



Evaluation some affecting factors on John Deere Combine 955series losses during harvest by mathematical models (Case study Ahvaz city)

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ABSTRACT

Wheat is the most important crops in Iran and study to reduce losses and costs related to this product are essential. Wheat like any other crop, have losses during harvest and trying to reduce losses in all the time is justifiable. Yet Combine John Deere 955 for harvesting operations is most used combines in Iran and study in order to reduce losses this combine is important. The aims of this study are assess these factors: combine forward speed, Grain moisture content (% , w.b.) and yield per hectare on combine losses John Deere 955 in Ahvaz city (Khuzestan province). One of the ways that reduces losses of combines is mathematical models based on survey and measurement of factors affecting on different combine losses. In order to perform this research was surveyed 28 combines in at different points of Ahvaz city and was calculated cutting platform, back combine, plots and natural losses. In this study, parameters such as combine forward speed, Grain moisture content (% , w.b.) and yield per hectare were considered as independent variables and cutting platform and back combine losses as dependent variables. To express the mathematical relationship between the dependent and independent variables was used multivariate regression test. Results of regression analysis of variance showed there is significant relationship between the independent variables and the dependent variables. Finally was estimated most appropriate models to cutting platform losses (CPL) and back combine losses (BCL).

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Introduction

In Iran, like other developing countries, agriculture has one of the most important economic sectors and comprises a considerably high percentage of production and employment. About 11 percent of the total country land area is cultivated while about one-third of total surface areas are suited for farmland. Still, 63% of the cultivable lands have not been used, and 185,000 km² of the present farms are being used with 50 to 60% capacity (Asadi et al, 2010). Wheat is the most important crops in Iran and study to reduce losses and costs related to this product are essential.

Qamar-uz-Zaman et al (1992) analyzed machine and crop parameters on wheat losses in harvests with combine. they selected two harvester combines (john Deere and claas) with three levels forward speed, three levels grain moisture(26%, 20% and 13%) and two wheat varieties(pak 81 and Punjab 85). The analysis showed that pak 81 is a better choice regarding during harvesting losses than Punjab 85. The grain damage was lower for Punjab 85. Separating losses reduced at lower moisture levels but shattering and quality losses increased. Also results showed with increasing forward speed increased head and separator losses and wheat losses in class combine was more than john Deere combines.

Rahama et al (1990) surveyed 60 combines in Sudan. They calculated cutting platform and back of the combine losses and measured parameters such as forward speed, thrashing revelation, distance between rotor and concave, rotational rotor, whole size sieves and adjustment fan impeller. They reported

average wheat losses 9 and 12% for years 1989 and 1990 respectively. Also they reported that optimum grain moisture for harvest is 9 to 14%. The lowest cutting platform loss was observed. The results showed minimum rotor losses are in speed 900 rpm (speed rotor).

Patel, and Varshney (2007) surveyed effect three levels crop moisture content (9, 10and 11%) and Three levels forward speed (1, 1.5 and 2 km hr⁻¹) on wheat losses in harvesting with combine. Results showed that with increase forward speed and reduce crop moisture content increased cutting platform losses. so that cutting platform losses in the Speed of 2 km hr⁻¹ and moisture 9% was 0.9 % and moisture 12% Speed of km hr⁻¹ was 0.2% which cause was reported more vibrations in effect of speedup

Behroozzi lar et al (1994) in the study Cutting platform losses, through random sampling, selected the number of combines In the provinces of Khorasan, Isfahan, Golestan, Fars and Hamadan and were measured natural, cutting platform, thrashing, separation and cleaning losses. The results showed total losses of khorasan province were 7.8% and without consideration of natural losses were 5.47%. In Esfahan province, average total lossess were 2.3% and was maximum losses related cutting platform. Average losses in Gorgan, Fars and Hamadan provinces 6.5%, 4.5% and 7% were reported respectively.

Sabir et al (2005) surveyed the Effect of combine and crop parameters on wheat losses. They selected three moisture levels (26%, 19% and 13%), three levels of cylinder-concave clearance (20, 25 and 30 mm) and three levels feed rate (2.82, 3.77 and

5.64 ton/ha). The results showed the lowest quantity losses were obtained in moisture 19%, distance 30mm and feed rate 2.82 ton/ha and maximum losses were obtained in moisture 13%, distance 20mm and feed rate 5.74 ton/ha. This research shown as decreasing moisture content, feed rate and distance between cylinder-concave increasing seed damage.

