Requirements of maize mechanical shelling

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Abstract: In order to optimize the maize productivity and quality, various aspects of production chains should be considered in an integrated way, including crucial steps to improve and conserve the maize crop. The lack of sufficient quantity of quality maize grains was sheller methods, clearances between cylinder, and maize grains moisture content is a major bottleneck to improve maize productivity and quality in Factory. This study is aimed to identify the effect of local thresher machine on maize cultivar Rabie based on some technical indicators, under two clearance of threshing cylinders (0.7 and 0.9mm) and three maize grain moisture content. The experiments were conducted in a factorial experiment under complete randomized design with three replications. The 0.9mm clearance was significantly better than 0.7mm clearance while the maize grains moisture content at range of 13%-15% was significantly superior to other ranges of 15%-17% and17%-19% in all studied parameters. For local THM the machine productivity, power consumption, threshing efficiency, grains damage, broken corn, grain cleaning, were 1.251 th-1, 9.358 kW, 88.717; 1.529; 3.272; and 1.318 percent respectively. The interaction among maize grains moisture content of 13%-15% and the clearance between cylinder 0.9mm gave the best result in all studied parameters.
Keywords: machines, maize, grain moisture ,clearance, Rabie cultivar , Sheller

Citation: Hamzah,I.J., Al Sharifi, S. K. A and A. A. Ghali. 2021. Requirements of maize mechanical shelling. Agricultural Engineering International: CIGR Journal, 23 (1):252-256.

1 Introduction

Maize is one of the most consumed crops in the world. Therefore, the identification of the maize cultivars is one of the most important factors for consumers. The identification of the maize cultivar class is a significant quality control standard for the Iraq food grain industries. A previous study explored that the clearance between cylinder had impact on milling efficiency by using Satake machine under 14%-16% moisture grain content and machine speed 4.7 m.sec (Al Sharifi, 2018). Threshing is the most important function of grain harvester. Grain loss and damage in harvesting are significantly related to threshing theory and technology. There are four kinds of threshing principles including impact, rubbing, combing and grinding, during removal of grains from the cobs (Jun et al., 2018).

The machine Satake type productivity was affected by the rotational speed cylinder threshing, as well as the moisture content of grain. Increasing moisture content lead to the increase of the breakage percentage and the decrease of the total productivity of the machine (Alwan et al., 2016) The performance evaluated that the POD shelling machine was easy to operate with only the adjustment of roller clearance. The POD shelling machine was found to have high dehulling and winnowing efficiencies at the optimum roller clearance. (Manieet et al., 2017). One report explained that there was a significant effect of the machine type and the moisture content on the energy consumption whenever the

Received date: 2019-12-04 **Accepted date:** 2020-03-25
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machine organization was desirable and lowest energy consumption (Al Sharifi et al., 2017a).

Increasing the forward speed of thrashing machine increasing the machine productivity in which the velocity of speed of threshing cylinder machine is toward more controls. The operator is responsible for managing this important parameter (Humburg, 2016). There was an impact for machine type and grain moisture content as well as speed machine on all studied properties during threshing process (Al Sharifi et al., 2019a).

Grain above 30% moisture can be difficult to remove from maize errand is easily cracked and damaged by over-threshing in the cylinder or rotor. Cylinder/rotor velocity and cylinder/concave clearance are the adjustments most critical to reduce grain damage and threshing losses (Chaudhary, 2016). Most grains damage are due to the mechanical treatment (Chilur et al., 2012). A study explained that there was a significant effect of the machine type and moisture content on husking efficiency and concluded that increasing in the moisture content led to decrease husking efficiency as well as decrease production process for machines which used in the experiment (Al Sharifi et al., 2018). Thus, the main goal of this research is to evaluate a maize sheller at different clearance and grains moisture content.

