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Research Article

INVESTIGATION AND COMPARISON OF HARVEST TIME ON BREAKAGE RATIO, CONVERSION DEGREE, AND CONVERSION EFFICIENCY FOR TWO RICE VARIETIESOF *HASHEMI* AND *GOHAR*

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ABSTRACT
Post-harvest waste is one of the essential problems that not only rises in the conversion process, but also on farm and at the time of inappropriate harvest it is generated. Optimum harvest time can decrease crop waste on farm and also at the stage of transformation. This study was done in HarazCenter of Technology Promotion and Development to evaluate effect of different harvest times on breakage ratio, conversion degree, and conversion efficiency of two rice varieties Hashemi (low-yield) and Gohar (high-yield). Yield time for Hashemi and Goharwere assumed 90, and 120, respectively, days after transplanting. Crop harvest commenced 5 days before determined theoretical time and continued until crop's loss. 9 stages were performed for each of the varieties. Yielded results showed that maximum and minimum values of conversion degree for varietyHashemiwere observed in fifth and eighth crop times, respectively, and for varietyGohar at fifth and ninth crop times. Maximum and minimum conversion efficiency of Hashemiwas observed in sixth and eighth crop times and for Gohar at fifth and first crop times. ANOVA shows that effect of crop time and variety is significant on all three parameters in the level of 1%, and reciprocal effect of time × variety on all three parameters is not significant.

Keywords: *Crop Time, Breakage Ratio, Conversion Degree, Conversion Efficiency, Rice*

INTRODUCTION
Rice is the main food of over half of world people's food (Maclean *et al.*, 2002). Increasing quantity and quality of crop for responding to the answers of consumers is of special importance (Peng *et al.*, 2004; IPCC, 2007). Qualitative parameters under study in rice include visual shape, conversion quality, cooking quality, and its nutritional properties (Koutrioubas *et al.*, 2004). Different factors affect rice quality before harvest, on harvest, and after harvest. Before harvest, such factors as bad weather conditions, cold weather, and rise of water tensions can be addressed. On harvest, factors like impropriate use of combine harvester, and harvest time humidity can be mentioned, and after harvest, factors such as improper transformation of paddy to white rice and inappropriate transportation and conservation can be addressed. The most important reason for reduction of rice quantity and quality on harvest time depends on the time of harvest (Siebenmorgen *et al.*, 2007). This moisture is different for different variety. In addition to humidity, place and time are among factors that affect performance of the final crop (Qin and Siebenmorgen, 2005).
Moisture amount of a crop affects its quantitative and qualitative traits including conversion efficiency, head riceyield (HRY), count of chalky grains, cooking quality, degree of whiteness, etc. Individual physical traits of grains and distribution of these physical properties in grain heap changes humidity of harvest time (Bautista and Siebenmorgen, 2005). Part of this change is due to maturity of grain, but mostly due to the role played by humidity percentage on grains' properties (Siebenmrgen and Mauromoustakos, 1998).
A study was conducted in 1989 and 1990 on harvest time of 5 rice varieties, with sampling done once every 6 days. Obtained results showed that on harvest time when crop moisture was 17.92 %, conversion efficiency was the highest and on first harvest when crop moisture was 22.16 %, the transformation coefficient was minimum. Also, highest crop breakage occurred on sixth harvest when crop moisture was 13.89 % (Hadjisavva-Zinoviadi and Ntanosand, 1996).

In a 1995 study in USA, researchers stated the moisture range of 15-22 % as the best condition of rice harvest (Lu *et al.*, 1995).
In 2004, 2005, and 2006, in some USA states, effect of harvest time moisture on three varieties of Drew, Cypress, and Bengal was experimented, and obtained results showed that appropriate moisture for harvest of long-grain varieties was 19-22 % and for average variety of Bengal, it was 22-24% (Siebenmorgen *et al.*, 2007). In 2008, in a 5-year study for examining the most economic harvest time in different moisture conditions, researchers stated that in the moisture of 21.7 % net rice value will reach its maximum (Siebenmorgen *et al.*, 2008).
The aim of this study is to evaluate the effect of different harvest times on breakage percentage, conversion degree, and conversion efficiency of low-yield variety *Hashemi*and high-yield variety *Gohar*.