Cutting platform losses increased with delay in harvest due to lower product moisture. Audsley & Boyce (1974) provided following equation for header losses.

$$\text{cutter - bar loss} = 0.001(15.3 + 0.83X1 - 0.065X^2) \cdot Y \quad (1)$$

Where:

X1 = number of days after 30% moisture

Y = quantity of grain ($t \text{ ha}^{-1}$)

Thrashing losses rises with increase forward speed and grain moisture content Abawi (1993) provided following equation for thrashing losses.

Lt=0.02

$$\left(\frac{\theta\chi\omega}{\lambda}\right)^2 \quad (2)$$

θ = grain moisture index

χ = crop yield index

ω = forward speed index

λ = ratio of grain to straw

The aim of this study was to assess factors combine forward speed, grain moisture content (% w.b.) and yield per hectare on combine losses John Deere 955 in Ahvaz city (Khuzestan province). Combine losses in general are include cutting platform and back combine losses. One of the ways that reduces losses of combines is mathematical models based on survey and measurement of factors affecting on different combine losses. Mathematical factors are appropriate method for management which Based on it can be Payments to analyze the effects of variables of considered. In this study, effecting variables listed on cutting platform and back combine losses was surveyed by Using mathematical models.

Material and methods

In this research, 28 farms in Parts of central and Hamidieh of Ahvaz city were selected and surveyed wheat harvest with combines in 2012. For survey quantity wheat losses in these farms were collected necessary information with put farm and completed questionnaires by farmers and combine drivers (it should be noted the many farm and combines were visited but some of them due to Combine high life or inappropriate crop conditions were not included in this study). Many factors effected on combine losses but the aim of this study was to assess factors combine forward speed, grain moisture content (% w.b.) and yield per hectare on combine losses. For minimize the influence of other factors such as combine settings, cutting height, speed carousel and rotor, necessary recommendations were given to drivers. Also i increasing losses in farms that Had Plots perpendicular direction of movement combine, analyzed as well as a separate factor analysis.

Measurement Forward speed: For calculation forward speed by stopwatch was recorded motion time combine at a distance of 100 meters.

Measurement grain moisture content: To measure the grain moisture randomly taken three samples of 100 grams in combine tank. Samples were weighted by a digital scale accuracy of 1%. g in place wheat harvest. After transferring samples to the laboratory were dried by using common method of devices oven. Then According to the following equation calculated moisture content by wet weight was obtained

$$\text{moisture content(\%w.b)} = \frac{\text{wet weight} - \text{dry weight}}{\text{wet weight}} \cdot 100 \quad (3)$$

Measurement yield per hectare: For this purpose in addition information farmers and driver combines, Was put a frame 50 in 50 cm in the three parts of the farm, then were cut wheat plants by a scissors and obtained grain weight weighted by a digital scale. Finally were obtained amount yield on the 25m² by taken average of three replicates.

Feed rate= for calculated feed rate used of following equation.

$$FR = \frac{S \cdot W \cdot Y}{10} \quad (4)$$

F.R. = Feed rate, $t \text{ ha}^{-1}$

S = Forward speed, km hr^{-1}

W = Cutting width, m

Y = Weight of crop, $t \text{ ha}^{-1}$

Natural losses: for measurement natural losses, a 50 × 50 cm frame was placed on ground and wheat plants by a scissors were cut in height of 25 cm then were collected grains, clusters on the ground and also unharvest clusters. The deeds were weighted by a digital scale. For increasing the accuracy this was repeated three times and was taken average. Finally was extended in hectares.

Cutting platform losses: In order to collecting of samples, the 100*100 cm wood Frame was randomly thrown in the vacant place behind the cutting platform where the output material of Combine has not poured. Then grains and clusters in wood Frame were gathered, weighed and recorded.

$$Lh = (b - a) \cdot 10 \quad (5)$$

$$Lh\% = \left(\frac{Lh}{p}\right) \cdot 100 \quad (6)$$

Where:

Lh =platform losses amount, kg ha^{-1}

p = the gross of the field

a =weight of both grains and clusters due natural losses

b = weight of both grains and clusters due at the back cutting platform

Measurement of back combines losses: The processing of losses in combine of thrashing losses and separation loss as well as cleaning loss. In order to Measuring of back combine losses after determining of combine path, was allowed to move combine about 20 meters in along path. Then a frame 100×100cm that was covered by fabric to prevent from falling the grains on ground was thrown quickly between the front and back wheels of combine. Along the combine direction so that all materials output of back combine Placed on frame. After the combine passed, grains and unthreshed clusters were separated and weighted. For increasing the accuracy this experiment, was repeated three times and was taken average. Finally was extended in hectares.

$$Lt = \frac{T}{1000} \cdot 10000 = \frac{T \cdot 10}{W} \quad (7)$$

$$Lt\% = \frac{Lt \cdot 100}{p} \quad (8)$$

Where:

Lt= grain loss at the back of the combine, kg ha^{-1}

T=weight (average samples) of both collected grains and clusters in the frame, g

W=correlation coefficient between Efficient cutting width and the left swath width of straws at the back of the combine.

Results and discussion:

In this study average of natural, cutting platform and back combine losses, was estimated respectively 0.7%, 1.8% and 0.8%. In the farms that had plots perpendicular to combine moving about 0.83% of total yield was added to the combine losses.

For analysis and prediction of change in dependent variables (cutting platform and back combine losses) with changing independent variables was used regression analysis. Significant overall regressions are shown in Table 1.

Table 1: Results of regression analysis examined the effect of variables on a platform cutting losses

sig	F	Means square	df	Sum of squares	model	dependent variables
0.000	46.537	2/04	3	6.121	Regression	cutting platform losses
		0.044	21	0.92	Residual	
			24	7.04	Total	
0.000	32.477	3.674	2	7.347	Regression	back combine losses
		0.113	22	2.489	Residual	
			24	9.836	Total	

According to in Table 1, F test for judgment about significance of the overall regression be used, Indicate that independent variables as a collection For the dependent variables and generally Regressions is significant for each dependent variables (cutting platform and back combine losses).In Table 2 Has been shown Summary Regression models Variables surveyed on cutting platform and back combine losses john Deere 955.

Table 2: Summary Regression models cutting platform and back combine losses

sig	t	Unstandardized coefficients		model	dependent variables
		Std. Error	B		
0.043	2.149	0.552	1.121	Constant	cutting platform losses
0.043	-2.457	0.054	-0.106	Yield (kg/ha)	
0.0250	2.173	0.174	0.420	Forward speed(km/h)	
0.000	-4.883	0.022	-0.110	Moisture content(% wb)	
Adjustment R square =0.84		R=0.93		Durbin-Watson=2.42	
0.000	-8.799	0.336	-3.127	constant	back combine losses
0.000	5.045	0.066	0/334 /0	Feed rate(ton/h)	
0.000	5.242	0.024	-0.126	Moisture content(% wb)	
Adjustment R square =0.72		R=0.86		Durbin-Watson=2.25	

T-test showed all of coefficients Are significant in High level of probability And the coefficients can be entered into the regression model. Correlation coefficient (R) was obtained for cutting platform 93% and back combines losses 86%, which represents Influence of variables on a cutting platform and back combine losses. Adjustment R square(R² ad) For the mentioned dependent variables was obtained 84% and 72% respectively Which indicate 84% of Changes cutting platform losses and 72 % of Changes back combines losses.

According to the results in Table 1 and the appropriate adjustment R square (R² ad), with controlling other factors affecting, Can be presented regression models 9, 10 to determine cutting platform and back combine losses.

$$CPL = 2.93 e^{-0.106 P + 0.42 S - 0.11 MG} \tag{9}$$

$$BCL = .04e^{(.334 F + .126 GM)} \tag{10}$$

For recognize error amount of regression relationships in prediction losses wheat, 3 combine Losses were compared with results these models. The average of observed errors was obtained for cutting platform and back combines losses 24 and 35% respectively. Figure 1 and 2 show difference between the losses rates calculated by equations 7 and 8 with losses observed in the field.