2 Material and methods

This study was conducted in 2019 to evaluate local threshing machine performance with speed 550 rpm because the machine gives the best performance and time, for thresher, power of Ac220v, Single - Phase required motor 5Hp productivity 1900 kg h^{-1}, dimension 1126*571*998 mm, RPM 2000r\m for Maize thresher local THM machine and this machine can be operated using an internal combustion engine or electric motor and the electric motor is adopted in this experiment (Figure 1). The experiments were done at three levels of grain moisture contents 13%-15%, 15%-17% and 17%-19% and two clearances between cylinder of 0.7 and 0.9 mm. The Rabie cultivar were selected and the heap were cleaned using sieves to remove all foreign matters, broken and immature grains. The initial moisture content of maize grain was determined by oven drying samples, which were taken by the probe collected on the form of heap. The heaps number were six and mass of each heap was 250 kg. The random samples of maize are taken from each method at 103°C for 48h (Al Sharifi et al.,2019b). The grains were kept in an oven at temperature of 43°C and monitored carefully for determining the moisture content of grain at 17%-19%. According the method used by Aljibouri and Alsharifi.(2019) .The machine production, power consumption, shelling efficiency, grain damage, grain cleanliness and the breakage proportion are evaluated.

Machine productivity: The machine was calculated as follow (Al Sharifi et al., 2018).

$$q = \frac{W\times 60}{T\times 1000} \quad (1)$$

Where, q is machine production (th-1), W is output mass, (g), and T is time (min).

Power required: Power required is the power, which is consumed by a machine to perform a specific job. The power required for this research is calculated as (Al Saadi and Al Ayoubi 2012).

$$P = \frac{\sqrt{3}}{1000}\cdot v\cdot I\cdot \cos\varphi \cdot E_{FE} \quad (2)$$

Where, P: Is power consumed (kW), $V$is voltage (V) and I :Is the electric current A, and cos (φ) is the angle between the current and voltage while (E_{FE}) is the efficiency of the motor (assuming as 90%).

Shelling efficiency: The shelling efficiency was determined as (Al Sharifi 2018)

$$E_{E} = \frac{W_S - W_{mU}}{W_S}\times 100 \quad (3)$$

Where: E_E: is the threshing efficiency (%)W_{mU}: is the mass unpeeled maize (g) and

W_S: is the mass of maize sample used. (g).

Grain damage: The grain damage with weight the split and cracked grains were weighted (Al Sharifi et al., 2019a)

$$P_{GD} = \frac{W_{Sg}}{W_S}\times 100 \quad (4)$$

Where: P_{GD}: is the grain damage (%)W_{Sg}: is the weight of split grains (g) andW_S: is the weight of maize sample used. (g).

Grain cleanliness: After threshing process a randomized of 1000 g grains were taken to calculated the percentage of grains cleaning was calculated as (Ghonimy and Rostom 2004).

$$G_C=\frac{W_s-W_I}{W_s}\times 100 \quad (5)$$

Where: G_C :Is the percentage of grain cleanliness (%) , W_s : Is weight of sample(g) and W_I : Is weight of impurities (g).

Breakage percentage: The breakage percentage was determined as (Al Sharifi et,al.,2017b , Al Sharifi, 2018)

$$P_{Br}=\frac{W_{br}}{W_s}\times 100 \quad (6)$$

Where: P_{Br}: Is the proportion of breakage (%) , W_{br}: is the weight of breakage grain. (g) and W_s: Is the weight of maize sample used (g).

