Improving Brick Manufacturing in Bangladesh to Promote Clean Air and Better Health

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Sector(s): Environment & Energy

Fieldwork: icddr,b

Sample: 276 kilns

Initiative(s): King Climate Action Initiative (K-CAI)

Target group: Small and medium enterprises

Outcome of interest: Pollution Technology adoption Climate change mitigation

Intervention type: Information

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Bangladesh is the nation with the highest air pollution in the world, and traditional brick kilns generate eleven percent of its PM2.5 and seventeen percent of its carbon dioxide (CO2) emissions. Pollution from brick kilns causes approximately 6,000 premature adult deaths annually in Bangladesh. Researchers evaluated if a training campaign for owners and operators of brick manufacturing kilns could reduce air pollution, CO2 emissions, and fuel expenses, and whether increasing attention to worker incentives resulted in further reductions. The trainings enabled many informal kiln owner to use these practices, leading to reduced PM2.5 and CO2 emissions.

Policy issue

Traditional coal-burning brick kilns generate eleven percent of all particulate matter pollution with a diameter of less than 2.5 microns (PM2.5) and seventeen percent of all CO2 emissions in Bangladesh. Reducing air pollution can improve local air quality

and health outcomes. “Zigzag” brick kilns can burn fuel more efficiently than traditional kilns, emitting less CO2 and pollution emissions while produce higher-quality bricks which are more profitable to kiln owners. Though 81 percent of registered brick kilns in Bangladesh are zigzag kilns, the vast majority are incorrectly constructed or operated, reducing their potential efficiency. Does training kiln owners to correctly operate zigzag kilns decrease pollution and increase profits?

Context of the evaluation

Pollution from brick kilns causes approximately 6,100 premature adult deaths annually in Bangladesh.[1], Many kilns are located near large population centers, exposing large numbers of people to pollution and increasing morbidity and mortality.[2], The government of Bangladesh placed strict regulations on traditional brick kilns beginning in 1989; however, these regulations have been loosely enforced.[3], [4] The government has been encouraging manufacturers to switch to zigzag kilns since 2010 as a way to reduce pollution from brick manufacturing, but many zigzag kilns are not operated correctly. Many kiln owners are reluctant to alter the way they manage their kilns because they are uncertain that they have the technical expertise to implement changes or workers will be able to adhere to the new practices.

About 90 percent of kiln owners in Bangladesh are members of the Bangladesh Brick Manufacturing Owners Association (BBMOA), which is an organization that supports kiln owners’ common interests, the improvement of the brick sector, and the introduction of new technologies. Across Bangladesh, kilns operate during the dry season in Bangladesh, from approximately November to May. Fuel for firing bricks is the most expensive input to the manufacturing process.

In 2022, for the sample of traditional brick kilns represented in the study, kiln owners had between fourteen and sixteen years of experience in brick manufacturing, employed around 110 workers, had converted their kiln to a zigzag kiln in mid-2014. They fired around 4.7 million bricks per year, and about 65 percent of those bricks produced were of the highest quality class (Class 1).

Fireman feeding coal into the kiln to fire bricks. Photo: icddr,b

Details of the intervention

Researchers partnered with the International Center for Diarrhoeal Disease Research, Bangladesh (icddr,b), and the Bangladesh University of Engineering and Technology (BUET) to conduct a randomized evaluation the impact of training kiln owners and encouraging them to incentivize workers on kiln productivity, pollution, coal consumption, kiln operations, and CO2 emissions. Initially, researchers identified 357 kilns for the evaluation, but kilns that had decided to burn firewood exclusively (as opposed to coal), decided not to operate during the season of research, or refused to participate were excluded, which left 294 eligible kilns, of which 276 were still operational at the end of the study. Kilns were randomly assigned to one of three groups:

- *Technical knowledge and training* (89 kilns): In this group, kiln owners received information, training, and encouragement to adopt a set of technical and operational changes in a classroom setting. Having a single person continuously feed fuel to the kiln instead of intermittently and stacking bricks differently for better air flow within the kiln were the two most impactful and popular practices. Labor supervisors and workers received technical training on-site. Owners and workers received additional technical support throughout the brick firing season.
- *Technical knowledge and training, plus incentive information* (95 kilns): This group received the same resources as in the technical knowledge and training group, but kiln owners also received additional information and encouragement about how to incentivize workers to adopt the new technical practices. Suggested incentives included financial incentives and

better working conditions. The research team also followed up with two later visits to remind kiln owners of the incentives' importance.

