The Happy Seeder: An Agricultural Solution to Air Pollution in South Asia

One of the key environmental problems facing South Asia is a layer of air pollution, known as the Atmospheric Brown Cloud that covers large parts of the region. Much of this pollution is caused by farmers burning agricultural field residue. This pollution has a significant negative impact on people's health and on regional climate and crop output. A recent SANDEE study from India's Punjab region looks at the factors that drive field residue burning. It also assesses the potential of new technology to address the problem. The study is the work of Ridhima Gupta, from the Indian Statistical Institute in Delhi.

Gupta finds that currently popular 'combine-harvester' technology used by farmers to harvest coarse (as opposed to Basmati) varieties of rice increases the likelihood of farmers burning biomass. However, there is an alternate technology available. This technology, the Happy Seeder, stops farmers from burning residues and doesn't increase field preparation costs or alter crop yields. Yet, because the Happy Seeder does not bring any significant economic advantages to individual farmers other than reducing residue burning in the field, its adoption is likely to be slow. Gupta recommends that the state do more to promote the machine in order to clean up the region's air.

The Residue Burning Challenge

Residue burning is a part of the 'rice-wheat cropping system' (RWCS) that is the dominant cropping system in South Asia. This system involves growing rice and wheat in rotation throughout the year. Uttar Pradesh, Punjab, Haryana, Bihar, Madhya Pradesh and Himachal Pradesh have the largest areas under this system among the Indian states. Rice residue is largely burnt because it is of limited value to farmers and removing it from the field increases farming costs.

Research suggests that farmers in India burned 116 million metric tons of crop residues in 2001, albeit with strong regional variations. This practice poses environmental challenges in terms of increases in black carbon, particulate matter and carbon dioxide emissions (see side bar for key environmental challenges from residue burning). The problem is so bad that it led to a ban on residue burning in some areas, including the Indian district of Amritsar. However, this ban has done little to solve the problem due to lack of monitoring and strong enforcement.

The Study Area

The state of Punjab was chosen for the study because, at the time the research was done, the Happy Seeder technology was only available in that state. Moreover, with rice and wheat yields of 3,858 kg per hectare and 4,179 kg per hectare respectively (in 2005-06), Punjab produces the highest food grain yields in India.

Two surveys were conducted to get data for the study. The first survey collected information on the ways in which farmers in the Punjab dispose agricultural residue and the factors that make them act in the way they do.

This policy brief is based on SANDEE working paper No. 66–12, ‘Causes of Emissions from Agricultural Residue Burning in North-west India: Evaluation of a Technology Policy Response’ by Ridhima Gupta, from the Indian Statistical Institute Delhi. Email: g.ridhima@gmail.com. The full report is available at www.sandeeonline.org
do. The second survey gathered information for the assessment of the Happy Seeder machine. Representative samples of farmers were selected from the districts of Amritsar, Ludhiana and Sangrur to capture geographical variation across Punjab.

### The Happy Seeder Machine

The Happy Seeder is a tractor-mounted machine that cuts and lifts rice straw, sows wheat into the bare soil, and deposits the straw over the sown area as mulch. It therefore allows farmers to sow wheat immediately after their rice harvest without the need to burn any rice residue for land preparation. Engineers of CSIRO Griffith at Punjab Agricultural University developed the first prototype of the Happy Seeder in July 2001 and it was first sold to a farmer in the district in 2007. At the time of the field survey, the Happy Seeder was being manufactured at Ramdass in the district of Gurdaspur.

Most farmers who took part in the survey, and who employed the Happy Seeder, used the machine on a limited area of their land while simultaneously using conventional tillage in other areas. This fact allowed the researchers to directly compare the costs of both approaches and take into account the impact of any other factors.

The cost of using the Happy Seeder comprises the cost of hiring the machine, the cost of the diesel needed to operate it, the amount spent applying weedicide and the amount spent purchasing fertilizers and weedicide. A prerequisite for using the Happy Seeder is that loose rice straw should be spread uniformly on the field – this adds a further cost to the use of the machine. The total cost of establishing wheat with conventional tillage comprises the cost of hiring farm equipment, the cost of the diesel to run it and the costs of purchasing and applying weedicide and fertilizers.