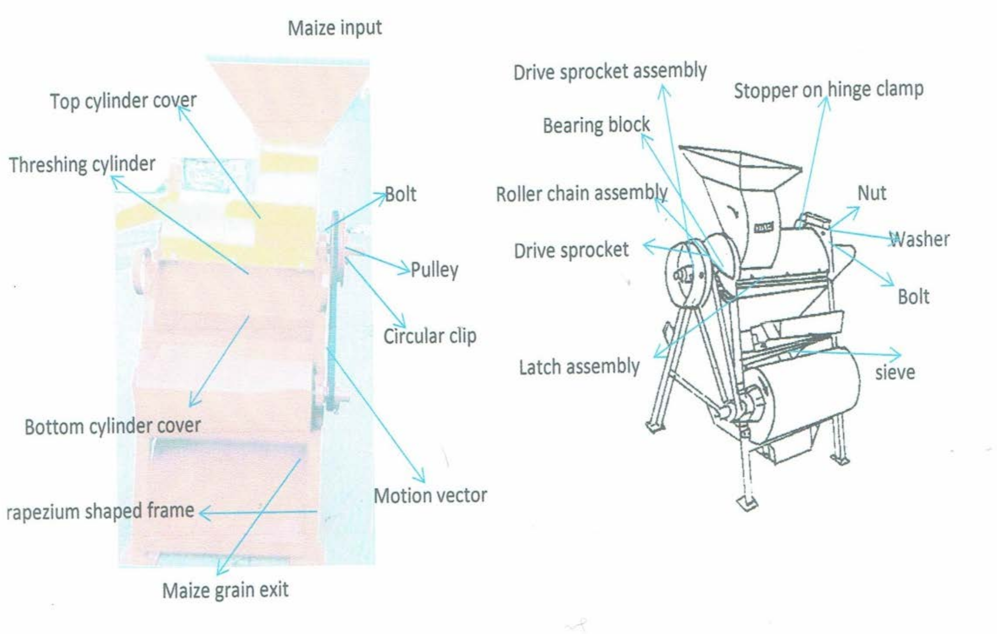

Figure 1 Machine (type Local THM) used for thresher maize

The results were analyzed statistically using the design complete randomized design (CRD) and the difference among treatments for each factor was tested according to the LSD test (Oehlent ,2010).

3 Results and discussion

3.1 Machine productivity

The decrease in the grain moisture content leads to increase the machine productivity, and the results were 1.559, 1.315 and 1.178 t.h^{-1} respectively. Because the low pressure on the grain in the threshing chamber increase machine production with the decreased grain moisture content . These results are consistent with the results of (Al Sharifi et al., 2018) shown in (Table. 1). The clearance of0.9mm indicated the highest machine productivity of 1.450 th^{-1}against 1.251 t.h^{-1} at clearance of 0.7mm. This is due to the fragility of the maize grains and increasing the pressure, which leads to increase the machine production with maize grains moisture content decrease. This is consistent with (Alsharifi et al.,2017b). The interaction among maize grains moisture content of 13-15% and the clearance 0.9mm provided the productivity of 1.682 t.h^{-1}.

Table 1 Effect of grain moisture content and maize sheller clearance on sheller productivity

Clearance mm	Grain moisture content, %.			Means of clearance
	13-15%	15-17%	17-19%	
0.7	1.436	1.226	1.093	1.251
0.9	1.682	1.403	1.266	1.450
LSD=0.05				0.044
Means of moisture	1.559	1.315	1.178	
LSD=0.05		0.102		

3.2 Power consumption

The power consumption of the clearance 0.9 mm (9.3587 Kw) is significantly lower than the clearance 0.7 mm (10.550 Kw (Table 2). The increasing grain moisture leads to the increase in power consumption and which was 9.117, 10.179 and 10.567 kw respectively. This is due to the increased Damocles effort on grains during the threshing process hence increased capacity consumed with increasing corn grains moisture content. This is consistent with (Al Saadi and Al Ayoubi, 2012). The interaction among corn grains moisture content of 13-15% and the clearance 0.9mm was the best (8.422 Kw).

Table 2 Effect of grain moisture content and maize sheller clearance on sheller power consumption .

Clearance mm	Grain moisture content, %.			Means of clearance
	13-15%	15-17%	17-19%	
0.7	9.812	10.806	11.033	10.550
0.9	8.422	9.552	10.101	9.358
LSD=0.05				0.621
Means of moisture	9.117	10.179	10.567	
LSD=0.05		0.154		

3.3 Shelling efficiency

The grain moisture content at 13%-15% showed the highest shelling efficiency of 87.343%, while the lowest shelling efficiency of 83.267% was for 0.7 mm clearance. This is due to the increase in moisture content of grain, which also leads to obstruct the thresher process hence decreasing thresher efficiency. These results are consistent with the results gained by (Al Sharifi, 2018). From Table 3, the clearance 0.9 mm (88.717%) was significantly better than the clearance 0.7 mm (82.626%). The decrease of the shelling efficiency is due to the blockage cavities of the machine at low clearance, which leads to obtain low shelling efficiency. These results are consistent with the results of (Al Sharifi et al., 2018). The interaction among corn grains moisture content of 13%-15% and the clearance 0.9mm was the best (90.332%).

