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How to Stop the Pollution Caused by Burning Rice Residue? A Study from Bangladesh

Rice is the most important crop in Bangladesh. Rice straw, produced as a by-product, can be used for many purposes. However, farmers burn a great deal of straw, contributing to a range of environmental pollution problems including atmospheric brown clouds and black carbon. This Brief examines farmer behaviour in Bangladesh and discusses whether farmers can be induced to use other methods to get rid of rice residue.

Farmers in Bangladesh choose to burn long straw and bad quality rice residue since this type of straw cannot be used for feeding animals. Incorporating excessive straw into the field is also difficult and removal is costly. This study finds that farmers who burn residue enjoy an average net annual benefit of US $43-45 per acre relative to farmers who don't burn. These relative gains are mainly because it is less costly to harvest the first rice crop if residue is burnt and yields are higher in the successive crop. In light of these findings, farmers would need to be subsidized by approximately US $2.10 million per year in order to avoid rice residue burning in Bangladesh. The study recommends that more agronomy research be done on reducing straw length so that farmers switch from residue burning to residue incorporation. The study is the work of Mohammed Ziaul Haider, Professor in Economics, Khulna University in Bangladesh.

The rice residue burning challenge

In 2010, Bangladeshi farmers produced 32 million metric tonnes of rice in 28 million acres of land and burnt an estimated 3.14 million metric tons of rice residue. This type of open burning generates large quantities of gaseous and particulate emissions including black carbon, which is the second largest contributor to global warming after carbon dioxide. Moreover, in South Asia the burning of agricultural residue in the field is a major cause of Atmospheric Brown Clouds. This has implications for regional climate, agricultural productivity, glacial melting and health.

In order to help find a solution to this challenge, the study set out to quantify the benefits of residue burning relative to alternative practices and to develop an understanding of the behaviour of farmers with respect to residue management. There is little information available on these issues and the study is arguably the first to use farm-level data to address the issue of residue burning in Bangladesh.

Surveying Aman farmers

Haider's study focused on rice farmers in the south-west region of Bangladesh. Aman and IRRI are the two main rice varieties cultivated in this region and double cropping of rice dominates. Thirty villages were selected for the study and a

A rice field (with burnt residue).

This policy brief is based on SANDEE working paper No. 71-12, 'Options and Determinants of Rice Residue Management Practices in the South-West Region of Bangladesh' by Mohammed Ziaul Haider, Professor in Economics, Khulna University, Khulna – 9208, Bangladesh. The full report is available at: www.sandeeonline.org

The study area

The study focuses on the south-west region of Bangladesh, this encompasses the districts of Kushtia, Meherpur, Chuadanga, Jhenaidaha, Jessore, Satkhira, Khulna, Bagerhat, Narail, Faridpur and Rajbari.

The Census Report 2001 and the district-wise community information of Bangladesh show that there are 72 thanas, 651 unions and 11,434 villages in the study area. Ten thanas were randomly selected from eleven south-western districts and thirty villages were randomly selected from the chosen thanas. Three hundred farming households were systematically sampled from the 30 selected villages. The two biggest plots of each sample household were surveyed irrespective of residue burning practice or location of the plots. Therefore, the survey covers 600 plots of 300 farming households.

The people who responded to the survey were all household heads and were male and married. The dominant age group in the sample was 36-50 years. Some 38% had at least 1-5 years of schooling. A large proportion (95%) of the farming households owned cattle. However, approximately half of the surveyed respondents had no access to electricity and about 70% had kacha houses.

With regard to land ownership, approximately one-fourth of the respondents had either 1 acre or less, another one-third owned 1-2 acres of land, while the rest owned more than 2 acres of land. Plots were scattered and all of the surveyed farmers cultivated two or more plots in 2010. Almost all the farmers used tractors for land cultivation, even though less than 10% owned tractors. In addition, all the surveyed farmers manually harvested rice and collected residue from the field.

list of farmers, crop varieties, land ownership and residue management practices at the end of the Aman season was prepared for each village.

Since Aman is the only rice variety that is burnt in the field, a total of 300 farming households that cultivated the Aman crop in 2010 were surveyed (see the side bar for more on the study area). Based on a structured survey, a variety of information ranging from socio-economic to residue management practices was obtained from farm households.

In order to assess the impact of different rice residue management techniques, the costs of rice harvesting and residue management for the Aman 2010 season (July/Aug – Nov/Dec 2010) were assessed along with the production benefits and costs associated with the successive season (Dec/Jan – Mar/Apr 2011). It should be noted that this approach does not give a complete picture as some benefits from different residue management techniques may be realized in later seasons as well.

