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MILLING QUALITY OF COMBINE HARVESTED RICE

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The milling quality of Basmati-385 harvested by John Deer 1055 R Combine was determined and compared with manually reaped samples. The machine parameters like cylinder speed, concave clearance and feed rate varied from 500 to 700 rpm, 15 to 25 mm and 8.7 to 17.4 tonnes per hour respectively. The analysis of variance revealed that the concave clearance cylinder speed and feed rate affected the head rice recovery significantly at 1.0% level of probability. Maximum head rice recovery (54.3%) was obtained at 500 rpm cylinder speed, 25 mm concave clearance and 17.4 tonnes / hour feed rate.

INTRODUCTION

Rice, the number two staple food in Pakistan , is grown on an area of two million hectares out of twenty million hectares total cultivated area. The production is about 3.20 million tonnes annually (National commission on Agriculture, 1988). It earns the highest foreign exchange contributing about 20% of the total export of the country .

Milling quality is the ability of rice grain to withstand milling without heavy breakage, yielding higher amount to total recovered milled rice. The paddy price is directly determined by its milling quality in terms of percent head rice consisting of milled kernels not less than three- fourth of the whole grain. Crop age, ripening conditions, moisture content at the time of harvest and post harvest handling operation influence grain breakage during milling . The economic importance of maintaining higher head rice yield is critical during post harvest operations (Sharma and Kunze, 1982).

Post harvest operations in rice consist of harvesting, threshing, cleaning, drying, sorting, milling, etc. The combine harvesters were introduced in Pakistan for wheat harvesting in 1984-85 with a kit for paddy harvesting. The raspbar threshing cylinder and concave for wheat harvesting is replaced by spike tooth threshing cylinder and concave for paddy harvesting. By the end of year 1987, 527 combine harvesters were in the field and 11% of the total paddy cultivated area was harvested by these machines (Abbas and Zaidi, 1988)

A combine harvester requires good understanding of its adjustments for proper functioning , otherwise grain loss and grain damage may occur. Rice Research Institute, Kala Shah Kaku conducted a field study on milling quality of paddy harvested by combine harvester. The paddy samples were collected from farmer, fields and grain markets of different districts. This study indicated that milling recovery of the paddy harvested by combine was 6% lower than that harvested and threshed manually (Ali et al., 1988). However, the study is silent on the crop condition, machine parameters and operator's skill. This situation necessitates the conduction of a systematic study to highlight the effect of mechanical harvesting on milling quality of rice. The present research was designed to determine the effect of combine cylinder speed, concave clearance and feed rate on milling quality of rice.

MATERIALS AND METHODS

Basmati-385, the highest yielding variety was selected for harvesting under the study as it is shorter than other Basmati varieties in height and has less chances of lodging. The samples were collected after

making various adjustments in the combine harvester and then samples were also obtained by manual reaping and threshing of rice from the same field. The tests were performed at Kot Mubarak, district Gujranwala in the third week of October, 1987. The effect of concave clearance, cylinder speed and feed rate on the head rice recovery was investigated and the data were recorded accordingly. Concave clearance was adjusted at 15, 20 and 25 mm. At each concave clearance three cylinder speeds i.e. 500, 600 and 700 rpm were tested to determine the effect of cylinder speed on head rice recovery by employing three feed rate levels, these being equivalent to 8.7, 12.1 and 17.4 tonnes / hour. In all, 27 test runs were performed, one for each of the 27 (3 x 3 x 3) possible treatment combinations of concave clearance cylinder speed and feed rate. The required feed rates were obtained by maintaining the forward speed at 1. 19, 1.66 and 2.38 km/ h respectively, at 4.11 m constant width of cut and maintaining a constant height of cut. The feed rate was calculated as:

Feed rate = Forward speed x Width of cut x Crop density.

Some of the machine adjustments such as chaffer setting, sieve setting, reel index and fan speed were kept constant throughout the investigation in accordance with the manufacturer's recommendations. Fan speed was maintained at 650 rpm while chaffer and sieve settings at 16 and 17 mm respectively. The combine was allowed to travel 30 meters before samples were taken to ensure that the combine was working under full load. Three samples were taken at each setting. The manually harvested and threshed samples were collected from the same field with the same crop conditions at the same time for comparison of milling quality with the mechanical harvesting.

Sun drying of all the samples was done to a moisture content of 11% because optimum moisture content for milling as recommended by De Padua (1973) is about 11% for rice mills. Head rice recovery was determined by the following formula:

Head rice recovery (%) =

$$\frac{\text{Head rice (g) x 100}}{\text{Rough grains (g)}}$$

The data collected were statistically analyzed using analysis of variance technique as described by Steel and Torrie (1980) .

RESULTS AND DISCUSSION

Mechanical harvesting: The data pertaining to the effect of cylinder speed and feed rate on head rice recovery are plotted in Figs. 1,2 and 3 for concave clearances of 15, 20 and 25 mm respectively. Fig. 1 depicts that the decrease in head rice recovery occurred with the increase in cylinder speed at each feed rate level. It is worth noting that when cylinder speed was changed from 500 to 700 rpm at 17.4 tonnes / hour feed rate, the head rice recovery varied from 54.0 to 49.5%.

