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Research Article

THE EVALUATION OF LOSSES IN HARVESTING CORN BY COMBINE JOHN DEERE MODEL 955 AND SUGGESTING APPROPRIATE SOLUTIONS

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ABSTRACT
Corn is of great importance a strategic product in providing animal feed and other food products and avoiding in harvesting this crop seems necessary. Thus, this study aimed to assess the losses due to non-optimal settings and providing appropriate solutions with Combine John Deere Model 955 under the climatic conditions of Parsabad city in Ardabil province. This study was conducted as a factorial experiment in a randomized complete block design with four replications. The round of threshers cylinder at three levels is (550, 650, 700 rpm) and the feed rate at three levels is (120, 170, 220 kg min) corresponding to the velocities (2, 2.75 and 3.50 km). The effect of velocity factor on the nose decline, threshers and percentage of impurities and fracture risk was significant at $P \leq 0.05$. With increasing advance of Combine, the feed rate greatly increased but the speed of threshers did not increase resulting in the incomplete thresh of corns and remaining grains on the corn? Also, due to the increased number of corns in threshers, a few corns were moved out of the Combine through cylinder without being separated. With the increase of feed rate of 220 kg per minute, the total losses increased with more intense. In general, the results of this study showed that the speed of 2 km per hour and the round of thresher cylinder as 550 rpm had the highest amount of loss (4.7 per cent) and the speed of 2.75 km per hour and the round of thresher cylinder as 550 rpm were identified as the most suitable combination due to the control of feed rate with the lowest loss rate (3%).

Keywords: *Corn Harvest, Losses, Combine, Feed Rate*

INTRODUCTION
Corn is one of the most important and high-yield grains that are of great importance in nutrition. It is considered at the third place after wheat and rice in terms of cultivation rate. The most important maize growing areas in Iran are Ardebil, Mazandaran, Gorgan and around Tehran. To determine the crop yield, the amount of grain loss that was made due to the environmental or mechanical factors is to be calculated. The harvesting machines and agricultural machines must be functionally tested and assessed. One of the things that must be considered in the evaluation of harvesting machines and is very important is the grain losses (Knell, 2001).
In order to minimize the loss in wheat combine, the following issues should be investigated.
A. Where and why are the losses?
B. How can the losses be measured?
C. How much loss is acceptable?
D. Which settings are required in order to reduce losses?
Advance speed of Combine is determined with regard to crop yield, Combine capacity and deriver’s skills. When the crop yield is high. The advance speed of Combine should be reduced, however the advance speed is affected by thresh capacity, separation and the Combine’s cleaning. If the advance speed of Combine is too high and the combine load increases, the losses will be greater than usual. Experiments conducted in the United States show that increasing the Combine advance speed from 3 km / h to 5.25 km / h will increase the losses two times (Modarres, 1994). Price in his report, stated that the corn is matured physically when the grain moisture reaches about 30%. The grain can be harvested from 20% moisture requiring the field heaters. Secure storage humidity is between 13 to 14 percent (Price, 1997).

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Shay and colleagues in a study conducted at the University of Missouri suggested a range at different parts of corn Combine and finally the total drop. They did not consider the machines with a drop over this range and the range include: drop before harvest, corn drop at the nose, thresher cylinder drop, the separator drop as 1%, about 0.4% less than 0/3% and 0/1% of total yield loss are acceptable for harvesting corn Combine as 3-5%.

To avoid grain losses and peeling at the corn nose, rollers and peeling plates at the corn nose, the rollers should be increased in farms with lower yield, so that the volume of incoming materials to the Combine is increased in order to reduce the maximum capacity of Combine (Hofman, 2004). High round of cylinder is the most important factor that leads to the collapse of grain and disjoint of the cob. Matching the settings of nose with the product conditions t is important to avoid losses in the harvest (Campbell and Alswager, 2003).

MATERIALS AND METHODS

This experiment was carried out using a Combine John Deere Model 955 in Parsabad. This study uses a factorial experiment in a randomized complete block design with four replications. The round of threshers cylinder at three levels is (550, 650, 700 rpm) and the feed rate at three levels is (120, 170, 220 kg min) corresponding to the velocities (2, 2.75 and 3.50 km). Grain moisture at the harvest time and the date and location of harvest time was recorded during the day. Finally, by comparing the results of different treatments, the most appropriate pattern (a combination of speed and distance at which the cylinder is minimal grain loss and advance speed and cylinder round at which the minimal grain loss and degradation happens) is determined.

Due to the high sensitivity of the measurement, the rpm of thresher cylinder was performed in two ways:

1. Using a digital telemetry by touching its tip with the monetary center and reading the number displayed on telemetry.
2. Using a digital telemetry and fluorescent labels to paste on revolving funds, and counting the number of labels per minute by digital telemetry.