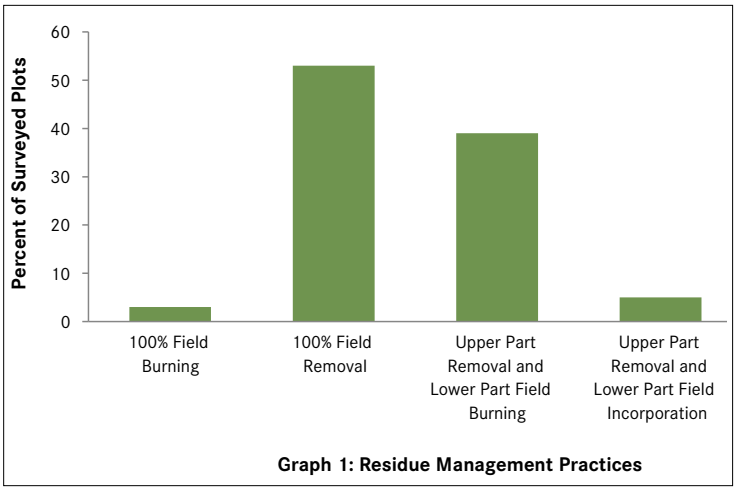
Options for managing rice residues

When it comes to managing rice residues, farmers in Bangladesh have three options: they burn residue in the field, incorporate it into the field or remove residue from the field. These practices influence crop production and soil fertility to varying degrees.

The study assessed different factors that may have a significant influence on farmers' decisions to burn residue. These included the interval between harvests, straw length, the elevation of agricultural land, the distance of a rice field from a farmer's homestead (a proxy for transportation cost), farm size, cattle ownership, the age of farmers and the price of residue. The study also estimates annual net revenues to farmers from two successive crops and compares revenues to farmers who burned residue relative to those who did not burn residue.

Residue removal is the most common management technique

The survey results indicate that among the various residue management practices, residue removal from the field was the most widespread followed by burning of residue in the field (see Graph 1). Residue



Graph 1: Residue Management Practices

removal was practiced on 53% of the surveyed plots. The second most common practice was, 'upper part removal and lower part field burning', which was observed in 38% of the surveyed plots. Complete field burning of residue was observed in only 3% of the 600 surveyed plots. The field survey found very limited practice of straw incorporation, which took place in only 5% of the surveyed 600 plots. Unlike in other parts of South Asia, in Bangladesh, rice harvesting and residue management is fully done manually.

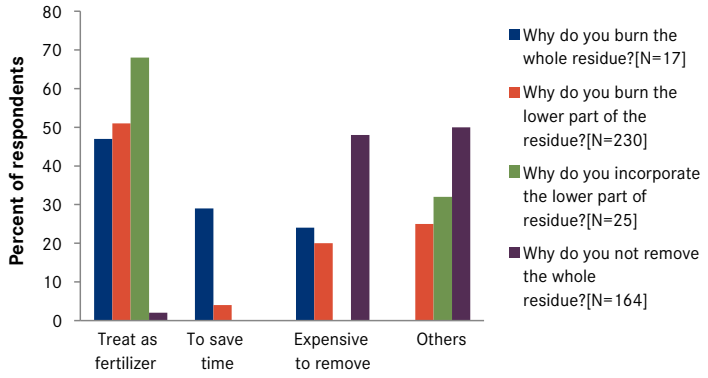
Why do farmers choose different residue management options?

The main reason why farmers remove residue rather than burn it is because they use residue as 'cattle feed'. Some farmers also sold residue: about one-third of the respondents sold the residue derived from one or more plots in 2010.