This may be attributed to the fact that impact threshing mechanism of combine harvester threshed the grain in one quick but severe blow.The magnitude of blow increased considerably with the increase of cylinder speed thus causing breakage of grains which led to high craking in milling. Almost similar results were reported by Boedicker et al. (1985) who recorded 2 to 6% broken grain for a corresponding cylinder speed of 550 and 950 rpm. Similar trend was observed for 8.7 and 12.1 tonnes /hour feed rates (Fig.1). Analysis of variance indicated that feed rate levels, cylinder speed and concave clearance had a significant effect on head rice recovery at 1% level of probability . However , all the possible interactions were insignificant as regards the head rice recovery except concave clearance and cylinder speed interaction which was found significant.

At 20 mm concave clearance the head rice recovery recorded varied from

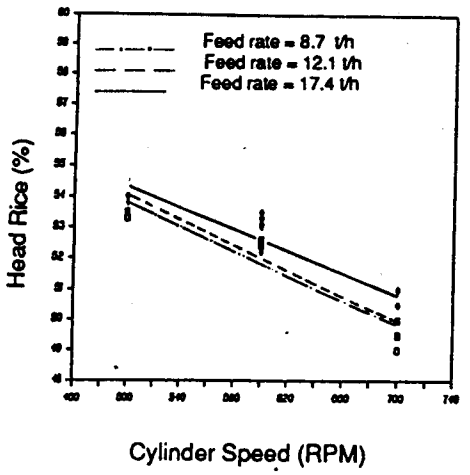

Fig. 1 Effect of cylinder speed on head rice recovery at 15 mm concave clearance and constant feed rate

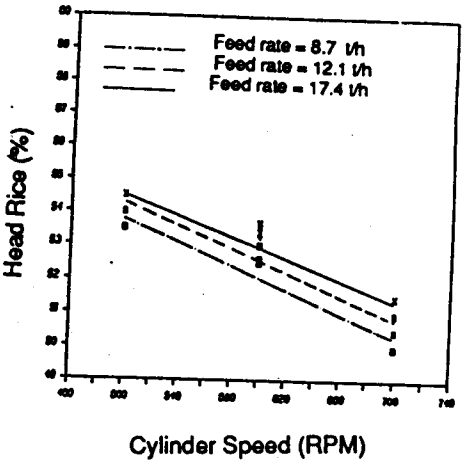

Fig. 2 Effect of cylinder speed on head rice recovery at 20 mm concave clearance and constant feed rate

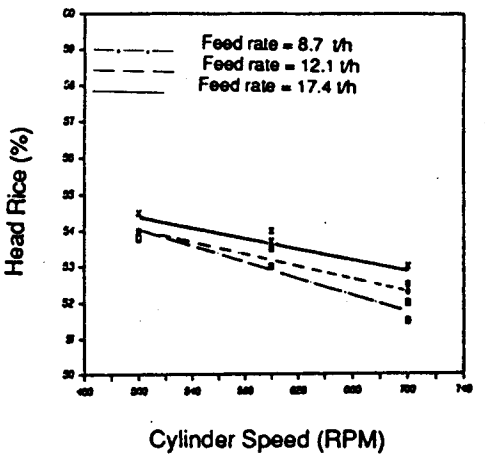

Fig.3 Effect of cylinder speed on head rice recovery at 25 mm concave clearance and constant feed rate

54.6 to 52.0% at 17.4 tonnes /hour feed rate when the cylinder speed was changed from 500 to 700 rpm. The head rice recovery followed the same trend for the 8.7and 12.1 tonnes /hour feed rates (Fig. 2). This indicated that at a higher cylinder speed high concave clearance helps in reducing breakage of grains due to the presence of large amount of chaff material in threshing mechanism causing less impact force. For example at 700 rpm cylinder speed, the head rice recovery registered was 49.5, 52.0 and 53% at 15, 20 and 25 mm concave clearance at 17.4 tonnes /hour feed rate respectively.

Fig. 3 signifies the fact that the effect of feed rate on head rice recovery was almost independent of the cylinder speed. A very small change in the percentage of head rice recovery i.e. 0.4, 0.6 and 1.1% was observed at all speed levels when the feed rate was changed from 8.7 to 17.4 tonnes/ hour . This indicated that higher concave clearance, independent of certain range of feed rate, assisted in reducing the impact forces on the individual kernels and therefore, an appreciable change in the head rice recovery was not noticed for a feed rate range of 8.7 to 17.4 tonnes/hour at all speed levels used in this study.

Manual harvesting: The samples of manual operations collected from the same field where the combine harvester was operated yielded 54.5% head rice corresponding to two different threshing operations i.e. threshing by beating on a slab and threshing by plucking the grains respectively. This may be justified by advancing the arguments that the impact force on individual kernels in beating the paddy bundles against a bed did not cause any mechanical injury to the kernels and hence no difference was experienced in the recovery of head rice by either of the manual methods. The head rice recovery by mechanical operations ranged from 49.0 to 54.3% for various settings of machine parameters. The maximum value 54.3% was obtained at 500 rpm cylinder speed, 17.4 tonnes feed rate and 25 mm concave clearance and compared favourably well with manually harvested samples. The following conclusions were drawn from this study:

1. The head rice recovery was in the range of 59.5 to 54.3% . It increased with an increase in the feed rate and concave clearance and decreased with the increase of cylinder speed
2. The cylinder speed, concave clearance and feed rate should be adjusted at 500 to 600 rpm, 20 to 25 mm and 12.1 to 17.4 tonnes/hour respectively in order to obtain good head rice recovery.
3. No significant difference was found in head rice revovery in case of manual and mechanical harvesting in the controlled experiments.

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