By calculating the mean number of plants per unit , the average number of corn per unit and the average weight of corn that had been pre-calculated, the feed rate (kg) that should enter the Combine per minute, was determined.

Equation (1) $FR = (WE - WH) \times N$

Where:

FR= Feed rate (kg / min)

WE= Average weight of a corn with the skin of the number of plants at the measured level

WH= the average weight of a corn skin

Thus, the number of corns that must be entered in a minute to Combine was obtained and the plant density per unit was also calculated before. With an average distance between each corn on row and since the corn nose of the Combine have 4 rows, thus a distance that should be passed by a Combine in a minute to enter the amount of feed (kg min) to the Combine, is obtained with the use of equation (Tajbakhsh,1375).

Equation (2) $L = N / X \times D$

Where:

L= Distance (m)

N= Number of corn that must be entered in a minute to the Combine at a specified the feed rate

X= Number of rows at combine nose (4 rows)

D= the distance between plants in row

Combine should pass the distance over a minute, but for more simple calculations 10 meters of length are based for the Combine and the distance is calculated by equation (Shahrestani and Minayi, 2002).

Equation (3).

Distance traveled for 60 seconds / 10 m x 60 s= time for travelling 10 m (s)

The combine should travel 10 meters at this time because there is no odometer in the Combine and by selecting the gear and costal range (speed clutch), the gear number and speed clutch were recorded. For measuring the losses due to the thresher unit and separator and cleaner, a 3x3 canvas was used at the back of the Combine. In this way, the remaining grains on the corn and the crushed grains were attributed to the thresher unit and the single grains on the canvas were due to the deficiency of the current unit. The results of the statistical analysis of the experimental factors were processed by SAS software. The comparison of data mean was performed by Duncan multiple range test.

Table: Statistical analysis of experimental factors on the basis of the fracture percentage, the percentage of impurities, winnows loss, cylinder loss and nose cylinder

Sources of changes	**Degrees of freedom**	**fracture percentage**	**percentage of impurities**	**winnows loss**	**cylinder loss**	**nose cylinder**
Rep	3	1.12	0.02	0.011	0.37	0.06
Speed of movement	2	16.3*	4.2*	0.16ns	4.03*	1.64*
Round of cylinder Thresher	2	11.2*	3.8*	0.1ns	2.6*	0.02ns
Speed x round of cylinder	4	53.1*	2.6*	0.22ns	0.06ns	0.001ns
Error	24	0.47	0.07	0.09	0.02	0.01
Coefficient of Variation		6.05	13.8	21.6	6.6	4.13

RESULTS AND DISCUSSION

The effect of repetition, speed of RPM cylinder threshers, the interaction between the effects of experimental error on the fracture, the percentage of impurities and screening drop, nose drop and loss of cylinder threshers are shown in Table 1. Effect on the percentage of repeat fractures, impurities and loss percentage was not significant, but the loss of threshers and Cape effect. The effect of speed on the fracture, the percentage of impurities, and thresher unit on a drop nose significant but not significant. The effect of cylinder threshers on broken away, of impurities, loss of significant threshers, but the decline was not significant and nose. Interaction of cylinder threshers' speed and distance on percentage of breakage and loss of significant impurities, threshers and nose unit had no significant effect. The gathering chain speed up the stems into a chance pulling the nose without causing tilting and loss are ear, It also increases the speed and feed rate resulting in high yields of the varieties combine to cause more load on the unit is collected. With increased advance speed due to increased feed rate, the volume of material passing between the cylinder and below it increases. In this case, the impacts of the thresher cylinder are absorbed by this layer and the seed is damaged less and with increasing the speed the fracture is reduced. High speed of thresher cylinder is the most important factor that led to the collapse of grain and cob (Maier and Parsons, 1996). With increasing the speed of thresher cylinder, the efficiency of thresher unit will be increased. It means that the losses of the thresher unit is declined for a given feed rate but the sifters and bolters were not overloaded because the non-grain material (straw) had a lower rate and it is only the cob that passes through the straw. It should be noted that raising the cylinder is allowed to a certain extent because it leads to the quality loss that will not be able to be measured under field conditions. The results are consistent with the studies (Maier and Parsons, 1996). Figure 1 suggests that by increasing the advance speed the corresponding material entered into the Combine were increased and as a result the corns that had to pass the distance between the cylinder and below it passed the pathway at a shorter time and thus were less affected. It should be noted that the amount of grain threshing in the thresher and the efficiency of the thresher is commensurate with the impact entered into the product by the thresher. The impact is also proportional to the relative velocity of the thresher and the amount of product. The reduction of the movement speed from 7 mph to 2 mph, while the speed is constant, can double the amount of damage to grain regardless of the type of Combine.

