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Evaluation of Wheat Losses Using New Holland Combine Harvester in Iran

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Abstract: Adequate wheat production is one of the most important issues in Iran. Based on governmental policies there has been a developing tendency toward importing foreign grain combine harvesters. Considering Iran condition, this study was carried out to evaluate suitability and determine wheat losses using combine "NEW HOLLAND TC56". With regard to the interaction effect of FS and RS on HL, the best combination was 3 kmh^{-1} and 25 RPM for FS and RS, respectively. The evaluation of losses in the form of semi-threshed heads revealed that minimum loss belonged to CC and CS by 7 mm and 850 RPM, respectively. However, from the cleaning unit losses and seed breakage points of view the proper CS was 850 and 750 RPM, respectively.

Key words: Combine NEW HOLLAND · Wheat harvesting losses

INTRODUCTION

Wheat is by far the most valuable crop and an important commodity in Iran. Although we achieved self-sufficiency in wheat in 2004 [1], low production in recent years prove that it has not been sustainable. In fact, high rainfalls besides favorable climate were two important reasons of that success which should not be neglected. Preventing large losses during harvesting is one of essential tasks toward obtaining self-sufficiency.

Average annual planted area under cereal is around 9.5 million hectares (73%), of which wheat occupies 72% [2]. Ultimately, the aim of any crop harvesting system is to retrieve from the field as much of the mature crop as possible. Harvesting is a critical stage in wheat production. On the one hand poor genetically-mechanically features of wheat against losses and on the other hand aged existing combines and deficiency in new ones result in considerable amount of losses in harvesting period in Iran. In addition, the mean yield per unit area is much low (3 $tonha^{-1}$ in irrigated farms). Consequently, Iran has been one of the greatest wheat importers in some previous years. Due to governmental policies there has been a positive tendency toward importing foreign grain harvesters during recent years [3]. Navid *et al*. [4] found a direct correlation between feed rate and the amount of losses.

Straksas [5] designed a stripper-header for grain harvesting and showed that via stripping and then threshing wheat the FS had no impact on grain threshing-separating losses. Kehayov *et al*. [6] in an assessment of the combine "CLAAS-DOMINATOR 106" found that the best FS, CS and CC were 4.31 ms^{-1}, 28.6 ms^{-1} and 20.1 mm, respectively. An evaluation by Geert *et al*. [7] revealed that the cleaning section settings such as lower and upper sieve openings had a minor effect on the content of MOG in the grain bin when compared to other variables such as fan speed and the loadings by chaff, straw and grain on the upper sieve

Some tests using interior combines evaluated the mean losses of 7.78% [8]. Although majority of imported combines were so modern, some field tests were required to confirm the suitability and performance of these combines in Iran condition. Since, grain combine harvester, generally, is complicated and consists of different parts with different adjustments; the studies on these kinds of machines should be done in such a way that could determine the interaction effect of parts on each other. To meet this need the main goal of current study was determination of best adjustments appropriate to wheat farms in Iran.

MATERIALS AND METHODS

This field study was performed in Fars province to evaluate wheat harvesting losses utilizing combine "NEW HOLLAND TC56". The adjustments were performed according to the combine operator manual. The farm yield was 6.7 ton ha^{-1} and grain moisture content was 11-13% during experiments. A fabricated 50×50 cm frame was used

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Table 1: levels of FS and RS in header losses experiment

A (kmh^{-1})		B (RPM)	
a1	2	b1	15
a2	3	b2	25
a3	4	b3	35

Table 2: levels of CC and CS in threshing losses experiment

A (mm)		B (RPM)	
a1	7	b1	750
a2	10	b2	850

Table 3: levels of CS, BS and FS in cleaning unit losses experiment

A (RPM)		B (RPM)		C (kmh^{-1})	
a1	750	b1	650	c1	3
a2	850	b2	700	c2	4
a3	1000	b3	800	---	---

Table 4: levels of CS, BS and CC in cleaning unit losses experiment

A (RPM)		B (RPM)		C (mm)	
a1	750	b1	650	c1	7
a2	850	b2	700	c2	10
a3	1000	b3	800	---	---

to determine the amount of natural losses. We put the frame in different places of farm, far from borders and after cutting long obtainable crop heads the short crop heads and free grains on the surface were gathered and calculated as the natural losses [9]. The combine performance was examined using factorial completely randomized design in three replications.

