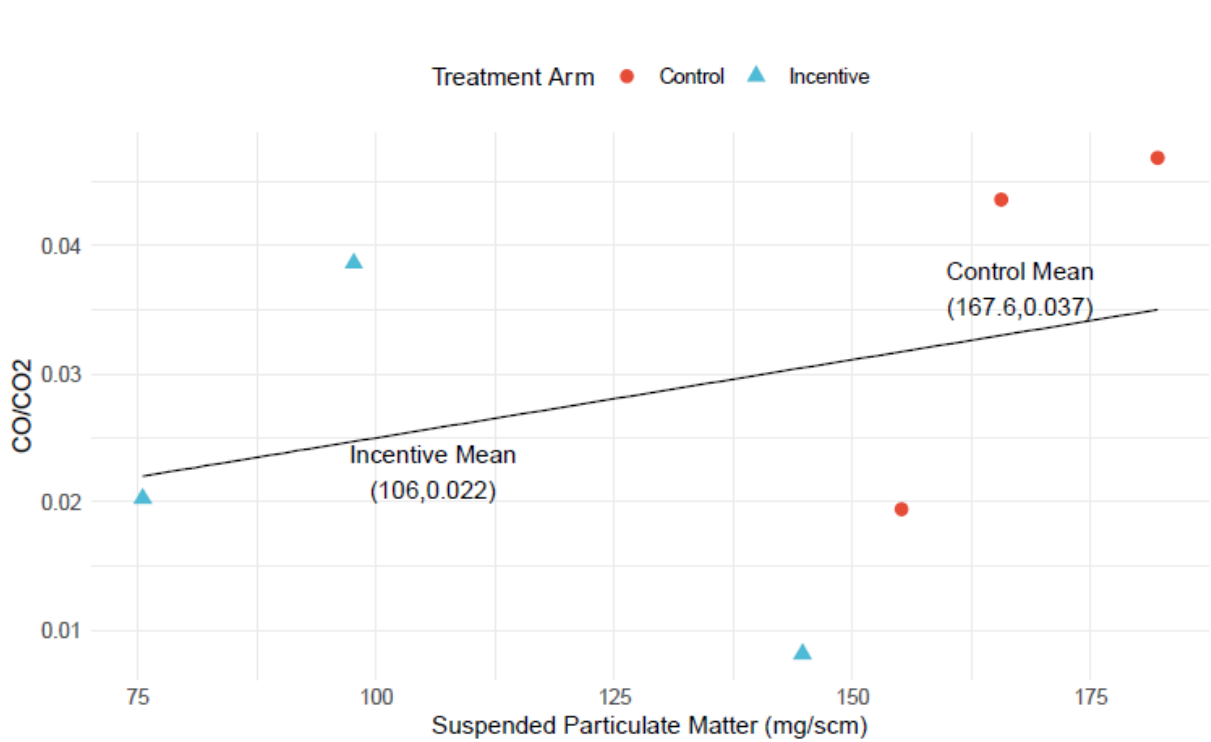
Environmental Outcomes



Notes: Panel A reports the mean CO/CO2 ratio, averaged over the pilot season, by treatment arm. The dashed horizontal line marks 0.025, which is indicative of optimal performance. Panel B reports the mean specific fuel consumption measured in tons/lakh br icks, averaged over the pilot season, by treatment arm. There is no threshold for optimal performace for specific fuel consumption due to large v ariation in the type of fuels used and w eight of bricks, but lower numbers indicated more efficient operation. Panel C reports mean specific energy consumption measured in MJ/kg−fired−br ick, averaged over the pilot season, by treatment arm. The dashed horizontal line marks 1.4, which is indicative of optimal performance. In all three panels, the means for each arm are reported above the corresponding bar and 95% confidence intervals around the mean are sho wn in black.

Figure 6: Comparison of kiln efficiency outcomes by treatment

Suspended Particulate Matter



Notes: This figure presents a scatter plot of suspended par ticulate matter (SPM) and CO/CO2 ratio for the six kilns where SPM measurements were collected. Control kilns are represented as red circles and treatment (technical group) kilns are represented as b lue triangles. A line of best fit is plotted and points representing the a verage SPM and CO/CO2 ratio among the inter vention and control groups are indicated in te xt.

Figure 7: Comparison of Suspended Particulate Matter and CO/CO2 Ratio

Class-1 Brick Production

	Intention-to-treat		Treatment-on-the-treated		
	(1)	(2)	(3)	(4)	(5)
Adopted Intervention			4.20	14.25	9.22
			(9.06) [0.87]	(11.37) [0.60]	(9.04) [0.62]
Bundled Treatment		4.61			
		(4.29) [0.27]			
Technical Group	2.10				
	(4.95) [0.33]				
Incentive Group	7.12				
	(4.95) [0.66]				
Control Mean	66.00	66.00	65.58	64.58	65.08
	(3.50) [0.00]	(3.50) [0.00]	(3.90) [0.00]	(4.89) [0.00]	(4.46) [0.00]
Num.Obs.	30	30	20	20	30

Notes: Standard errors in parentheses. Exact p-values in square brackets. Column 1 presents results for the ITT model (Equation 1). Column 2 presents results for the ITT model with both treatment arms bundled. Column 3 presents the 2SLS (Equations 2 and 3) results using assignment only to the technical arm as an instrument for adopting the intervention. Column 4 presents the 2SLS results using assignment only to the incentive arm as an instrument for adopting the intervention. Column 5 presentsthe 2SLS results using assignment to both treatment arms as an instrument for adoption.

Figure 8: Effect of the Intervention on Class-1 Brick Production

Coal Spending per Brick

	Intention-to-treat		Treatment-on-the-treated		
	(1)	(2)	(3)	(4)	(5)
Adopted Intervention			-0.311	-1.137	-0.724
			(0.546) [0.848]	(0.866) [0.696]	(0.646) [0.610]
Bundled Treatment		-0.362			
		(0.296) [0.246]			
Technical Group	-0.155				
	(0.339) [0.613]				
Incentive Group	-0.569				
	(0.339) [0.286]				
Control Mean	3.598	3.598	3.629	3.712	3.671
	(0.240) [0.000]	(0.242) [0.000]	(0.235) [0.000]	(0.372) [0.000]	(0.319) [0.000]
Num.Obs.	30	30	20	20	30

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Figure 9: Effect of the Intervention on Coal Spending per Brick

Concluding remarks

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- Reduction of pollutant gases and suspended particulate matter
- Incentive arm doing better - workers' incentives matter

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