Technical and Economical Comparison of Performance in New Wheat Combines with Conventional Combines in West Azarbaijan Province

K. Kake Mami, M.A. Asoodar and A.R. Jamshidi

Abstract: In this study we investigated on effect of combine type and rotational speed of Concave on wheat losses during harvesting. We used parted plot in totally random blocks in 3 replications as statistical design and also Duncan’s test for statistical analyzing and analysis. Type of combine in 4 levels (Medion, Class John Deere 955 combine and John Deere 1165) and rotational speed of grinder cylinder in 3 levels (650, 750, 850 rpm) Selected as main plot and subplot respectively. Test has done in wheat fields of farmers all over the west Azerbaijan province. In each treatment following factors were measured: 1) Losses before harvesting (natural), 2) Losses of plot from (Cutter), 3) Concave unit losses, 4) Looses related to isolating and cleaning units, 5) Total losses, 6) Qualitative losses, 7) Progress rate and field capacity of combine, 8) Rotational speed of Concave and fan, 9) Rotational speed of real, 10) Moisture of seed, 11) High of cutter during harvesting, 12) Yield. Test treatments also analyzed economically by using the method of analyzing final investment turnover rate. The results of technical evaluation showed that class combine had a higher field capacity compared with the rest of investigated combines. Also this combine showed lower qualitative losses compared with other combines. For total losses Medion combine had the lowest value among the other treatments. Most proper rotational speed of Concave for examined combines was measured 650 r.p.m. Economical evaluation showed that combine of John Deere 955 is not recommended due to negativity of the profit and investment on class combine is more economic than Medion.

Key words: Yield, Combine, Wheat, cost, combine type.

INTRODUCTION

Wheat is the most important food stuff in consumption trend of the country; as in Iran 50 percent of energy uptake is supplied by wheat bread. west Azarbaijan province (Iran) has the four thin rank on wheat production into the country. Beside good weather also pioneer farmers, production staff efforts, researching results and using the latest scientific consequences had a vital role in production. In agro-year of 2009-2010 (agro-year: agronomical year) west Azarbaijan province could reach the 4st rank in wheat production by 12 percent of total production in country although it was on 2nd rank based on surface area then Khorasan and Golestan and khozestan provinces by 11.23 and 8.44 and 14 percent wheat production in country reached 2nd and 3rd rank and 1 rank in country respectively (Mostofi et al., 2006). The average natural loss and combine wastes in different parts like platform other parts, summation of parts and summation of all losses including natural losses reported by project executive office were 2.2, 2.62, 2.15, 4.77 and 6.97 percent (Mostofi et al., 2006). With decrease in wheat wastes in harvesting step, there is the possibility of increase in production of country fields. In this study we compared the yield of new combines with old combines and investigated the effect of combine type and rotational speed of Concave on losses and wastes of wheat during the harvesting. Also most economic treatment ensuring the maximum benefit was determined. There have been a lot of studies on combine losses that are including: Rahimi and Khosravani, 2003 in a multi-step sampling design selected and assessed 68 fields during harvesting by combine in west Azarbaijan province. The results showed that average wastes of wheat in harvesting in west Azarbaijan province was 4.81 percent of production. Most of this waste was related to combine head (68%) and then natural, screening, shredder and qualitative losses. Effecting factors on total wastes of wheat during harvesting are time of wheat planting, number of field blocks, familiarity of farmer with combine life time of combine, type of culture, speed of real, height of cutter and combine driver training. Asghari Meydani, et al.2003 assessed two combines of class and John Deere in 2 different harvesting times by distance of 15 days on two cultivars of dry land wheat. The results showed that the second time viz harvesting with delay had more losses than the first time and 9kilograms increased into each hectare per a day. Also class combine had lower losses than John Deere that it was because of having finger lings in combine head while John Deere has metal belts in real.
The results showed that in west Azarbaijan province on average there is 105.42 kg per hectare equal with 7.2 percent of outflow during the harvesting that by following technical recommendations and agronomical principles it can be lowered to 29.06 kg by 3.31 percent.