BS in this part was considered to recognize if it had any impact on throwing broken seed away of combine; indeed, it is an indirect effect of BS on losses in the form of broken seed.

RESULTS AND DISCUSSION

Interaction effect of FS (A) and RS (B) on HL: As it is given in Table 5, data analysis of variance showed that FS, RS and their interaction had a significant effect on HL at 1% LS. Because the interaction effect was significant, the analysis of simple effects was calculated and revealed that FS in all levels of RS was significant, while RS was not significant in any levels of FS. These results proved that even if RS is properly adjusted, in high FS (level a3) it will not lead to reduction in losses.

Fig. 1 shows that in levels b2 and b3 by raising the FS the losses diminished, in other words in these levels FS and RS were getting matched more. The losses increasing trends in b1 cleared that it is not efficient in Iran condition. It was seen that by increasing FS from a2 to a3 the losses dramatically increased. This is in agreement with the result of Servistava *et al*. [10]. Therefore, in this part the best combination of FS and RS was a2b2.

Interaction Effect of CC (A) and CS (B) on the Threshing Unit Losses in the Form of Semi-threshed Heads: The analysis of variance showed that CC at 1% LS and both CS and the interaction effect of CC and CS had significant effect on losses at 5% LS in the form of semi-threshed wheat heads (Table 6). Simple effect analysis of variance revealed that CC was significant in level b1 (750 RPM), but not in level b2 (850 RPM) and it confirmed that change of CC in high CS (b2) had no significant effects on the reduction of losses.

Fig. 2 shows that by raising CC losses incremented too and it is considerably more in level b1 (750 RPM); the losses in a2b1 rather to a2b2 increased by 0.25%. It is clear that maximum and minimum losses occurred in a2b1 and a1b2 by 0.45% and 0.147%, respectively.

Table 5: Analysis of variance of header losses (HL)

SOV	*Sum of Squares*	*df*	*Mean Square*	*F*
FS (A)	15.34	2	7.67	76.7^{**}
RS (B)	6.53	2	3.27	37.7^{**}
A×B	3.64	4	0.91	9.1^{**}
Error	1.8	18	0.1	---

**Indicates significant at 1% level of significance

Table 6: Analysis of variance of threshing losses

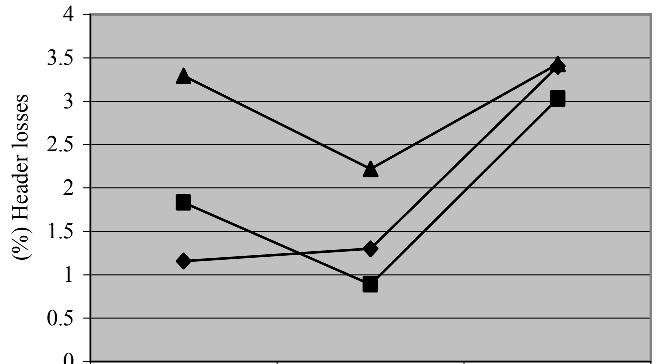
SOV	*Sum of Squares*	*df*	*Mean Square*	*F*
CC (A)	0.102	1	0.102	25.5^{**}
CS (B)	0.036	1	0.036	9^{*}
A×B	0.022	1	0.022	5.5^{*}
Error	0.03	8	0.004	---

