# Effect of husking machines and clearances on two rice cultivars

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**Abstract**: In order to optimize the rice productivity and quality, various aspects of production chains should be considered in an integrated way, including crucial steps to improve and conserve the rice grains. The lack of sufficient quantity of quality rice grains was husking methods, clearances between cylinder, and two rice cultivars is a major bottleneck to improve rice productivity and quality in Factory. This study is aimed to identify the effect of thresher machines on rice cultivars based on some technical indicators. Two types of rice husking machines (S-KB40 and Y-ST50) were tested at three clearances of 0.5 mm, 0.7 mm and 0.9 mm, for two rice cultivars of JA and M-33. The experiments were conducted in a factorial experiment under complete randomized design with three replications. The clearance 0.9 mm was significantly superior to the other two levels of 0.5 mm and 0.7 mm in all studied parameters. For S-KB40 the machine productivity, power required, husking efficiency, broken rice ratio, head rice ratio, were 1.768 t $hr^{-1}$, 14.432 kW, 77.151%, 6.816% and 59.724% respectively under the same operating conditions for Y-ST50. The results showed that the JA cultivar was significantly better than the M-33 in all studied conditions. The interaction among S-KB40 husking machine, JA cultivar and the clearance between cylinder 0.9 mm gave the best results in all studied parameters.

**Keywords:** rice, machines, clearances, husking, JA and M-33 cultivars.

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## 1 Introduction

Rice occupies the forefront of the list of necessary food crops, on which the majority of people depend on it for their food, that the efforts of the research centers at the Ministry of Agriculture are continuing to improve the productivity of this crop, as it follows modern technological methods in the cultivation of high-productivity early maturing varieties, which is reflected in increased production and improvement of the quality of the crop, in addition to directing surplus production to export (Hamzah et al., 2021;Alsharifi, 2022). However, the rate of production per unit area remained low compared to the productivity of the Arab countries and the countries of the world, even though Iraq is one of the countries known for cultivating this crop since ancient times (Alwan et al., 2016c).

The rice productivity provided for processing operations is affected by two factors: To obtain high quality and productivity of rice, it depends on the rice type, its moisture content, the exotic matters amount,

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the number of broken grains, and the damaged rice, all of these factors mentioned are taken place upon receipt of the product by farmers (Salim et al., 2021). Bai et al. (2005), and Alsharifi et al. (2019a) reported that the machine productivity was so affected by the speed, as well as the clearances between cylinders. Increasing the clearance, lead to increase the breakage ratio and decrease the total machine productivity. Abu Khair et al. (2005), Alsharifi et al. (2019b), and Aljibouri et al. (2021) reported that the machine regulation has a direct effect on the machine output.

Understanding the mechanism of paddy grain impact hulling is key to improving the performance of rice hullers, with less energy consumed, high efficiency in the separation process, and the production of raw rice with the lowest breakage rate (Long and Huang, 2004; Chu et al., 2022). confirmed that an increase in broken rice due to increase in the mechanical effort during rice manufacture leads to increase percentage broken rice (Singha, 2013;Puri, and Sodhi 2014).

Chung and Lee (2003) and Alsharifi et al. (2017b), through studies and research conducted by some researchers, there is a clear and tangible effect of the clearance between the husking cylinders and the machine type used in the husking process, they concluded that regulating the machine according to the length and thickness of the rice grain, is absolutely necessary in order to come out with the lowest fracture rates and the highest peeling efficiency. It was concluded through the study that he conducted by adopting feeding rates and grain moisture ratios different, that as increasing the feeding rate leads to an increase in the breakage ratio in the rice grains, and in return, the capacity of the machine decreased with the decrease in the feeding rate (Gbabo and Ndagi, 2014; Alsharifi et al., 2017a). The rice kernel cracked during the hulling process is one of the main problems facing the rice industry (Alwan et al., 2016a; Taher ,2017). The threshing speed, grain moisture and husk removal time have a significant impact on the head rice, higher the speed and the manufacturing time, the negatively reflected on obtaining whole grains (Kim and Lee, 2012; Eliçin et al., 2022). The main goal of this research is to study the effect of husking machines (S-BK40 and Y-ST50) on JA and M-33 cultivars at different clearance levels.

