

Beyond Carbon Capture: The Case for Combating PM2.5 with Biochar

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ABSTRACT

As climate ambitions grow more urgent, the world appears to have reached a quiet consensus: traditional emissions control hasn't worked. Despite decades of global climate pledges, carbon levels continue to climb, and the conversation has moved toward carbon capture technologies as our best hope to undo the damage. Yet while climate change rightly dominates headlines, it has perhaps eclipsed another catastrophic threat—one that is silent, deadly, and tragically ignored.

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As climate ambitions grow more urgent, the world appears to have reached a quiet consensus: traditional emissions control hasn't worked. Despite decades of global climate pledges, carbon levels continue to climb, and the conversation has moved toward carbon capture technologies as our best hope to undo the damage. Yet while climate change rightly dominates headlines, it has perhaps eclipsed another catastrophic threat—one that is silent, deadly, and tragically ignored.

That threat is PM2.5

PM2.5 refers to particulate matter measuring 2.5 microns or less in diameter. It is the killer component of smoke, capable of infiltrating the lungs and bloodstream, triggering heart attacks, strokes, respiratory illnesses, and premature death. According to the World Health Organization, PM2.5 is the fifth deadliest risk factor worldwide, claiming 7.2 million lives each year—more than hepatitis A, malaria, HIV, and tuberculosis combined. 90% of these deaths occur in developing nations.

Unlike carbon dioxide, PM2.5 doesn't linger invisibly in the atmosphere for centuries. It's tangible, palpable, and often visible in smoky skies and ash-laden air. It results from incomplete combustion—particularly in the open

burning of agricultural waste, a practice largely absent from wealthy countries but common in the fields of South Asia, sub-Saharan Africa, and Latin America. For millions of farmers operating on subsistence budgets, open field burning remains the most expedient and lowest cost way to dispose of crop residues. But the human cost is high.

Enter Biochar

Biochar is a charcoal-like substance produced when organic materials—like crop waste—are burned in a low-oxygen environment, a process known as pyrolysis. This not only eliminates PM2.5 emissions but also locks carbon into solid form, preventing it from returning to the atmosphere. In essence, biochar turns an environmental hazard into a multifaceted solution: improving air quality, enhancing soil fertility, and sequestering carbon.

In an ironic twist, the fight against PM2.5 may offer the most practical path toward slowing climate change in the agricultural sector of the developing world. Policy measures aimed at curbing CO₂ emissions in these regions often falter due to weak enforcement and limited incentives. But what if farmers were driven not by abstract climate targets—but by their own immediate concerns - for instance health?

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Unlike CO₂, PM_{2.5} is personal. It hurts. It shortens lives. In smoky north Thailand people live 4 years less than those living in the south, while the region has the highest infant mortality and elderly premature death rates in the country. This visceral connection may be the key to meaningful change. Farmers who adopt biochar techniques out of concern for their lungs and their families unwittingly become climate heroes, replacing high-emission field burning with carbon-negative practices. This bottom-up transformation might succeed where top-down policy has failed.

The health benefits alone are super. Eliminating PM_{2.5} could save millions of lives annually, lower child mortality rates, reduce childhood asthma, and relieve pressure on underfunded healthcare systems. But the climate impact may be even more profound. Biochar remains stable in soil for hundreds—sometimes thousands—of years, effectively removing carbon from circulation. In the soil, biochar improves fertility, reduces acidity and improves agricultural outcomes. As agriculture accounts for roughly one-third of global greenhouse gas emissions, this shift may help reduce greenhouse gas emissions considerably.

Biochar is accessible for poor smallholders. Unlike costly carbon capture infrastructure, which demands technical expertise and massive investment, biochar can be made with simple kilns, often crafted from local materials. Training programs and out-

reach efforts have already shown promise, as farmers learn to transform waste into value, from soil amendment to marketable fertilizer and carbon credits.

As agriculture there's more: biochar can reduce reliance on chemical fertilizers, mitigate methane emissions from rice paddies, and improve crop yields. In other words, it's not just a climate tool—it's a development tool.

Why Isn't Biochar at the Center of Climate Policy?

Part of the reason lies in the optics. Biochar isn't flashy. It doesn't come packaged in glossy campaigns or futuristic tech. It's low-tech, rural, and decentralized. But therein lies its power. Real change will not come from Davos speeches or splashy product launches—it will come from farmers breathing cleaner air and growing healthier crops.

As we scramble to fund moonshot climate solutions, we should not overlook this humble miracle. Biochar isn't just another tool—it's the nexus where air quality, soil health, and climate action converge.

If carbon capture is the future, biochar is the future we can afford—today.