* and **Indicates significant at 5% and 1% level of significance, respectively

Table 7: Analysis of variance of cleaning unit losses

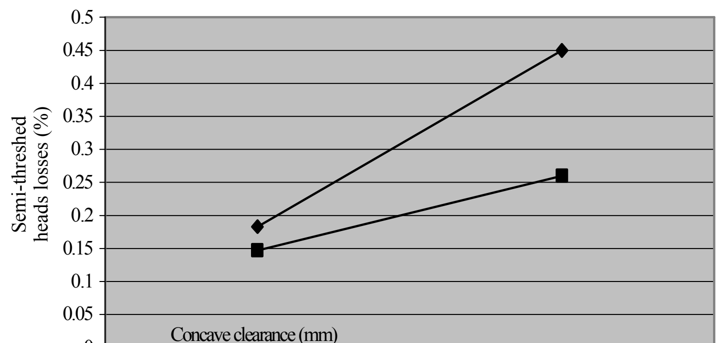
SOV	*Sum of Squares*	*df*	*Mean Square*	*F*
CS (A)	0.061	2	0.031	5.167^{*}
BS (B)	0.819	2	0.410	68.33^{**}
FS (C)	0.001	1	0.001	$0.167^{n.s.}$
A×B	0.254	4	0.064	10.67^{**}
A×C	0.022	2	0.011	$1.83^{n.s.}$
B×C	0.054	2	0.027	4.5^{*}
A×B×C	0.049	4	0.012	$2^{n.s.}$
Error	0.202	36	0.006	---

*, ** and n.s. Indicates significant at 5%, 1% level of significance and not significant, respectively



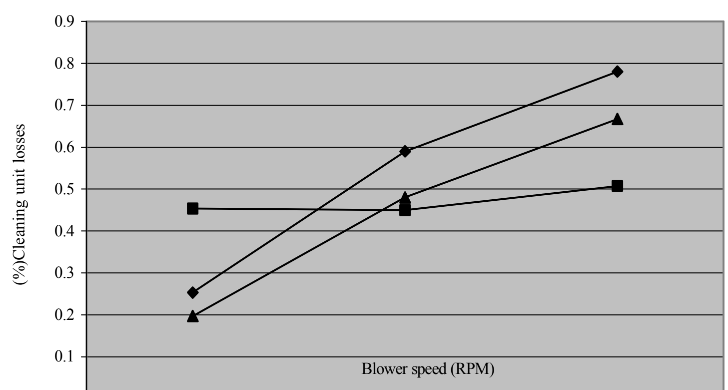
	a1(2)	a2(3)	a3(4)
b1(15)	1.16	1.3	3.4
b2(25)	1.83	0.89	3.03
b3(35)	3.29	2.22	3.43

Fig. 1: Interaction effect of FS (A) and RS (B) on the HL



	a1(7)	a2(10)
b1(750)	0.183	0.45
b2(850)	0.147	0.26

Fig. 2: Interaction effect of CC (A) and CS (B) on threshing unit losses



	b1(650)	b2(700)	b3(800)
a1(750)	0.253	0.59	0.78
a2(850)	0.453	0.45	0.507
a3(1000)	0.197	0.48	0.667

Fig. 3: Interaction effect of CS (A) and BS (B) on threshing losses in c1 (3 km h^{-1})

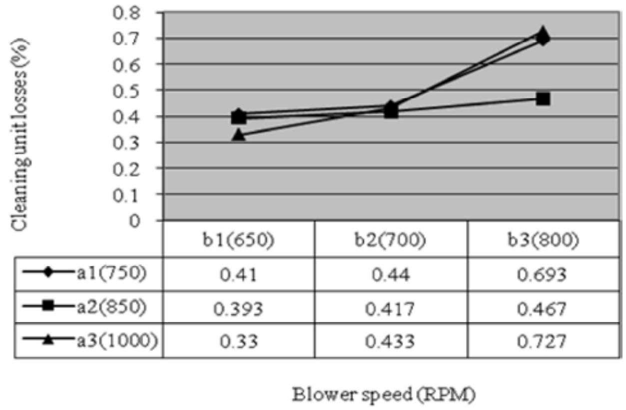


Fig. 4: Interaction effect of CS (A) and BS (B) on threshing losses in c1 (3 kmh^{-1})

Table 8: the average value of losses in cleaning unit evaluation

	a_1(750)								a_2(850)						a_3(1000)			
	b_1(650)		b_2(700)		b_3(800)		b_1(650)		b_2(700)		b_3(800)		b_1(650)		b_2(700)		b_3(800)	
	$c_1$3	$c_2$4	$c_1$3	$c_2$4	$c_1$3	$c_2$4	$c_1$3	$c_2$4	$c_1$3	$c_2$4	$c_1$3	$C_2$4	$c_1$3	$c_2$4	$c_1$3	$c_2$4	$c_1$3	$c_2$4
Average of levels abc (%)	0.253	0.410	0.590	0.440	0.780	0.693	0.453	0.393	0.450	0.417	0.507	0.467	0.197	0.330	0.480	0.433	0.667	0.727
Average of levels ab (%)	0.322		0.515		0.737		0.423		0.434		0.487		0.264		0.457		0.697	
Average of level a (%)			0.525						0.448						0.473			

