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# Study of dust content in wheat straw harvested by wheat straw combines

**ABHISHEK BHARDWAJ** AND **J.S. MAHAL**

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See end of the Paper for authors' affiliation

Correspondence to :

**ABHISHEK BHARDWAJ**
Ludhiana College of Engineering and Technology, Katani Kalan, LUDHIANA (PUNJAB) INDIA

**ABSTRACT :** Mechanical harvesting of wheat has gained popularity over the years. To collect and bruise the wheat straw and stubbles, left after wheat harvesting with grain combines, another locally developed machine is used known as wheat straw combine. The straw harvested by straw combines contains dust that is harmful for animal health. Views of about 100 farmers were collected regarding the quality of wheat straw harvested by straw combines and 78 % of the farmers stated that straw produced by straw combine is inferior in contrast to that obtained using harambha thresher due to high dust content. Another survey was conducted to investigate the bruising system. Samples from five randomly selected harambha thresher and straw combines were collected and were given chemical treatments to determine ash content and acid insoluble ash present in the wheat straw.

**KEY WORDS :** Wheat straw, Wheat straw combine, Ash content, Acid insoluble ash (AIA).

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Wheat is the second major crop of India. Total area under wheat cultivation in India was 29.5 million ha whereas in Punjab it was 3.52 million ha during the year 2011-12 (Anonymous, 2013). 82 per cent of the area under wheat in Punjab is harvested by combines (Gajri *et al.,* 2002). Manual harvesting of wheat is accomplished in two stages. In the first stage, crop is bundled after harvesting and is subsequently threshed in the second stage using harambha thresher. But with the use of a combine harvester, harvesting and threshing are done in a single operation.

Combine harvesting technologies which have become common in rice-wheat system (RWS) in India leave behind large quantities of straw in the field at an average straw grain ratio of 1.5:1 and 1.3:1 for rice and wheat, respectively (Varshney *et al.,* 1995). Farmers usually burn them in- situ to avoid problems in field operations for the next crop. The residual burning adds harmful emissions to the atmosphere, wastes nutrients, decrease soil organic matter, reduces microbial population and can cause fire hazard thus calling for improvement in harvesting technologies and sustainable management of RWS. To collect and bruise the wheat straw and stubbles left behind after wheat harvesting with grain combines, another locally developed tractor operated machine commonly known as 'straw combine' or 'straw reaper' is used. Ahuja *et al.* (1993) studied the performance of wheat straw combine and observed that it was a viable machine with a cost benefit ratio of 1:2.52. Verma *et al.* (1992) described the constructional features of the straw combine. The tractor operated straw combine can be operated by a 45-50 hp tractor. Average field capacity of the machine was found to be 0.24 to 0.4 ha/hr. The net return with the use of straw combine was Rs. 475/ha and only one person was required for its operation. Singh (1995) studied the effect of concave bar spacing, cylinder speed and feed rate on average straw length and split straw percentage. It was concluded that with the increase in concave bar spacing, average straw length increased, but average straw length decreased with the increase in cylinder speed and higher feed rate. He also reported reduction in splitting as the concave bar spacing increased, but on the other hand he also reported increase in splitting percentage with the increase in cylinder speed and higher feed rates.

A random survey was conducted in various districts of Punjab during the harvesting season of year 2007. It was found that on an average 83.8 % of the area under wheat crop was combine harvested. Straw combine was used over 89.8 % of the combine harvested area (Mahal, 2006). A flash survey was conducted by the author at Kisan Mela, P.A.U., Ludhiana (2006), in which views of about 100 farmers, regarding the

straw quality produced by straw combine in comparison to *harambha* thresher, were collected. 78 % of the farmers stated that the straw harvested by straw combine is of inferior quality than the straw produced by *harambha* thresher due to high dust content. Keeping in view, the present study was undertaken to find out the dust content in wheat straw harvsted by wheat straw combines.

## METHODOLOGY

The present study was carried out in the Department of Farm Machinery and Power Engineering, College of Agricultural Engineering, Punjab Agricultural University, Ludhiana. In the study, samples from five randomly selected straw combines were collected. Straw samples were given chemical treatment to determine ash content and acid insoluble ash present in the wheat straw.