- *Comparison group* (92 kilns): In this group, kilns did not receive information, training or encouragement.

Researchers piloted the interventions during the 2021 brick firing season (between November 2021 and May 2022), before launching the full evaluation during the 2022 firing season (November 2022 to May 2023). Researchers assessed the kilns' performance at the end of the firing season, between March and May 2023, during which time they measured the amount of coal the kilns consumed, the amount and quality of bricks produced, and measures of coal-burning efficiency related to local air pollution.

Brick manufacturing in the informal sector across South Asia characteristically engages and commonly exploits impoverished workers. There is a risk that by improving the operations of these kilns the researchers could be complicit in this exploitation and risk expanding these businesses and the number of people whom they exploit. Researchers were engaged by the primary research team to focus on efforts to monitor and improve workers' conditions as part of this larger effort.

Results and policy lessons

The trainings enabled many informal kiln owners, workers, and supervisors to use these practices, improve kiln profitability, and reduce coal use and emissions. Encouraging kiln owners to additionally incentivize workers did not alter these results; thus, the results from the two treatment arms are presented together.[5]

Use of efficient practices: During the study season, 65.2 percent of kilns in the training groups adopted the practices of continuous fuel feeding and improved brick stacking, compared to 19.6 percent of kilns in the comparison group. Many kilns in the comparison group requested information about the practices during the study, though they were promised they would receive the full training and support the following year. A year later, the researchers returned to the kilns that had been trained and found that adoption had increased to 73.8 percent in this group. The training was provided to kilns in the comparison group after the study, and 56.6 percent of them either continued or adopted the practices in the second year.

Economic benefits for kiln owners: Kiln owners benefitted financially from using the efficient practices. Those who were offered the training spent less on fuel per brick by the amount of BDT 0.36 (US$0.0031) than the comparison group's average fuel cost per brick of 3.74 BDT (US$0.0365), a decrease of 9.6 percent. Over the whole season, those who received the training spent on average BDT 1.94 million (US$17,887) less than the control group, which spent an average of BDT 22.71 million (US$209,396). Kiln owners in the group that received the training also increased the percentage of high-quality bricks, which sell for a higher price, by 6.3 percentage points from 78 percent in the comparison group, an increase of 8.1 percent. Class 1 bricks sell for BDT 11 per brick (US$0.09) on average, compared to lower prices for inferior quality bricks. The researchers were unable to detect a meaningful change in the total value of brick production over the firing season.

Energy and coal use: Due to being more likely to use the efficient practices, the kiln owners who received the training used less energy per kilogram of bricks by 0.11 megajoules (MJ) relative to the comparison group average of 1.07 MJ (a 10.5 percent decrease). The amount of coal used to manufacture 100,000 bricks reduced by 1.8 tons relative to the comparison group average of 16.3 tons, a decrease of 11.5 percent.

Carbon dioxide and local air pollution: The kiln owners with the option to receive the training reduced CO2 emissions by 171 tons per kiln over the season, a 9.0 percent decrease from the comparison group average of 1,903 tons of CO2. Emissions of fine particulate matter (PM2.5) reduced by 0.45 tons per kiln over the season, compared to 5.02 tons per kiln on average in the comparison group, a 9.0 percent decrease.

Cost-analysis: The primary cost for the intervention was the training expense and technical support throughout the season, which amounted to approximately US$486 per kiln. On average, each kiln in the training group reduced carbon emissions by an amount valued at US$31,580, based on the costs of damages caused by accelerated climate change placed at US$185 per ton of CO2.[6]

The findings suggest that in the informal sectors like brick manufacturing in Bangladesh, where regulation is difficult to enforce, economic benefits can incentivize firm owners to adopt new, efficient practices, and these practices can achieve substantial emissions reductions.

After the conclusion of this randomized evaluation in 2023, the researchers and their partner icddr,b began scaling up the intervention in the same division as the evaluation, Khulna Division, as well as Dhaka Division in Bangladesh. They maintained the same training structure.

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