## 2 Materials and methods

This study was conducted in 2022 to evaluate the effect of husking machines (S-KB40 and Y-ST50). The experiments were done at three levels of clearances between cylinders at levels of 0.5 mm, 0.7 mm and 0.9 mm. The Mashkhab (M-33) and Jasmine (JA) cultivars were selected for the experiments and the samples were taken by the probe and collected on the form of heap, which the number heaps were six and each heap weight was 160 kg, according to the method used by (Alsharifi et al., 2017b; Alsharifi et al., 2018). The rice samples were cleaned by using sieves to remove all foreign matters, broken and immature grains. Then the random samples which are taken from each heap in 1000 g weight. The initial moisture content of rice grain was determined by oven drying methods at 103℃ for 48 h (Huang et al., 2001; Ajmi et al., 2023). The rice of JA cultivar was kept in an oven at temperature of 43℃ and monitored carefully for determining the moisture content of grain at 13%-15% then the samples were taken and placed in the precision divider to get a sample of 300 g weight and then the samples were carefully sealed in polyethylene bags. The Satake type machine was adjusted on 0.9 mm clearance between cylinders and linear speed of 4.7 m $s^{-1}$ and then the samples of 200 g were placed in the machine. Then the sample was taken out of the machine and placed in a cylindrical insulating device from a Satake type with operating time which was adjusted to 2 min. The angle of inclination was 25° insolating the broken and full grain for all sizes. The machine productivity, power required, husking efficiency, broken rice and percentage of head rice, were calculated for each running test.

### 2.1 Machine productivity

It was calculated according to Roy et al. (2008), Singha (2012) and Aljibouri et al. (2022).

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

Where, $P$ is the production process (t $hr^{-1}$), $W$ is the output weight (g), and $T$ is the time (min).

**2.2 Power required**

It was calculated according to Shwetha et al. (2011), Alwan et al. (2016b) and Aljibouri and Alsharifi (2019).

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

Where, $P$ is the power consumed (kW), $v$ is the voltage (V), $I$ is the electric current (A), $cos\varphi$ is the angle between the current and voltage, and $E_{FE}$ is the efficiency of the motor (90%).

**2.3 Husking efficiency**

The husking efficiency was determined by (Minaei et al., 2007; Alsharifi et al., 2019a).

$$P_E = \frac{W_S - W_{RU}}{W_S} \times 100 \quad (3)$$

Where, $P_E$ is the husking efficiency (%), $W_{RU}$ is the weight of unhusked paddy (g) and $W_S$ is the weight of paddy sample used (g).

**2.4 Broken rice ratio**

It was calculated according to (Aljibouri et al., 2021; Hamzah et al., 2021)

$$P_{BR} = \frac{W_{br}}{W_S} \times 100 \quad (4)$$

Where, $P_{BR}$ is the broken rice ratio (%), $W_{br}$ is the broken grains weight (g)

**2.5 Head rice ratio**

Head rice ratio represents the head rice amount resulting from the husking process and broken rice and cracked grain percentage. Was used for calculation of the head rice ratio (Ali and Shatti, 2006; Alwan et al., 2016a; Alsharif, 2018).

$$P_{Fg} = \frac{W_{Fg}}{W_S} \times 100 \quad (5)$$

Where, $P_{Fg}$ is the proportion of head grain, (%),$W_{Fg}$ is the weight of whole grain (g)

After the hulling process (husk removing), the random samples were taken of 300 g weight. Then the samples were taken and placed in the room of whitening machine. The S-KB40 type machine was adjusted on 0.9mm clearance between cylinders and at linear speed of 4.7 m s-1 for 2 min. All the experiments were done in three replications for both cultivars of M-33 and AJ.