**Total ash content:**

In this study, the straw samples were checked for dust content on the basis of ash content. It is the measure of inorganic matter left after burning the substance at 550-600° C in a muffle furnace. A sample of 5 g sieved samples (under sieve) were taken and placed in clean silica crucibles. The contents were charred on a hot plate till no more smoke come out. They were let to cool down and after that placed in a muffle furnace at 550° C for 4-5 hours. The muffle furnace was switched off and the crucibles were allowed to cool. After that the crucibles were transferred into the desiccators for further cooling. The cooled crucibles containing ash were weighed quickly. The same ash was obtained to determine the acid insoluble ash. The total ash was calculated as:

$$\text{Total ash (\%)} = \frac{W_2 - W_0}{W_1 - W_0} \times 100$$

where, $W_0$ = weight of empty crucible (g)
$W_1$ = weight of crucible + dry sample (g)
$W_2$ = weight of crucible + ash (g).

**Determination of acid insoluble ash:**

The ash obtained was transferred into 100 ml beaker with 25 ml of dilute HCl. The beaker was placed on a hot bath to reduce its volume to almost half. Concentrated HCl (5 ml) was added and allowed to heat to dryness. The sample was heated for another 30 minutes to dehydrate silica. After that, another 10 ml dilute HCl was added into the beaker and heated for few minutes on the same water bath. The contents were filtered through ash less Whatman filter paper No.1 with several washings with distilled water. The filter paper along with AIA was removed, folded into small packets and then placed in the same crucibles. The crucibles were placed in the muffle furnace for 2-3 hours. After that the crucibles were transferred into desiccators, allowed to cool and then the crucibles were weighed along with the AIA. Per cent acid insoluble ash (AIA) was calculated as follows:

$$\%\text{AIA} = \frac{W_2 - W_0}{W_1} \times 100$$

where,
$W_0$ = weight of empty crucible (g)
$W_1$ = weight of crucible +dry sample (g)

**Table 1 : Ash content and acid insoluble ash in straw samples obtained from straw combine**

| | Total ash (%) | AIA (%) |
|---|---|---|
| Sample 1 | 13 | 3.4 |
| Sample 2 | 17 | 5.02 |
| Sample 3 | 12.3 | 8.22 |
| Sample 4 | 15.7 | 7.11 |
| Sample 5 | 10.6 | 9.32 |
| Average | 13.72 | 6.61 |

**Table 2 : Ash content and acid insoluble ash in straw samples obtained from haramba thresher**

| | Total Ash (%) | AIA (%) |
|---|---|---|
| Sample 1 | 7 | 2.5 |
| Sample 2 | 10.25 | 4.45 |
| Sample 3 | 7.6 | 3.8 |
| Sample 4 | 8.8 | 4.1 |
| Sample 5 | 10.6 | 5.6 |
| Average | 8.85 | 4.09 |

$W_2$ = weight of crucible + ash (g).

## RESULTS AND DISCUSSION

Preliminary experiments were conducted to assess the straw quality of straw combines. Samples of straw produced by different straw combines and harambha thresher were collected. Three samples of clean straw were produced by continuously sieving wheat straw till no dust was separating through the sieve. The samples from these three sources were analysed for total ash content and acid insoluble ash.

**Recommendations by Department of Animal Nutrition, GADVASU, Ludhiana:**

As per recommendations of Department of Animal Nutrition, GADVASU, ash content should not exceed 7-8 per cent and acid insoluble ash (AIA) should not exceed 4-5 per cent.

**Ash present in straw samples of different straw combines:**

Samples from five randomly selected straw combines were collected. Straw samples were given chemical treatments to determine ash content and acid insoluble ash present in the wheat straw (Table 1). Similar straw samples from five randomly selected harambha threshers were collected and chemically treated to determine ash content and acid insoluble ash (Table 2).

It can be concluded that values of ash content (8.5 %) and acid insoluble ash (4.09 %) present in straw obtained from haramba threshers (Table 2) lies closely to the recommended values given by Department of Animal Nutrition, GADVASU, Ludhiana whereas in case of raw samples obtained from straw combines, values of ash content (13.72) and acid insoluble ash (6.61) exceeds the recommended values, thus indicating that the straw produced by straw combine contains more dust as compared to haramba thresher. Total ash content and AIA in 'cleaned' sample was, respectively 8.2 % and 3.6%. It was quite close to straw produced by haramba threshers.

**Conclusion:**

Seventy eight per cent farmers were of the opinion that straw produced by the straw combines is inferior to that produced by haramba thresher because of high dust content. Ash content and acid insoluble ash are good indicators of dirt present in wheat straw. Wheat straw produced by straw combine has 13.7 per cent toatal ash and 6.61 per cent acid insoluble ash. Wheat straw produced by stationary wheat threshers has only 8.85 per cent ash content and 4.09 per cent acid insoluble ash which is very close to desired levels.

Authors' affiliations:

**J.S. MAHAL,** Department of Farm Machinery and Power Engineering, Punjab Agricultural University, LUDHIANA (PUNJAB) INDIA

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