Mansoori and Minai 2003 studied the effect of machine parameters on wheat losses in John Deere combine. In this study the effect of combine moving, rotational speed of shredder, distance between shredder cylinder and Anti-shredder plate and rotational speed of air turbine on wheat losses were measured. Results showed that by increasing the moving speed, losses of cutter platform are going to be highly increased. Increasing rotational speed of shredder cylinder causes breakability of seeds and minimal decrease of shredder losses, as breakability of seed by increase of speed from 750 to 950 rpm is twofold. Increasing rotational speed of air fan increases wastage of splitting and cleaning units.

Minai and Afkari Sayeh 2002 in a study at first reviewed the importance of mechanical losses in agricultural products and its relationship with properties and behaviors of products then studied machine wastage of cereals in harvesting steps and after harvesting. With this regard they studies issue of wastage in following steps and indicated on researches and efforts of native experts and scientists: 1) wheat losses in mechanized harvesting by combine, 2) cereal losses during transportation, loading and landing, 3) mechanical damages in agricultural products, 4) cereal wastes in processing steps.

Minai and Abozahr 2002 studies the effect of automatic control systems for head height, speed of real, input material flow rate, speed of shredder cylinder, balance of splitter unit and speed of air blowers of combine on combine performance respect to decline in losses and studies some automatic control systems that were applied for combines. They reported that these systems besides losing the losses of products and improvement of combine yield also decrease fatigue of driver and totally increase field capacity of combine.

Sharadin and Qoolan 1991 performed a study named effect of hour and date of harvesting on wheat seed losses. Results showed that the lowest losses occurred in 8 a.m. to 12 p.m. and this lasted 10 days then delay in harvesting caused the increase in losses. Furthermore seed moisture can be decreased linear by delay in harvesting and causes the increase in seed losses. Finally the proper time for on-time harvesting and decrease in losses is recommended about 14-15 %.

Mahd et al., 1997 studied wheat losses during harvesting with combine in Sudan; then measured factors like moving velocity, cylinder round, the amount of openness of screens, adjusting of the fan and seed moisture. Their study results showed that among 55 combines no adjustment was not like other adjustment. Average measured losses in 1st year were 9% and in 2nd year was 12.7 %. They suggested that the proper moisture for harvesting is 9-14 %. The lowest losses related to the combine head in moving velocity were 5.5 Km/h and the lowest losses related to Concave round were 900 rpm.

Sing et al., 1991 in a study on finding the most proper time for changing harvesting combine concluded that the most proper time for changing old harvesting combine is between 8-9 years equal to 4056-6756 working hours in John Deere combine and 8-10 years equal to 1440-3700 working hours in SKPR-4 combine.

Methodology:
Method of Technical Evaluation of Combine Performance:
In this study we reviewed the effect of combine type and rotational speed of Concave on losses and wastage of wheat during harvesting. For statistical analysis we used parted plot in totally randomized blocks in 3 replications. Type of combine in 4 levels (Medion, class and John Deere 955 combine and John Deere 1165 and rotational speed of trashig 3 levels (650,750, 850 rpm) selected as main and subplot, respectively. The test was performed in agricultural lands of farmers in provincial level.

The number of studied combines arranged by type of machine is:
5 Medion combines, 5 Class combine, 5 John Deere 955 combines and 3 John Deere 1165 combines. We measured following factors in each treatment:

- **Losses before Harvesting (Natural):**
  Before entrance of combine into the field we weighted and collected fallen seeds and shoots in a wooden frame with size of 0.25 m.

- **Losses Related to Cutter Bar:**
  After harvesting a part of the field by combine seeds and shoots were collected and weighted for assessing losses of cutter bar. It must be noted that we subtracted natural losses from this loss.

