

**Topic** | Mitigating crop residue burning, a major air pollutant in India, through financial incentives to farmers

**Pitch** | Social venture that pays Indian farmers to not burn their crop residue offers a highly cost-effective opportunity to save 18,000+ lives annually in India for ~\$115M/year

- Payments are highly cost-effective and scalable, saving a life for ~\$6,000 (USD)
- Effective near-term government intervention unlikely, leaving large role for civil society
- Scaled across North India could save 18,000+ lives annually, and more in other regions

**Context** | Poor air quality in India results in one of the largest health burdens from pollution globally, with crop residue burning a major contributor

- Poor air quality reduces life expectancy in North India by up to 7 years<sup>1</sup>
- Crop residue burning causes about a third of peak pollution during harvest months and ~66,000 premature deaths in India annually, as of 2015<sup>2</sup>
- Despite Indian govt. efforts to curtail burning, the practice has increased in past decade and political dynamics mean further action unlikely in short-to-mid term

**Evidence for solution** | 2018 [RCT](#) in 171 villages (1,668 farmers) across two districts of Punjab

- Treatment: Paid farmers ₹800 to ₹1,600 (~\$10-20) per acre to not burn residue
- Effects: Payments led to 10 percentage points (pp) fewer farmers burning residue (from 91.5 to 81.7% of farmers burning)
- Costs: ~\$25-50 per burned acre avoided, suggesting ~\$3600 to \$5400 per life saved
- Mechanism: Payments that are conditional on not burning residue make alternatives to burning (which cost ₹1000-3000+ per acre) more attractive; providing a portion of the payment up-front, which improved trust and financial liquidity, was essential for impact

**Opportunity** | Base case to cover Punjab, Haryana, & Uttar Pradesh<sup>3</sup> (three high burn regions) is ~18,000 lives saved and costs of ~\$116M annually (~\$6.5K per life saved; ~150:1 B:C ratio)<sup>4</sup>

- Almost all program costs due to payments; monitoring <5% total costs in study and expected to be similar or lower at scale
- Program costs & benefits sensitive to payment amounts & uptake assumptions
- Model assumes both higher payment levels and higher uptake, and less effective targeting of infra-marginal recipients than study, ensuring conservative estimate (*additional assumptions & parameters in footnote 4*)

<sup>1</sup> Lee and Greenstone, 2021

<sup>2</sup> Global Burden of Disease Working Group, 2018

<sup>3</sup> Combined acreage of rice estimated ~17.37M across the three regions, and estimate ~50% of that burned (likely conservative on the high-side) based on Liu et al. (2020)

<sup>4</sup> Base case used payments of ₹2,200/acre for compliance and ₹200/acre up-front. Costs assume: (1) contracting ~6.25M acres total (approx. 1M farmers), (2) 75% of contracted land would have been burned without program, and (3) of the 75%, 50% compliance with contract. These lead to 37.5% of contracted farmers comply who would not have otherwise. Benefits assume: (1) 66,000 deaths attributable to burning from the region, (2) 50% of paddy acreage is burned, and (3) deaths linearly correlated to burn rates. These lead to a death per burned acre of 0.0075.

**General operating model|** Effective implementation requires a core set of activities:

1. Decide payment levels & contract structure: Recommend paying ₹2,000 to ₹3,000 /acre to fully offset mitigation costs and offer small up-front payment; recommend modest ~₹200/acre payment
2. Establish compliance monitoring approach: Study primarily used in-person field surveys but remote sensing also possible
3. Set coverage area: Focus on high burn rate regions with low presence of other NGOs who are effectively addressing the problem
4. Operate program: Contract with farmers, measure compliance, make payments, iterate

**Program options to explore|** There are many factors to explore in developing program:

1. Alter payment levels: Study found paying ~25% up front had large impact on uptake but increased costs, so test lower %; given low overall uptake, test higher total payments
2. Alter contracting structure: Test making those who take upfront payments and then burn ineligible in future years; will reduce payments to people who still burn
3. Improve targeting: More cost-effective if those not planning to burn are not included
4. Improve compliance verification approach: In-person monitoring only cost ~5% of payments; test further improvements to increase accuracy and lower costs
5. Bundle training / support for utilizing alternatives: Test benefit of increasing know-how for use of baler or Happy Seeder technology, the two most common alternatives
6. Buy bales instead: Option for subsidizing not-burning by increasing profitability of one alternative (baling). Easier to monitor but limits set of alternatives to burning
7. Expand program to other areas: Burning is widespread in other regions including in Maharashtra, Punjab (Pakistan), and in many other countries (e.g., Bangladesh, China)

**Next steps|** Scaling a venture to reduce crop residue burning in India could be among the highest impact air pollution interventions in the world and effective within a 5-year horizon:

- Clear funding opportunity: Air pollution in India and globally is a growing funding priority for select philanthropies, multilaterals, and governments
- Refine solution: Payments are effective at reducing burns and can be scaled; with further experimentation the impact and effectiveness can be increased even further
- Identify downstream opportunities: Supporting broader residue management value chain (e.g., constructing biofuel plants & improving access to balers) may increase program effectiveness
- Exit strategy: As program is scaled and impact measured, government will be better positioned to take over operations or provide funding. Also, innovations in alternative technology may reduce program costs or even obviate the need for payments to farmers