MATERIALS AND METHODS

Paddy Preparation and Planting Rice Varieties

Two experimental paddies each with an area of 3000 m^2were obtained in Haraz Center of Technology Promotion and Development, located in Mahmoud Abad City of Mazandaran Province, with longitude of 52.24 degrees east and latitude of 36.62 degrees north. Low-yield rice variety *Hashemi* and high-yield rice variety *Gohar* were used.
Transplanting the varieties *Hashemi* and *Gohar*was done on March 22 and April 1, 2013, respectively, with seedling being done April 26 and May 8. Theoretical harvest time was considered 90 and 120 days respectively, after transplanting. Sampling from *Hashemi* and *Gohar*was done 85 and 115 days after, respectively, after initial transplanting until complete settlement [Persian: *vars*] of the crop. For eachvariety 9 samples were picked in different days from the paddy field. Experimental harvest was doneon fifth harvest for both crops. Relevant information has been shown in table 1 (Ht_n and Gt_n denote varieties *Hashemi* and *Gohar* respectively). Moistures are shown as wetness percentage. Moisture fluctuations are due to weather circumstances.

Table 1: Harvest date, and harvest-time moisture of Hashemi and Gohar

Harvest-time humidity (% w.b)	Harvest date	Samples
16.7	20 July	Ht1
18.6	22 July	Ht2
17.5	24 July	Ht3
18.1	26 July	Ht4
18.5	27 July	Ht5
18.3	28 July	Ht6
21.5	30 July	Ht7
18.6	1 August	Ht8
20.2	3 August	Ht9
18.1	31 August	Gt1
21.6	2 September	Gt2
21.9	4 September	Gt3
20.0	6 September	Gt4
18.5	8 September	Gt5
19.2	9 September	Gt6
22.3	10 September	Gt7
19.4	12 September	Gt8
18.9	14 September	Gt9

Measuring Breakage Ratio

To measure breakage ratio, after crops were harvested and were exposed to outdoor conditions for two days and threshing was done, three 100-item samples of paddy were randomly selected, and then paddy skin was carefully removed by hand off paddies. Next, peeled grains were segregated using ocular split meter, and they considered, and counted (Model: DC-50).

Paddy Conversion to Rice and Calculation of Parameters

After sampling, initial damp was measured via digital damp meter model *kett model Riceterl*, and harvested stalks were exposed to outdoor conditions for 48 hours. Then, threshing operation was performed using thresher *macp-A*. Obtained paddy was damp-measured again and measured damp was named MC_1. After that, three 500-gram repetitions were placed in oven *Evervelll Model: Ps*-760 for drying. Each one of 500-gram repetitions were first placed in 45 °C for 60 minutes and then for 30 minutes in 55°C. Oven temperature was then increased to 65 °C and was conserved at this temperature until the end of drying process. Over the process of drying, once in 30 minutes weight of repetitions was measured, and drying continued until according to equation 1, crop's damp reached 10%±1 on wetness base.

$$(\%)MC_1 = \frac{M_0 - M_s}{M_0} \qquad (1)$$

Where, MC_1: humidity of conversation duration (%w.b), M_0: initial weight of each repetition (gr), M_s: weight of solid particles (gr)

Having dried the samples, peeling operation using rolling peeler (*Yanmar model: ST-50)* was done, and the weight of brown rice was measured. For whitening the peeled rice, then, vertical whitener ***YamanamotoModel:*** *VP-31T*was employed. Once whitening procedure was completed, white rice was weighed by digital scale, and using equation 3-3, degree of samples conversion was obtained.

$$M.D = \frac{W.M.R}{W.B.R} \times 100 \qquad (2)$$

Where, M.D.: conversion degree, W.M.R.: weight of milled (white) rice, W.B.R.: weight of brown rice.

Also, conversion efficiency was obtained using equation 3.

$$M.R = \frac{W.M.R}{M_0} \times 100 \qquad (3)$$

Discussion and Conclusion

ANOVA for effect of harvest time and rice variety on breakage ratio, conversion degree, and conversion efficiency are presented in table 2. ANOVA shows that effect of harvest time and variety on all three parameters is significant in the 1% level, and mutual effect of time×variety on all three parameters is not significant.