Table 9: Analysis of variance of seed breakage

SOV	*Sum of Squares*	*df*	*Mean Square*	*F*
CS (A)	94.389	2	47.195	208.825**
BS (B)	1.175	2	0.588	2.6$^{n.s.}$
CC (C)	4.335	1	4.335	19.181**
A×B	1.931	4	0.483	2.136$^{n.s.}$
A×C	0.028	2	0.014	0.062$^{n.s.}$
B×C	0.093	2	0.047	0.206$^{n.s.}$
A×B×C	0.045	4	0.011	0.050$^{n.s.}$
Error	8.147	36	0.226	---

Table 10: the average value of seed breakage

	a_1(750)								a_2(850)						a_3(1000)			
	b_1(650)		b_2(700)		b_3(800)		b_1(650)		b_2(700)		b_3(800)		b_1(650)		b_2(700)		b_3(800)	
	$c_1$7	$c_2$10	$c_1$7	$c_2$10	$c_1$7	$c_2$10	$c_1$7	$c_2$10	$c_1$7	$c_2$10	$c_1$7	$C_2$10	$c_1$7	$c_2$10	$c_1$7	$c_2$10	$c_1$7	$c_2$10
Average of levels abc (%)	2.33	1.83	2.23	1.70	2.47	1.63	3.30	2.80	3.43	2.90	3.53	2.86	4.87	4.43	5.73	5.17	5.83	5.30
Average of levels ab (%)	2.08		1.967		2.05		3.05		3.167		3.2		4.65		5.45		5.567	
Average of level a (%)			2.032						3.139						5.222			

Interaction effect of CS (A), BS (B) and FS (C) on losses of cleaning unit: Analysis of variance is given in Table 7. It was seen that CS and BS had significant effects on the losses at 5% and 1% LS, respectively. Their interaction, also, was significant at 5% LS. FS had no expressive effect on the losses of this unit, while it's interaction with BS was important and effective at 5% LS. Fig. 3 and 4 display that in moderate CS (a2=850 RPM) by increasing BS the amount of losses remained steady in both examined FS (C1 and C2), but in lower and higher CSs by raising BS the losses raised almost directly.

Table 8 shows the average value of losses in each level. Appropriate CS augmentation in companion with proper BS (b2) led to diminishing in cleaning unit losses. For instance, look at levels a1b2 (0.515%), a2b2 (0.434%) and a3b2 (0.457%) in both levels of FS (c1 and c2).

Interaction effect of CS (A), BS (B) and CC (C) on seed breakage: From analysis of variance it was realized that both CS and CC had significant effects on seed breakage at 1% LS and none of interactions was important (Table 9). This is in agreement with those obtained by

Neal and Cooper [11] and Rahama *et al.* [12]. The average amount of broken seed in each level is given in Table 10. The data revealed that raising CS resulted in more seed breakage. For finding it compare levels a1b2 (1.967%), a2b2 (3.167%) and a3b2 (5.45%).

CONCLUSION

This study was performed to evaluate wheat losses using combine "NEW HOLLAND TC56" in Iran condition. The results revealed that best FS and RS were 3 kmh^{-1} and 25 RPM, respectively. Proper setting of these two factors will result in minimum losses in header. Regarding the interaction effect of CS and CC on semi-threshed heads, the minimal belonged to lowest CC (7 mm) and highest CS (850 RPM). However, the losses of cleaning unit and seed breakage should be considered. According to cleaning unit losses the best CS was 850 RPM, but with regard to SB the best CS was 750 RPM. Therefore it can be said that based on farmers' opinion one of them should be chosen.

Nomenclature		HL	Header Losses
LS	Level of Significance	CC	Concave Clearance
FS	Forward Speed	CS	Cylinder Speed
RS	Reel Speed	BS	Blower Speed
RPM	Revolution Per Minutes	MOG	Materials Other than Grain

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