- **Losses Related to Concave Unit:**
  We placed a webbed wooden frame under the combine so by movement of combine back wheels and exiting materials pour on the frame from back end of the combine; then by gathering un-shredded and semi-shredded clusters existed in frame and weighting obtained seeds the amount of this loss was measured.
• **Losses Related To Splitter And Cleaner Unit:**
  For measuring this factor, we found the amount of this factor by collecting existed seeds in webbed frame and weighting the seeds in section 3.
  It must be noted that processing losses are of total Concave unit losses and the losses of splitter and cleaner units that divided by correction coefficient (F):

\[
F = \frac{W_C}{W_S}
\]

Where:
\(W_C\) = is optimal cutting of combine (m)
\(W_S\) = residue Band width (m).

• **Total Losses of Harvesting by Combine:**
  This factor measured by following relationship:
  Total losses in harvesting by combine (100%) = collection losses percentage + processing losses percentage
  Processing losses percentage = processing losses (Kg/ha)/ product yield (Kg/ha) × 100
  Collection losses percentage or cutter bar = collection losses (Kg/ha)/ product yield ×100

• **Qualitative Losses:**
  By sampling from wheat in combine reservoir and splitting broken seeds from proper seeds, we measured weight-percent of broken seeds and finally qualitative losses.

• **Moving Velocity and Filed Capacity of Combine:**
  By measuring the time for traveling a certain distance in filed we measured the movement of combine during the harvesting in m/s. filed capacity was measured using moving velocity and effective width of combine.

• **Rotational Speed of Concave qand Fan:**
  Using Revolution-counter we measured rotational speed of Concave and fan in round per minute (rpm).

• **Rotational Speed of Real:**
  By tagging on one of the blades of real and using a time meter we measured rotational speed of real in rpm.

• **Seed Moisture:**
  Sampling the wheat in combine and moisture probe, moisture of seed measured in percent.

• **Height of Cutter Bar at the Time of Harvesting:**
  Measuring wheat stems’ height (the remained plants in field) this factor was measured. Also product yield reported in surface area unit.

**Economical Evaluation of Combine Yield:**
For determination of most economic treatment we collected information about statistics (that ensures maximum profit) and data about costs (including constant and variable costs of buying and maintaining each of studied combines) and also their benefits (including value of amount of decreased wastes, saved time and other parameters that can be quantified and valued) then we performed economical evaluation using analyzing investment turnover rate.

**Analyzing Investment Turnover Rate:**
For this reason, we measured net profit variations and variable costs at the result of displacement of a treatment with the other one and introduced them as final net profit and final variable cost. Multiplying quotient of above mentioned parameters by 100 is identical for final investment turnover rate. If this value be higher than bank deposit profit investment in treatment with higher profit is preferred.

**RESULTS AND DISCUSSION**

**Technical Currency Result:**
The first survey showed that velocity of a combine into the field is not in recommended range (2.5 - 3 Km/h). Mean velocities in each kind of combine were lower than 2.5 (it was 2.31, 2.29, 1.37 and 1.87 for Medion, Class, John Deere 955 and John Deer 1165 respectively). Of course factors like product intensity,
surface roughness, no scientific leveling of the field and type of combine (Medion and class could move in
determined speed range) had an important effect on movement velocity during harvesting. Since the measured
parameters determined in real conditions of the farm lands optimal cutting width in combine was measured.
Usually optimal cutting width is lower than combine cutting width and it is variable according to field
conditions. As field capacity of combine has a direct relationship with its moving velocity, so field capacity of 4
studied combines was lower than optimal level. However the highest field capacity was for Class combine with
1.02 ha/h then after that it was for Medion, John Deere 1165 and John Deere 955 by 0.81, 0.62 and 0.26 ha/h
respectively. It must be noted that rotational speed of fan is effective on performance and efficiency of cleaner
unit and have no effect on product yield. As rotational speed of Concave was effective on qualitative and total
losses so variance analysis and comparing the mean values was done for 2 above mentioned factors. Variance
analysis of qualitative losses amount in 4 combines (table 1) says that there is a meaningful relationship between
the amount of this combine, rotational speed of Concave and their interaction. Comparing mean values of
qualitative losses in effect of combine and rotational speed of Concave(table 2) showed that the highest
qualitative loss was in John Deere 1165 combine with 5.57 % and the lowest was in Class with 3.69 %. Of
course these losses have no significant difference between Class and John Deere 95 combines. Also revealed
that the highest qualitative losses were in 580 rpm speed and with 5.8 % and the lowest losses were in 650 rpm
speed with 2.96 % but they were in a same group statistically. Comparing mean values of qualitative losses in
interaction of combine type and rotational speed of Concaves depicted in diagram 1 and it says that the lowest
loss was in 650 rpm and the highest loss was in 850 rpm.