Table 2:ANOVA for effect of harvest time and rice variety on breakage ratio, conversion degree, and conversion efficiency

Coefficient of Variation (CV)	Experimental error (E)	mutual effect (t×v)	Variety (V)	Time (t)	
	36	8	1	8	Degree of freedom
12.91	1.23	3.47^{Ns}	95.11^{**}	96.03^{**}	F.K (%)
2.89	4.00	5.59^{Ns}	1741.51^{**}	39.96^{**}	M.D(%)
2.95	1.94	2.20^{Ns}	891.09^{**}	9.23^{**}	M.R(%)

Ns,, ** respectively mean insignificance and significance in probability level of 5 percent and 1 percent (Minitab-Tukey).*

Mean analysis of mutual effect of factors of variety and harvest time on peeling efficiency, conversion degree and head rice percentage are presented in table 3.

Table 3:Mean analysis of mutual effect for factors of variety and harvest time on peeling efficiency, conversion degree, and ratio of grains

M.R (%)		M.D (%)		F.K(%)		Harvest
G	H	G	H	G	H	time
41.6^{e}	51.2^{abc}	65.0^{efg}	77.0^{ab}	1.5^{f}	2.9^{ef}	t1
42.2^{e}	50.7^{abc}	64.1^{efg}	76.3^{ab}	3.7^{ef}	5.5^{cdef}	t2
43.5^{e}	51.7^{abc}	65.7^{defg}	76.3^{ab}	5.2^{def}	7.0^{bcdef}	t3
43.3^{e}	52.1^{abc}	62.8^{fg}	77.0^{ab}	6.3^{bcdef}	7.4^{abcdef}	t4
44.9^{de}	53.6^{ab}	66.5^{def}	79.7^{a}	7.4^{abcdef}	8.5^{abcdef}	t5
44.0^{e}	53.9^{a}	63.7^{efg}	75.1^{abc}	8.9^{abcdef}	13.7^{abc}	t6
43.2^{e}	50.2^{abc}	62.7^{fg}	71.7^{bcd}	9.6^{abcdef}	14.1^{ab}	t7
43.3^{e}	48.9^{cd}	61.3^{fg}	69.3^{cde}	10.0^{abcde}	14.4^{ab}	t8
43.3^{e}	49.3^{bc}	60.1^{g}	71.8^{bcd}	12.8^{abcd}	15.5^{a}	t9

Means shown with common characters do not have significant differences (Minitab-Tukey).

Based on means represented in table 3, diagram for each parameter under discussion was separately drawn for variety *Tarom Hashemi* and *Gohar* in Microsoft Excel 2010.
Figure1 and 2 show breakage ratio *Hashemi* and *Gohar* in different harvest times. It is observed that maximum and minimum breakage percentage for two varieties of *Hashemi*and *Gohar* were respectively obtained at ninth and first harvest times. Over the period of its growth, a rice grain receives water and nutrients under natural circumstances of its growth environment. In final stage when crop matures, field water is typically cut and the juice inside the grain starts drying. In this stage, grain transfers more humidity to air compared with what it receives from stalk and roots and therefore, temperature and humidity of the environment is quickly affected. After final drying, the seed continues absorbing damp under the effect of the environment in which it resides. This absorption and discharge of damp causespread of split in grains.