Table 3 Effect of grain moisture content and maize sheller clearance on shelling efficiency

Clearance mm	Grain moisture content, %.			Means of clearance
	13-15%	15-17%	17-19%	
0.7	84.355	83.906	80.217	82.826
0.9	90.332	89.003	86.317	88.717
LSD=0.05				1.712
Means of moisture	87.343	86.455	83.267	
LSD=0.05		2.321		

3.4 Grain damage

Table 4 shows the influence of clearance between cylinder's and grain moisture on the grain damage percentage. The results indicated that increasing grain moisture led to increase the grain damage percentage, and the results were 1.413, 1.641 and 1.958% respectively for different moisture contents. When grain moisture increased, it led to the adhesion of the grains to the cobs resulted in grain damage with beating inside the machine. This is consistent with the results of (Manieet et al., 2017). The lowest grain damage percentage (1.529%) was obtained at the clearance of 0.9mm and the highest grain damage percentage (1.812%) was obtained at the clearance of 0.7 mm. Because there is not so much impact of blows when clearance between cylinder's increased hence decreasing the grain damage percentage. These results are consistent with the results gained by (Chilur et al., 2012) that the interaction among moisture content of 13%-15% and the clearance 0.9 mm caused the best result of 1.223%.

Table 4 Effect of grain moisture content and maize sheller clearance on grain damage

Clearance mm	Grain moisture content, %.			Means of clearance
	13-15%	15-17%	17-19%	
0.7	1.604	1.822	2.011	1.812
0.9	1.223	1.461	1.904	1.529
LSD=0.05				0.022
Means of moisture	1.413	1.641	1.958	
LSD=0.05		0.089		

3.5 Breakage percentage .

The breakage percentage of the clearance 0.9 mm (3.272) is significantly lower than clearance 0.7 mm (4.099%). From Table 2, the increasing grain moisture leads to the increase in power consumption and which was 3.031%, 3.588% and 4.438% respectively, Because the ease grain flow leads to the decrease of the proportion of breakage of grain, with decreased grain moisture. This is consistent with (Alwan et al., 2016). The interaction among corn grains moisture content of 13%-15% and the clearance 0.9 mm was the best (2.640%).

Table 5 Effect of grain moisture content and maize sheller clearance on grain breakage

Clearance mm	Grain moisture content, %.			Means of clearance
	13-15%	15-17%	17-19%	
0.7	3.421	3.063	4.813	4.099
0.9	2.640	3.114	4.062	3.272
LSD=0.05				0.043
Means of moisture	3.013	3.588	4.438	
LSD=0.05		0.096		

3.6 Grain cleanliness

The increase in clearance between cylinder leads to the decrease of maize grains cleanliness being 91.318% and 89.374% respectively for different levels of clearance between cylinder (Table 6). The grains moisture content of 13%-15% resulted in the highest grain cleanliness (92.945%) and at the maize grains moisture content of 17%-19% indicated the lowest grain cleanliness (88.452%). This is due to the increased straw with increasing grain moisture leads to maize grains cleanliness decrease (Ghonimy and Rostom, 2004). The interaction among maize grains moisture content of 13%-15% and the clearance between cylinder 0.9 mm gave best result (94.678%) .

Table 6 Effect of grain moisture content and maize sheller clearance on grain cleanliness

Clearance mm	Grain moisture content, %.			Means of clearance
	13-15%	15-17%	17-19%	
0.7	91.211	89.821	87.091	89.374
0.9	94.678	90.063	89.813	91.318
LSD=0.05				1.632
Means of moisture	92.945	89.942	88.452	
LSD=0.05		2.089		

4 Conclusions

The maize grains moisture content 13%-15% was superior significantly ontwo levels 15%-17% and 17%-19%. Additionally, the clearance between cylinder's 0.9 mm was superior significantly on the clearance 0.7 mm in all studied properties. The overlap between the clearance 0.9 mm and maize grains moisture content 13%-15% was also superior significantly.