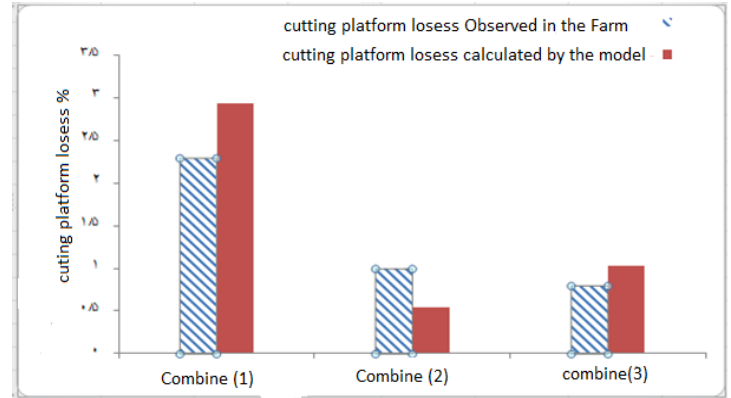


Fig 1: difference between cutting platform losses calculated by equation 9 and cutting platform losses observed in the field

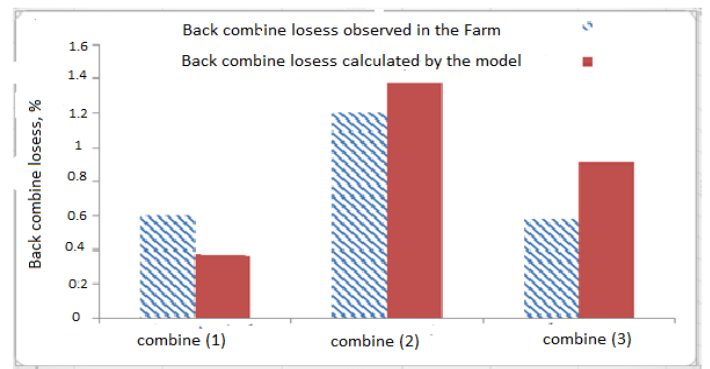


Fig 2: difference between back combine losses calculated by equation 10 and back combines losses observed in the field

According to collected data from field and output results of regression models (7, 8), was determined By reducing speed and increasing the moisture content of grain, Increased cutting platform losses. Also with increasing crop yield, reduce cutting platform losses. Effect of grain moisture content and ground speed combine On Losses John Deere combine cutting platform is showed in Figure 3. By reducing the moisture content until 12% moisture content Occurs a small increase in combine cutting platform. But with further reduction of moisture content Increase Losses intensified combine cutting platform. Also, with increasing ground speed, Process Increase Losses in Low moisture content much more than high moisture content Occurs. For example, cutting platform losses with speed increase of 1.5 km to the 3.5 km in moisture content 20% only increase about 0.5% (from 0.43 to 0.96%). Whereas cutting platform losses with the same increased speed in moisture content of 8% about 2 percent (from 1.62 to 3.6 percent). These results were similar with the results Patel, and Varshney (2007). In research they are

expressed with increased speed and decreased grain moisture increases cutting platform losses.

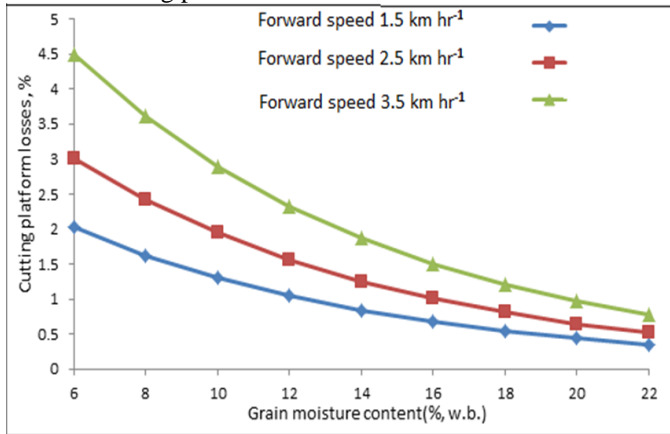


Fig 3: Effect of grain moisture content and ground speed combine On Losses cutting platform

According to collected data from field and output results of regression models (7, 8) was determined with Increasing feed rate and grain moisture Rises back combine losses. Effect of grain moisture content and feed rate On Losses John Deere combine back combine losses showed in Figure 4. With increasing feed rate back combine losses Rises back combine losses and this increase was very much in high moisture content. For example With feed rate increase In John Deere 955 combine From 5 tons to 7 tons per hour In moisture content of 8%, back combine losses Only increase about 0.57% (from 0.53 to 1.12%) Whereas this change hour In moisture content of 20%, increase about 2.73% (from 2.57 to 5.3%) . Effect of grain moisture content and feed rate combine on back combine losses of John Deere combine was showed in fig 4.