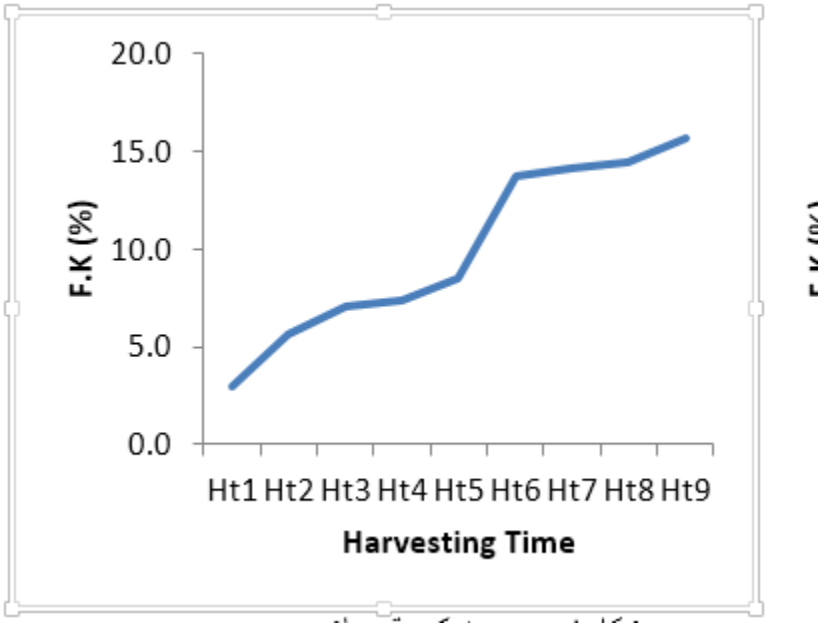

Figure 1: Breakage ratio of variety Hashemi

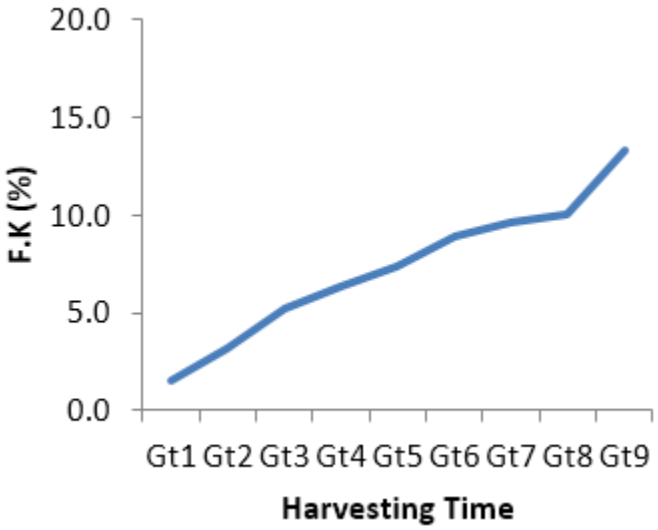

Figure 2: Breakage ratio of variety Gohar

Figure 3 and 4 show conversion degree of *Hashemi* and *Gohar* in different harvest times. It is observed that maximum and minimum conversion degrees for Hashemi were obtained at fifth and eighth harvest times respectively and for variety Gohar, in fifth and ninth harvest times respectively. In the beginning of harvest, due to immaturity and extreme softness and in the end of harvest range, due to maturity and extreme hardness of the crop, rice grains were completely crushed into powders in friction against each other within whitener machine and were expelled out of machine in form of waste. Therefore amount of rice gained decreased and hence conversion degree decreased, but in certain times, this amount was optimal for each crop.