Acknowledgement

The authors would like to appreciate the engineering staff at the University of Tehran, College of Agricultural for their support in the completion of this research.

References

Al Saadi, F. T., and T. Al Ayoubi. 2012. Study some of the technical characteristics of the type of excessive and the impact feed speed and drying temperature and their impact on the nutritional value of maize crop. *Euphrates Journal of Agricultural Science,* 2(3):70-76.

Al Sharifi, S. K., A. Arabhosseini, M. H. Kianmeher, and Ali. M. Kermani. 2017a. Effect of moisture content, clearance and machine type on some qualitative characteristics of rice on (TarmHashemi) cultivar. *Bulgarian Journal of Agricultural Science*, 23(2): 348–355.

Al Sharifi, S. K A., A. Arabhosseini, M. H. Kianmeher, and A. M.Kermani. 2017b. Effect of clearance on mechanical damage of
processed rice. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 65(5): 1469–1476.

Al Sharifi, S. K. 2018. Affecting on threshing machine types, grain moisture content and cylinder speeds for maize, Cadiz variety. *CIGR Journal*, 20(3): 233-244.

Al Sharifi, S. K., A. Arabhosseini, M. H. Kianmeher, and Ali. M. Kerman. 2018. The effect of clearance on the performance of machine husking rubber rolls for two rice cultivars. *Journal of University of Babylon*, *2*6(3): 207-214.

Al Sharifi, S. K., A. Mousa, and A. T. Manhil. 2019a. Effect of sheller rotational speed on some maize cultivars quality. *CIGR Journal*, 21(2): 196-203.

Al Sharifi, S. K., A. Mousa, and A. T. Manhil. 2019b. Effect of threshing machines, rotational speed and grain moisture on maize shelling. *Bulgarian Journal of Agricultural Science*, 25(2): 243–255.

Alwan, S. K., A. Arabhosseini, M. H. Kianmehr, and A. M. Kermani. 2016. Effect of husking and whitening machines on rice Daillman cultivar. *CIGR Journal*, 18(4): 232-242.

Aljibouri, M.A.and S.K. Alsharifi, 2019. Evaluation of Local Design Machine for Corn Threshing .*Indian Journal of Ecology* ,46(4): 913-920 .

Chaudhary, S. 2016. Development and performance evaluation of modified maize dehusker cUM sheller. Ph.D. diss., Dept. of Farm Machinery and Power Engineering PAU, Ludhiana, India.

Chilur, R., V. P. Sushilendra, M. Veeranouda, R. S. Yaranal, S. Hiregoudar, and N. B. Mareppa. 2012. Effect of operational parameters on dehusking cum-shelling effi ciency and broken grain percentage of maize dehusker-cum sheller. *International Journal of Scientific Research*, 3(8): 10-14.

Ghonimy, M. I. and M. N. Rostom. 2004. Design and performance evaluation of canola-seed cleaning machine. Misr *Journal of Agricultural Engineering,* 21(3): 869-884.

Jun, Fu., C. Zhi, H. Jia, and R. Quan. 2018. Review of grain threshing theory and technology. *International Journal of Agricultural and Biological Engineering,* 11(3): 12-20.

Humburg, D. 2016. Combine adjustments to reduce harvest losses. In *Grow Maize: Best Management Practices,* eds. D. E. Clay, C. G. Carlson, S A. Clay, and E. Byamukama. USA: South Dakota State Univ.

Manjeet, P., R. Prem, S. J. Pragi, K. L. Dabhi, and A. V. Baria. 2017. Pod shelling machines –A review. *International Journal of Agricultural Science and Research,* 7(1): 321-326.

Oehlent, G. W. 2010. *A First Course in Design and Analysis of Experiments*. USA: Library of Congress Cataloging-in-Publication Data.