Table 1: Variance analysis of qualitative and total loss amounts in 4 types of studied combines.

<table>
<thead>
<tr>
<th>S.O.V</th>
<th>Df</th>
<th>Seedling emergence</th>
<th>Speed of emergence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>2</td>
<td>.16</td>
<td>.00</td>
</tr>
<tr>
<td>Combine type (A)</td>
<td>3</td>
<td>6.25**</td>
<td>2.95**</td>
</tr>
<tr>
<td>Experimental error</td>
<td>6</td>
<td>.06</td>
<td>.02</td>
</tr>
<tr>
<td>Speed Concave (B)</td>
<td>2</td>
<td>24.32**</td>
<td>.11</td>
</tr>
<tr>
<td>(A×B)</td>
<td>6</td>
<td>.57**</td>
<td>.06</td>
</tr>
<tr>
<td>Experimental error</td>
<td>16</td>
<td>.08</td>
<td>.003</td>
</tr>
</tbody>
</table>

*, **: Significant at 5 and 1% probability levels, respectively ns: Not significant

Table 2: Comparing mean values of qualitative losses on the effect of combine type and speed of Concave.

<table>
<thead>
<tr>
<th>Combine type (A)</th>
<th>Quality losses (%)</th>
<th>Rotational speed of Concave (rpm)</th>
<th>Quality losses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medion</td>
<td>4.36 b</td>
<td>650</td>
<td>3 a</td>
</tr>
<tr>
<td>Class</td>
<td>3.79 c</td>
<td>750</td>
<td>4.35 a</td>
</tr>
<tr>
<td>John Deere 955</td>
<td>3.92 c</td>
<td>850</td>
<td>5.90 a</td>
</tr>
<tr>
<td>John Deere 1165</td>
<td>5.67 a</td>
<td>850</td>
<td></td>
</tr>
</tbody>
</table>

in each column Similar letters are indicator of absent of meaningful differential

Table 3: Comparing mean values of total losses on the effect of combine type and speed of Concave.

<table>
<thead>
<tr>
<th>Combine type (A)</th>
<th>total losses (%)</th>
<th>Rotational speed of Concave (rpm)</th>
<th>Total losses (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medion</td>
<td>2.5 b</td>
<td>650</td>
<td>3 c</td>
</tr>
<tr>
<td>Class</td>
<td>2.82 a</td>
<td>750</td>
<td>2.57 a</td>
</tr>
<tr>
<td>John Deere 955</td>
<td>2.90 a</td>
<td>850</td>
<td>2.50 b</td>
</tr>
<tr>
<td>John Deere 1165</td>
<td>1.70 c</td>
<td>850</td>
<td></td>
</tr>
</tbody>
</table>

in each column Similar letters are indicator of absent of meaningful differential.

Analysis of variance values of total waste in 4 combines is presented in table 1 and it shows that among
these values there is a significant 1 % difference in effect of combine type, rotational speed of Concave their
interaction.

