SHATTERING LOSSES AS AFFECTED BY COMBINE INDICES

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Interactions of combine indices (cutting and reel) with crop variety and grain moisture at harvest in relation to shattering loss of wheat and grain moisture were statistically significant at 5% level of probability. The results demonstrated that wheat recovered was 1.2 to 2.8% less as the grain moisture decreased from 24 to 15%. Crop variety also indicated a significant effect on the losses. Change in the reel as well as cutting indices had quadratic relationship with the shattering loss. Values of 1.25 and 2.00 were considered desirable for reel and cutting indices respectively with regard to minimization of harvesting losses.

INTRODUCTION

The urgency of increasing food grain availability necessitates minimization of losses during wheat harvesting. According to Iqbal *et al.* (1980), the harvesting losses of wheat increased linearly with time, ranging from 3% in first week to 7% in the third week after ripening of the crop. In another study harvesting losses have been estimated at 2% of the potential yield of cereals (Chaudhry, 1982). Two per cent shattering losses from a total production of 15 million tonnes of wheat in Pakistan is a huge amount of grain on national basis. Any effort to reduce these losses would be worthwhile.

Shattering losses in a combine harvester are a function of cutting index (ratio of linear speed of cutter to forward speed of travel) and reel index (ratio of linear speed of reel to forward speed of travel). Desirable values of these indices, among other factors depend upon grain moisture at harvest and wheat variety. The present study was, therefore, planned to investigate shattering losses as affected by changes in reel and cutting indices during harvesting of two popularly grown wheat varieties at various grain moisture contents.

FIELD PROCEDURES

Experiments were conducted using MF-87 combine during wheat harvesting season of 1989-90. Effects of changes in reel index, cutting index, crop variety and grain moisture on shattering losses were investigated.

Reel index: Three levels of reel index (1.00, 1.25 and 1.50) were selected by changing the position of pitman end in a slotted drive plate and measuring the reel speed with a tachometer as under:

$$\text{Reel index} = \frac{C.S_r}{S_c}$$

where
C = reel circumference (m),
S_r = reel speed (rpm), and
Sc = forward speed of combine (m min^{-1}).

Cutting index: Four levels of cutting index (1.6, 1.8, 2.0 and 2.15) were selected and

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managed by varying the size of pulley that provides drive to cutter bar. Four pulleys for this purpose were fabricated. The cutting index was calculated as follows:

$$\text{Cutting index} = \frac{2\,LSp}{Sc}$$

where

Sp = speed of cutter bar drive pulley (rpm),

L = cutter bar stroke (= 0.0762 m), and

Sc = forward speed of combine (m min^{-1}).

Crop variety: Fields of Pak-81 and Punjab-85 wheat varieties were selected. The varieties were included to study their interaction with reel and cutting indices and to broaden the scope of experiment and applicability of results.

Crop moisture: Grain moisture was, in fact, used as an index of crop threshability. Each variety was harvested for shattering losses at three moisture levels which were obtained by harvesting on different dates. For grain moisture measurement, samples were taken from grain tank at different hours on the day of experiment. The samples were weighed before and after drying at 105 °C for 24 hours. Per cent moisture on wet basis was calculated.

Crop yield: Yield was determined by harvesting wheat manually from 1 square meter as described by Abdelmotlab (1986). The shattering grains from the area were manually picked and yield calculated as under:

$$Y = 10\,(W_t + W_s)$$

where

Y = Crop yield (T ha^{-1}),

W_t = Weight of threshed grain (kg sq. m^{-1}), and

W_s = Weight of shattered grain (kg sq. m^{-1}).

Shattering loss measurement: There were 3 and 4 levels of reel and cutting indices respectively. For each factor combination, the machine was run for about 20 meters, backed up by 5 m and heads and grains manually picked up from 0.93 sq. m frame placed on the cut swath. Grains were manually threshed for calculation of per cent shattering loss. This procedure was replicated for the two varieties at two different moisture contents.

RESULTS AND DISCUSSION

Mean shattering losses for various factors are presented in Table 1.

Grain moisture content (Index of threshability): Analysis of variance of the shattering loss data indicate the main effect of moisture content as highly significant for both the wheat varieties. Shattering losses increased with decreasing moisture content due to increased brittleness in plants. Employment of Duncan's Multiple Range test further revealed that all the moisture levels were statistically different from each other as regards shattering losses (Table 1). A decrease in moisture content from 24-15% had a significant effect on the losses. For instance, the shattering loss increased from 49 kg ha^{-1} to 124 kg ha^{-1} when averaged across the two varieties. Harvesting wheat at higher moisture appears beneficial, however, literature reveals (Arnold, 1964) that higher moisture creates problems in threshing operation by clogging the threshing drum in addition to increased grain moisture. Thus harvesting should be done at the grain moisture desirable from both harvesting and threshing standpoints.