### The Link between Rice Varieties and Residue Burning

The study finds a strong link between the cultivation of coarse varieties of rice and residue burning. This is explained by the fact that the use of coarse

<table>
<thead>
<tr>
<th>Residue Management</th>
<th>Harvesting Method</th>
<th>Variety of Rice - Basmati</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully Burnt</td>
<td>Manual (177 ha)</td>
<td>1</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Partially Burnt</td>
<td></td>
<td>0</td>
<td>16</td>
<td></td>
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<tr>
<td>Incorporated</td>
<td></td>
<td>0</td>
<td>18</td>
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<tr>
<td>Removed</td>
<td></td>
<td>99</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Variety of Rice - Coarse</td>
<td>Combine (94 ha)</td>
<td>0</td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Fully Burnt</td>
<td></td>
<td>0</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Partially Burnt</td>
<td></td>
<td>0</td>
<td>4</td>
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<td>Incorporated</td>
<td></td>
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<td>0</td>
<td>4</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Variety of Rice - Coarse</th>
<th>Harvesting Method</th>
<th>Manual (0)</th>
<th>Combine (869 ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully Burnt</td>
<td></td>
<td>0</td>
<td>76</td>
</tr>
<tr>
<td>Partially Burnt</td>
<td></td>
<td>0</td>
<td>16</td>
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<td>Incorporated</td>
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</table>
(as opposed to Basmati) varieties of rice increases the likelihood of farmers using a combine-harvester. Farmers prefer not to undertake manual harvesting of course varieties because it increases farming costs while simultaneously the price of coarse varieties is lower than that of Basmati rice. Indeed, in plots that were planted with coarse varieties, farmers were, on average, 63% more likely to use combine-harvesters. Combine-harvesters scatter crop residue as they harvest. As a result, rice residue left behind by a combine-harvester is more likely to be burnt than residue left after a rice crop has been harvested using manual labour.

These results suggest that the use of combine-harvesters should be targeted to tackle the residue burning challenge. However, combine-harvesters are immensely popular with farmers because they offer financial and time savings. One way of breaking the link between combine-harvesters and biomass burning is the use of balers that allows the residue to be collected separately. Indeed, such balers have already been introduced in the district of Amritsar and a sugar mill in the district is also using the baled residue to generate electricity. However, the study finds that baling of residue may not be a viable mitigation strategy as the supply of baled residue may outweigh its demand.

**The Happy Seeder Provides a Viable Alternative to Residue Burning**

The study finds that the Happy Seeder technology is a viable alternative to open-field burning of rice residue in Punjab. It also finds that operators of this technology can save about INR. 1000-1060 per hectare (or USD 23) on average in field preparation costs compared to plots that were conventionally tilled. In addition, the mean output of wheat crops is similar from plots that have been conventionally tilled and from those that have been cultivated using Happy Seeder technology. Farmers also enjoy substantial time savings because the Happy Seeder can be brought into the field immediately after the rice harvest. This enables farmers to sow wheat while the rice straw is still too green to burn. These savings are significant because any delay in planting wheat affects its productivity.

Further, the study supports claims that the Happy Seeder reduces the need for farmers to use weed control measures as the mulch it produces suppresses weeds. This was demonstrated by the fact that operators of the Happy Seeder in the study applied lower quantities of fertilizer and weedicide to their wheat crops. This reduction in agricultural inputs not only saves farmers money and time, but also reduces the amount of chemical pollution caused by their activities.

**Why the Government Should Promote the Happy Seeder**

While the Happy Seeder technology is profitable, careful data analyses shows that it does not provide significant advantages relative to conventional tillage. This means that, on its own, the Happy Seeder technology will spread only slowly. Farmers often resist taking on new approaches. They are likely to prefer to stick with the tried-and-tested status quo in order to avoid any uncertainties associated with new technology.

However, since the Happy Seeder offers a viable way to tackle the residue
burning problem, it makes good policy sense to promote the machine to secure the pollution control benefits it can bring to society as a whole. Accordingly, the study recommends that the government should promote the machine through subsidies. The study also recommends that policy makers should highlight the time and weed-control benefits that the technology brings.

Combine-harvesters can be fitted with a spreader to evenly distribute loose residue. Using these attachments removes one cost element from the use of the Happy Seeder machine. It can also improve wheat crop yields. The study therefore recommends that the government should increase the availability of combine-harvesters that have a spreader attached to them.

Overall, the study recommends that policy makers and other interested parties should play a more proactive role in promoting the use of the Happy Seeder machine in order to reduce residue burning. This will have benefits to society at large. The study also highlights the need for further research in order to assess the long-term impact of the Happy Seeder technology on soil fertility and yield.

Variable Width Notched Box Plots of Field Preparation Costs (per hectare) Across plots that was Cultivated using Happy Seeder Technology and Conventional Tillage

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**SANDEE**

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**Author**

Ridhima Gupta

**Editor**

Rufus Bellamy

**Series Editor**

Priya Shyamundar

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