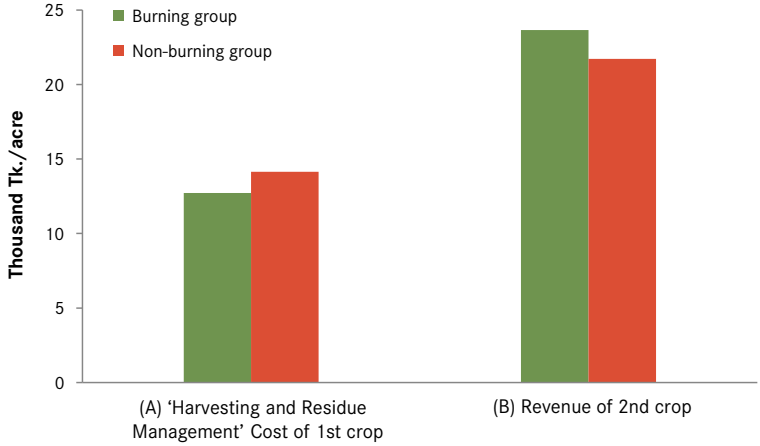
The main reasons identified by farmers for burning the lower part of residue in the field were the following: (i) to use it as fertilizer; (ii) because it is too expensive to remove; and (iii) in order to clear land quickly (see Graph 2). While farmers reported that 'higher removal costs' was the main reason behind not removing the residue, approximately half of the respondents also thought that residue burning fertilized the rice field for successive seasons.

Analysing factors that affect the decision to burn

The study found that residue that grew less than 4 feet tall was mostly removed from the field. In comparison, more than 70% of the farmers burnt the rice straw in their fields if it was over 4 feet in length.



Graph 2: Reasons behind residue management



Graph 3: Costs and Benefits in two successive crops for farmers who burn those and who do not burn

Distance of a plot from the homestead of the farmer also influences residue management practice: the further away a plot the more likely a farmer was to burn residue. This highlights the importance of transportation costs.

For low-elevation land, residue burning in the field was the dominant trend followed by removal. The main reason for this is that varieties with long-straw are usually grown in low-lying land so that the crops can survive flooding. For high-elevation land, residue removal practices dominated. In the case of medium-elevation land, both burning and removal practices were observed equally.

The shorter the time-gap between the cultivation of two successive crops, the higher the likelihood of burning. This implies that when farmers are in a hurry to cultivate the next crop, they prefer to burn rather than remove the residue.

The study did not find any strong correlation between residue incorporation and straw length, land elevation or rice variety.

Does burning improve productivity?

In order to better understand why farmers burn residue, this study looked at profits to farmers in two seasons – the current and the successive season. Haider's findings suggest that residue burning enhances the productivity of the field in the successive season. Residue burning also reduces the costs of rice harvesting, including residue management, in the current season.

The study finds that farmers who burn enjoyed a yearly net benefit (compared to the non-burning group) of Tk. 3,240-3,353 per acre (US $43-45 per acre) on average. This benefit accrued because farm productivity in the successive rice

season was higher by about 9% in fields where burning had occurred in the successive season and because the costs of rice harvesting, including residue management, in the current season were lower by about 10% (see Graph 3).

There is some literature that indicates that residue burning in the field has production advantages in subsequent seasons. Therefore, the benefits of residue burning in the long run might be more than those reported in this study. However, this is not entirely clear because other literature suggests that burning adversely affects soil properties.

Compensation could stop farmers burning residue

The findings of the study clearly indicate that residue burning in the field generates significant private benefits to the farmers, at least in the short run. For this reason farmers are unlikely to voluntarily stop burning residue without some form of compensation even though this practice is bad for the environment and health.

The study establishes that farmers may be willing to stop rice residue burning if they were offered compensation of Tk. 3,240-3,353 per acre (US $43-45 per acre). This is far less than the average market price for high-quality residue (at Tk. 6,746 per acre or US $90 per acre). Thus, an alternative to providing a subsidy is to strengthen markets and improve the quality of cut residue (about one-third of farmers in the sample sold their residue), recognizing, however, that if all farmers sell then the market price will drop.

Accounting for all farmers who burn residue in Bangladesh, it would cost the government approximately US $2.10 million per year in subsidies to avoid rice residue burning in Bangladesh. While this seems to be a large sum, the author estimates that this would amount to approximately 4% of the subsidies currently available to farmers for fertilizer use and other agricultural inputs.

Potential policy measures

Several policy measures can be taken to address the problem of residue burning in the field. These would include subsidies for the purchase of new varieties of seeds, strengthening markets for rice residue and educating farmers with high/medium-elevation land to move to short-straw varieties.

In low-elevation lands, farming conditions dictate the use of long-straw varieties. An alternative approach in such areas would be to persuade farmers to switch from residue burning to residue incorporation. However, more research on strategies for incorporation is required.

There is a need for agronomic research on rice varieties and residue collection methods to reduce straw length and the time between planting and harvesting. New harvesting technologies, such as the Happy Seeder technology used in India, could be introduced and tested to see if it leads to better management of rice residue.

SANDEE

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