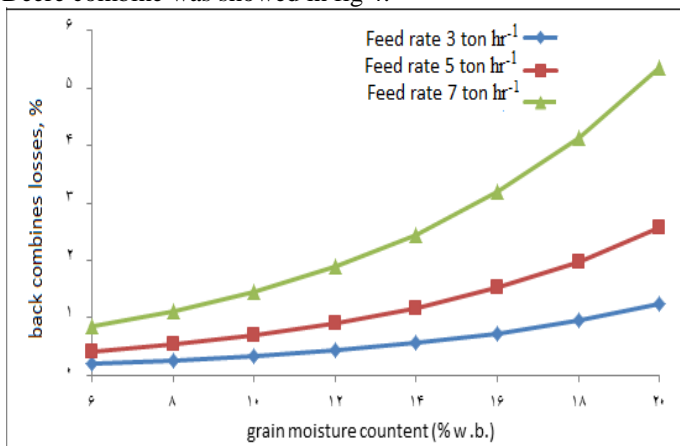


Fig 4: Effect of grain moisture content and feed rate on cutting platform losses

Total losses were obtained from Sum of cutting platform and back combine losses. There is Losses Minimum farm and combine in for many agricultural products a narrow range of moisture content (hunt, 1995). According to results of the regression equations and observations Farm in this research, was obtained minimum combine losses in the range of 10 to 16 % grain moisture content. And the lowest Losses in occurred in 14% grain moisture content. This results with the results of Rahama and et al (1990) was similar. They reported optimum moisture content for wheat harvest from 9 to 14 percent. In the figure 5 was showed effect of grain moisture content On John Deere Combine losses in 955 in performance of 3500 kg and forward speed 2 km.

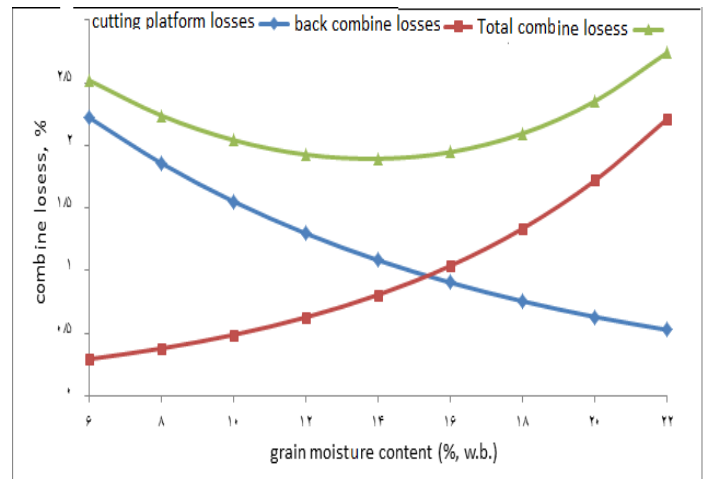


Fig 5: Effect of grain moisture content on total losses John Deere Combine

Conclusions

Average of natural losses was obtained 0.7% per hectare and average total losses John Deere 955 combines surveyed in the city of Ahvaz was 2.6% per hectare. These lose in fields were cultivated that form the Plot incusted to 3.4%. Most losses related to cutting platform equal to 1.8 %. In general was increased cutting platform Losses in farms of Low-density and non-uniform. Also, cutting platform losses increase sharply, when passing from plots. Whatever lands was Lower Plots Losses-cut platform found a significant reduction. From other reasons Increase cutting platform Losses can be delay in harvesting and very low moisture grains. In general combine losses in high moisture content grain is very high and reduced to reduce the moisture content grain losses but with a further reduction of grain moisture Increased grain loss during harvest again. The Best range order to minimize grain loss In harvest with the combine Was obtained Between 10 and 16 % (% w.b.). In the early season harvest Is better in early morning hours do not harvested but harvest In these hours Is recommended due to excessive drying of the product. Field Reviews for conducted in this study and the analysis results regression model Showed which If used of unusual ground speed Is Most important factor of grain losses in harvest. And will be large damages. By increasing the speed of 1.5 to 2.5 km increase losses was low but at speeds above 2.5 km increased grain losses in Combine was very high.

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