Crop variety: In order to understand the varietal effect on the losses, data were analysed keeping variety in the main plot and reel and cutting indices in the subplots. The main effect of variety tested significant for

all the moisture levels. Pak-81 had lesser losses compared with Punjab-85 and this gap widened as the moisture level decreased (Table 2). However, interactions of the variety with either cutting or reel index were non-significant.

gesting importance of this factor as regards shattering loss in wheat harvesting. When averaged across levels and crop varieties, shattering loss decreased from 89 to 80 kg ha^{-1} as the reel index increased from 1.0 to 1.25, whereas the mean value of the loss

Table 1.   Mean shattering losses (averaged across grain moisture levels for reel and cutting indices)

Factor	Level	Wheat variety			
		Punjab-85		Pak-81	
		Losses		Losses	
		kg ha^{-1}	(%)	kg ha^{-1}	(%)
Grain moisture (%)	15	124.1	2.78 A	101.2	2.51 A
	20	82.6	1.58 B	70.6	1.75 B
	24	59.8	1.34 C	48.8	1.21 C
Reel index	1.00	88.8	1.99 B	73.8	1.83 B
	1.25	79.8	1.79 C	65.7	1.63 C
	1.50	98.2	2.20 A	81.0	2.01 A
Cutting index	1.60	96.8	2.17 A	79.8	1.98 A
	1.80	80.3	1.80 B	66.9	1.66 B
	2.00	82.1	2.00 B	68.6	1.70 B
	2.15	96.0	2.15 A	78.6	1.95 A

Numbers with unlike letters for the same factor are statistically different at 5% level of significance.

Reel index: It was indicated that the effect of reel index was highly significant for both varieties and all the grain moisture levels (Cheema, 1989). Duncan's test further indicated that all the reel index levels had different behaviour from one another sug-

again increased from 80 kg ha^{-1} to 98 kg ha^{-1} as the reel index increased from 1.25 to 1.5. The relationship of shattering loss with reel index appears quadratic in behaviour and such a relationship is of particular interest in the present investigation. The quadratic

form of the relation clearly suggests that the shattering loss would be the least at the vertex of the parabolic curve. In the present investigation, a reel index value of 1.25 produced minimum shattering loss. As the reel index value did not result in significant interactions with other factors, therefore, a reel index of 1.25 would be an ideal value for all the other factor combinations. However, this observation would hold good only for range of the factors considered in this experiment.

index are also influenced by the grain/stalk moisture at harvest.

The mean value of shattering loss (averaged across moisture levels and crop varieties) decreased from 97 kg ha^{-1} to 80 kg ha^{-1} as the cutting index increased from 2.0 to 2.15 (Tables 1 & 2). Of particular interest is the quadratic relationship of shattering losses with various levels of cutting index. During the present investigation a cutting index of 1.8-2.0 resulted in lower losses.

Table 2.   Mean shattering losses (averaged across varieties for reel and cutting indices)

| Factor | Level | Grain moisture | | | | | |
| | | 24% | | 20% | | 15% | |
		(%)	kg ha^{-1}	(%)	kg ha^{-1}	(%)	kg ha^{-1}
Variety	Punjab-85	1.34 A	59.8	1.58 A	82.6	2.78 A	124.1
	Pak-81	1.21 B	48.8	1.75 B	70.6	2.51 B	101.2
Reel index	1.00	1.28 B	54.4	1.79 B	76.0	2.65 B	112.6
	1.25	1.05 C	44.6	1.64 C	69.7	2.43 C	103.2
	1.50	1.49 A	63.3	1.96 A	83.2	2.85 A	121.1
Cutting index	1.60	1.48 A	62.9	2.03 A	86.2	2.71 B	115.1
	1.80	1.19 C	50.6	1.59 D	67.5	2.41 D	102.4
	2.00	1.06 D	45.0	1.71 C	72.6	2.54 C	107.9
	2.15	1.36 B	57.8	1.87 B	79.4	2.92 A	124.0

Numbers with unlike letters for levels of the same factor are statistically different at 5% level of significance.

Cutting index: The effect of cutting index was statistically significant for all the moisture levels and both crop varieties (Cheema, 1989). The interaction of cutting index with moisture content was significant suggesting that variations in the losses due to cutting

CONCLUSIONS

1.   The shattering losses significantly increased as moisture contents decreased for both the crop varieties. As grain moisture decreased from 24-15%,

shattering loss increased from 49 kg ha^{-1} to 124 kg ha^{-1}.

2. A significant effect of varieties on shattering loss indicated a superiority of Pak-81 over Punjab-85 wheat variety.

3. There is a parabolic relation between the reel index and shattering loss. A reel index of 1.25 being at vertex of the parabola was considered a desirable value.

4. Cutting index value of 2.0 resulted in the minimum losses at 24% grain moisture, whereas the cutting index value of 1.8 showed the least losses at both 20 and 15% grain moisture.

REFERENCES

Abdelmotlab, I.A. 1986. Optimum period for rice and wheat harvest in Egypt. Presented at Summer Meeting Am. Soc. Agri. Engineers, California Polytechnic Inst., San Louis Obispo, California, USA.

Arnold, R.E. Experiments with raspbar threshing drum. Some factors affecting performance. J. Agri. Res. 9 (2): 99-131.

Chaudhry, M.A. 1982. Postharvest food losses, storage and preservation. Proc. Symp. World Food Day. Univ. of Agri., Faisalabad.

Cheema, F.H. 1989. Shattering losses as affected by operational parameters combine harvester. M.Sc. Thesis, Univ. of Agri., Faisalabad.

Iqbal, M., J.K. Sial and G.S. Sheikh. 1980. Harvesting and threshing losses of wheat with mechanical and conventional methods. A.M.A. Summer, 66-70.