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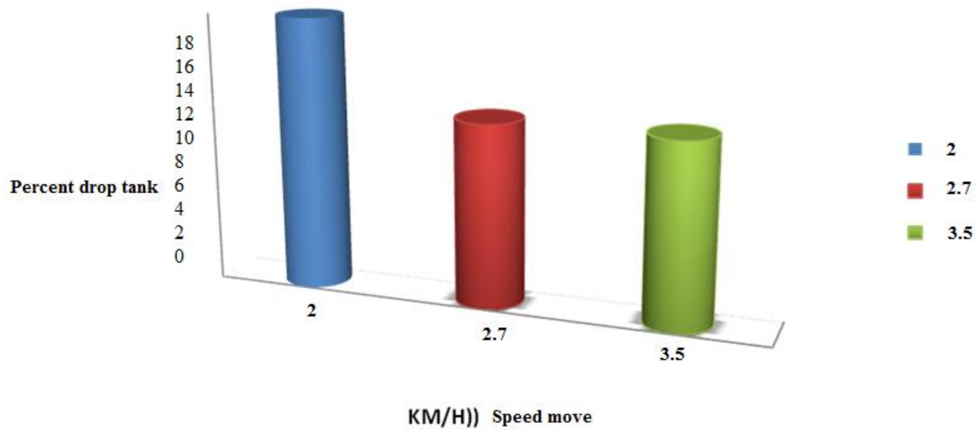


Figure 1: Effect of advance speed on the loss to the percentage

According to the graph (Tajbakhsh, 1997) the maximum loss in the reservoir (20) has occurred at a speed of 2 km/h and the speed of cylinder 550 rpm and the minimum loss (7.90) has occurred at a speed of 2.75 km/h and the speed of cylinder 550 per minute. It indicates that at the low feed rate due to the exposure of grain against the direct blows of thresher cylinder, the grain will be break (obvious and hidden) and the quality of the harvested crop will be severely reduced. Meanwhile, by keeping the round constant as 550 rpm and by increasing the speed from 2 to 2.75 km/h, the grain quality will be highly increased. At the round 650 rpm of the thresher a decreasing trend is observed with increasing speed showing the decreased quality of the reservoir and a descending slope to reduce the reservoir loss. By observing the curve of 700 rpm of cylinder, it can be realized that the high round of the cylinder has very high grain breakage and even increasing feed rate was not able to compensate for it.