Comparison of total mean losses values related to type of combine and rotational speed of Concave is
presented in table 3 and it says that Class and John Deer had the highest total losses with values of 2.72% and
2.84% respectively and there was no significant difference between them, finally the lowest total loss was
related to John Deer 1165 combine with value of 1.61 %. Also it revealed that the highest total losses were
related to speed of 750 rpm with 2.97 % and the lowest total losses were related to 650 rpm with 2.29 %.
Comparison of mean loss values related to combine type and rotational speed of Concaves presented in diagram
2 and it shows that there was no significant difference among mean loss values by three studied speed in Medion
and John Deer 955. In Class combine the lowest total losses were in 650 rpm with 4.55 % and the lowest total
losses were in 650 rpm with 7.44 % that has no significant difference with 850rpm.
Fig. 1: Comparing mean values of qualitative losses in interaction between combine type and rotational speed of Concave.

**Economical Evaluation Results:**

**Fix and Current Currency of Using of Sample Combine:**

All current costs measured based on 1 hour work of a combine. Based on our results current cost of different combines was between at least 124 $ in John deer combines and at most 178 $ in Medion combines.

For assessing the fixed and variable cost we measured total cost or final price of a working hour of different combines. Based on results fixed cost for 1 working hour for the combine was at least 95760 $ in John Deer combine and at most 178272 $ in Class combine.

By summation of these two costs we measured total or final cost of 1-hour working for different combines. This amount was between at least 148 $ in John Deer and at most 282 $ in Medion (table 4).

**Table 4: Current costs for using sample combines (hour –$).**

<table>
<thead>
<tr>
<th>Combine type (A)</th>
<th>currency cost</th>
<th>Fix cost</th>
<th>total cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medion</td>
<td>178750</td>
<td>164513</td>
<td>343263</td>
</tr>
<tr>
<td>Class</td>
<td>145332</td>
<td>178272</td>
<td>323604</td>
</tr>
<tr>
<td>John Deere 955</td>
<td>124503</td>
<td>95760</td>
<td>220263</td>
</tr>
<tr>
<td>John Deere 1165</td>
<td>124852</td>
<td>116500</td>
<td>241352</td>
</tr>
</tbody>
</table>

Source: research findings

**Economical Comparisons of Treatments:**

Recognizing cost and income of different combine we can compare treatments of our test. For analyzing our results economically we used final revenue rate analysis method. Our measurements were based on three aspects: farmers, combine owners and social aspect. For farmers probable decline in qualitative and quantitative wastes is beneficial and increase in rental price is a cost. For combine owners increase in fixed and variable costs is as costs and increase of renting cost and more surface area in harvesting is as benefits. For social aspect we removed rental cost from our measurements and using new combine is economic when benefits from reduction in quantitative and qualitative wastes be more than increase of fixed and variable costs of combines. For measuring benefits for farmers and combine owners its necessary that see one of the combines as control and compare others with it. For this reason we selected John Deere 955 as control treatment and compared other combines with that.

**Result:**

Results show that harvested wheat by class and John Deer combines had a higher price than the base price (2860 R) because of better quality; but wheat harvested by other two combines showed price drop.

Change in profit and a cost in table 5 is because of alternation in qualitative and quantitative wastes. In 2007-2008 agro-year renting cost for John Deer 955 and 1165 was 450 $/ha and it was 550 $/ha for Medion and Class combines; so by changing the type of combine payment cost by farmers changes.

The results of technical survey showed that Class combine had a higher field capacity than other combine; as it had the highest field capacity with 1.02 ha/h. Also it showed that Class combine had the lowest qualitative losses, as it had the lowest amount of 3.69% losses. For total losses, Medion had the lowest losses with 2.37 % losses among treatments. The other important point in concluding is that we can't introduce an optimal speed because in John Deere 955 and Medion combines no significant losses were detected among the studied speeds and in Class and John Deere 1165 there were two optimal speeds. But based on qualitative losses in all 4 combines 650 rpm had the lowest losses; so we can say that most proper rotational speed for Concave is 650rpm.

Concluding on results of economical evaluation showed that John Deere 955 combine is not recommended because of the negativity of the profit. Based on the results net profit is the highest in Class combine and also
variable cost is lower than Medion and more than John Deere combines. So investment for Class combine is economic against Medion.

REFERENCES