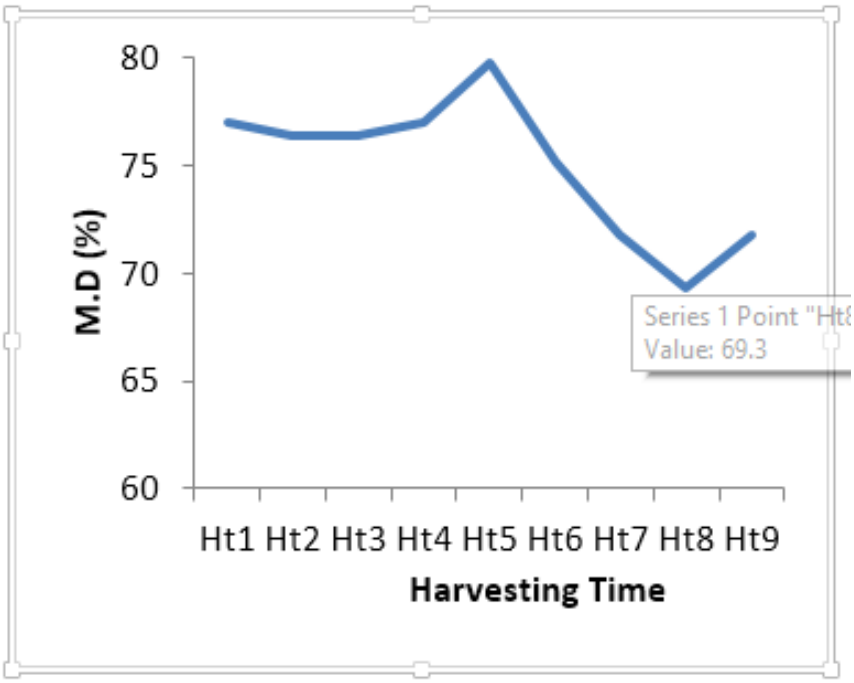

Figure 3: Conversion degree of variety Hashemi

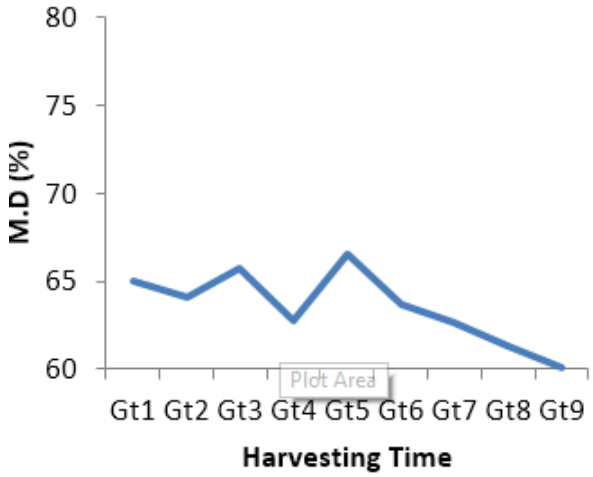

Figure 4:Conversion degree of variety Gohar

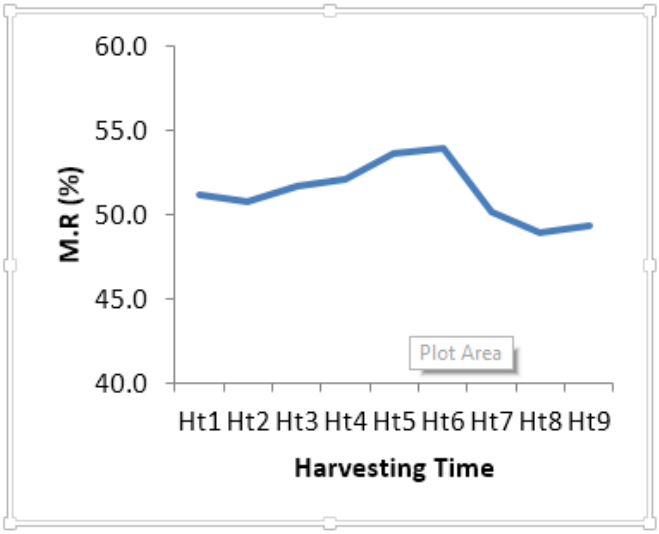

Figure 5: Conversion efficiency of Hashemi

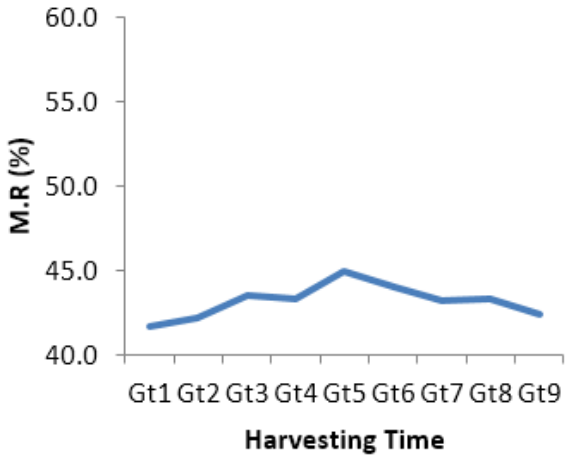

Figure 6: Conversion efficiency of variety Gohar

Figure 5 and 6 show conversion degree of Hashemi and Gohar in different harvest times. Maximum and minimum conversion efficiency of Hashemiwas observed at sixth and eighth harvest times and for Gohar, at fifth and first harvest times. Samples harvested before and after these two times, have less efficiency due to immaturity or extreme maturity of the crop. Once the crop is immature, endosperms of grains are softer and because of this, during peeling and whitening, grains are crushed under the effect of pressing and rubbing forces. Also, when grains are too mature, fragility against these forces increases in them and grains exit these machines in the form of very small particles along with wastes, but in mentioned times, these wastes are minimized and conversion efficiency is maximized.

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