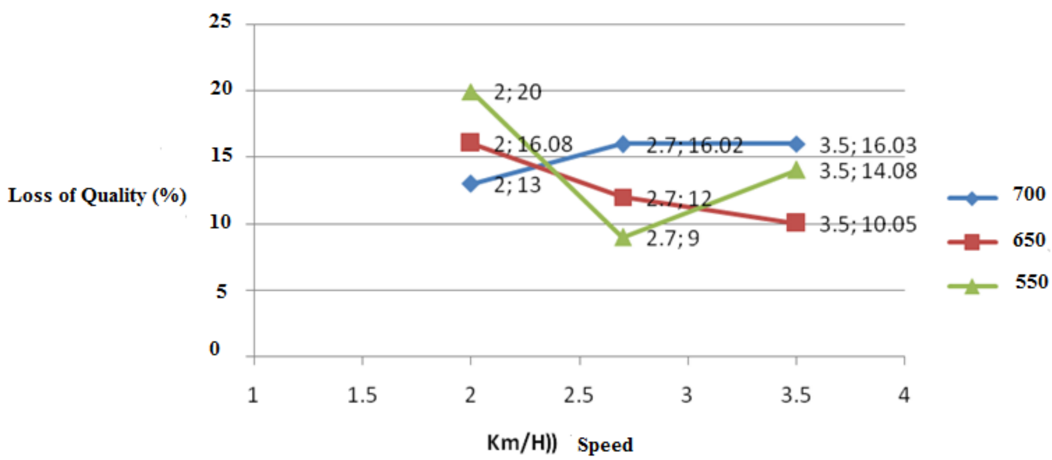
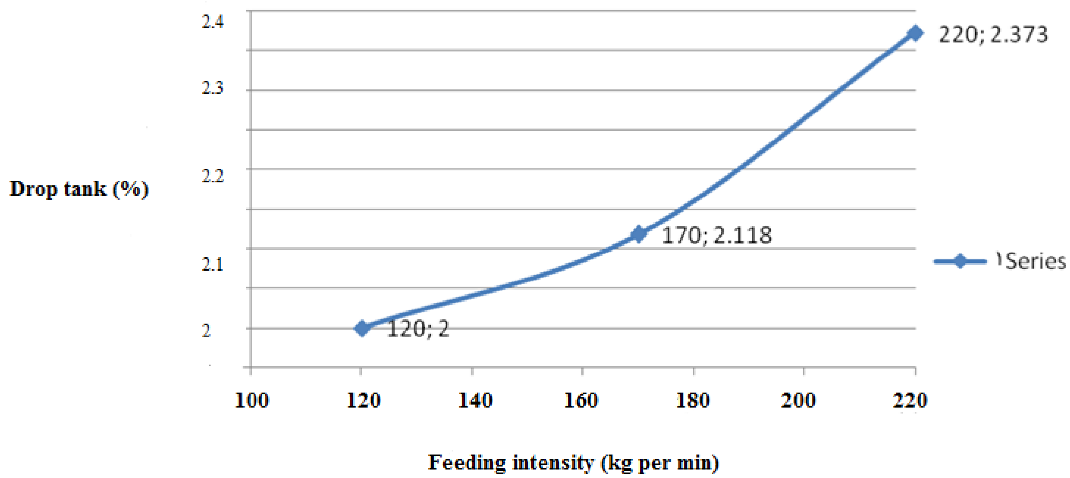
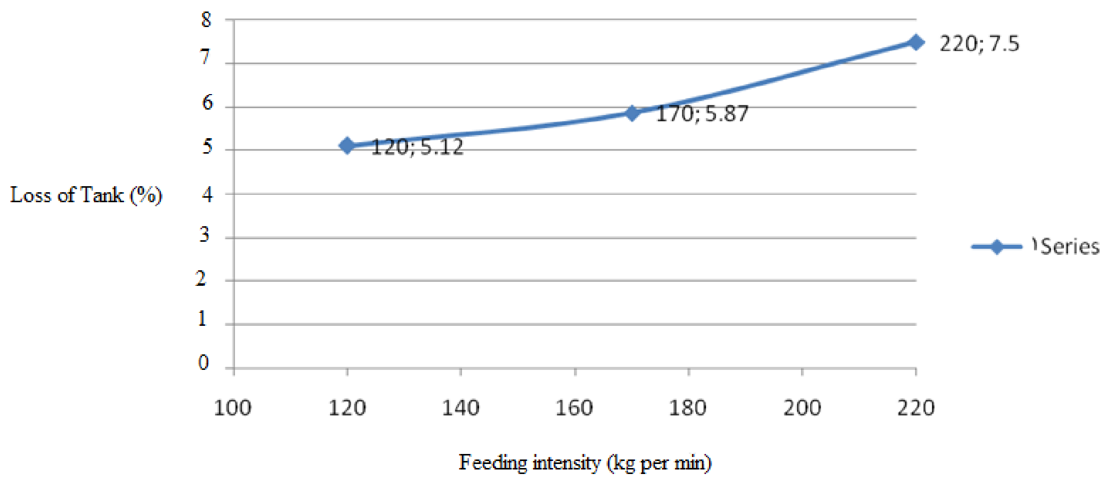


Figure 2: Interaction of advance speed and the round of thresher cylinder on the loss of delivery as percentage

According to the graph (3). We found that with increasing the feed rate, the total loss will be increased that is due to the low efficiency of the thresher unit and the losses at the nose. Another point is that with increasing feed rate from 120 to 170 kg per minute, a perceptible rise in the slope of the curve is not found. But the rate from 170 to 220 kg per minute and then increased slope of the curve is very noticeable and significant. It shows a rapid decrease in the efficiency of John Deere 955 at this feed rate. It is mostly due to the inability of the thresher cylinder in terms of size and length, mismatch of chains and rollers and the increasing volume of product.





As shown in Figure (4), by increasing the feed rate more than 170 kg/h the total mortality curve increased with a faster slope that is a reason for the inability of Combine thresher system John Deere 955 in higher advance speeds. It reduced the capacity of the Combine, increased the harvest period in the region and imposed the cost of delay in work to the farmer. According to the results of the test and the evaluation of quantitative and qualitative losses measured in the study, it was shown that the best treatment combination, which has the lowest loss, was the movement with the speed of 2.75 km/h and the cylinder round of 550 rpm

Conclusion

The interaction between advance speed and round of thresher cylinder on significant (qualitative) loss implies that in low feed rate due to the exposure of grain to the direct blows of cylinder, the grain will be break (obvious and hidden) and the quality of the harvested crop will be severely reduced. Meanwhile, by keeping the round constant as 550 rpm and by increasing the speed from 2 to 2.75 km/h, the grain quality will be highly increased. The highest loss of nose 2.73 % occurred at the speed of 3.50 km/h, showing the

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lack of matching between corn and Combine device. The maximum grain breakage occurred at a rate of 2 km/h. This result suggests that the grain fracture can be reduced by increasing the feed rate. Highest total loss was achieved at the movement speed of 3.50 km/h and 550 rpm of the thresher showing the inability of the threshers at low speeds.

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