**2.6 Husking machine**

Two types of husking machines (S-KB40 and Y-ST50) were used for experiments after they maintained. The machines were organized on certain clearances and at linear speed of 4.7m.$s^{-1}$.

The rubber roll- M- KB40 is characterized of the power of AC230 V, Single phase 400 W, RPM of 1900 rpm main shaft and 1000rpm movable shaft, size of rubber roll W 35×Dia 100mm, dimensions 2070×600×1880 and weight 32 kg for S-KB40 machine (Figure 1) .

Figure 1 Husking machine (S-KB40 type)

The rubber roll M-ST 50 is characterized of the power of AC220 V, Single phase 400 w, RPM of 1900 rpm main shaft and 1000 rpm movable shaft, size of rubber roll 1.1/2" ×4", dimensions 700×700×310 and weight 37 kg for Y-ST50 machine (Figure 2).

## 3 Results and discussion

### 3.1 Machine productivity

The results in the statistical analysis shown that there is a highly significant effect of the machine type factor on the machine production values. When comparing the treatments in Figure 3, there are significant differences, as the treatment of the machine type S-KB40 on record the highest values of

1.768 t hr$^{-1}$, while the treatment of Y-ST50 gave the lowest values of 1.691 t hr$^{-1}$, respectively. The superior productivity values of the S-KB40 type machine compared to the Y-ST50 machine is due use of full absorption capacity of the S-KB40 machine (Roy et al, 2008; Ajmi et al., 2023).


Figure 2 Husking machine (Y-ST50 type)

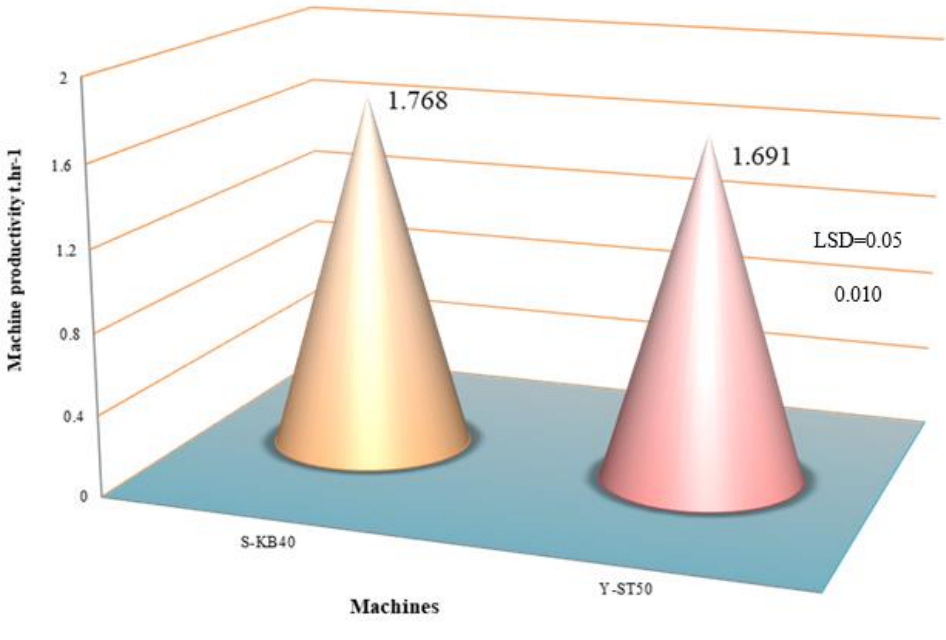


Figure 3 Effect of machine type on machine productivity

As for the effect of the rice variety on the machine productivity values, as it appears from the results of the statistical analysis, there is a highly significant effect, as it appears from the Figure 4, that there are substantial differences between all treatments. The JA cultivar recorded the highest value of 1.784 t hr$^{-1}$, while the M-33 cultivar recorded the lowest value of 1.675 t hr$^{-1}$, respectively. The reason for the high productivity is attributed to the JA cultivar, the suitability of its size and its high resistance in husking rooms (Bai et al., 2005; Aljibouri et al., 2021).

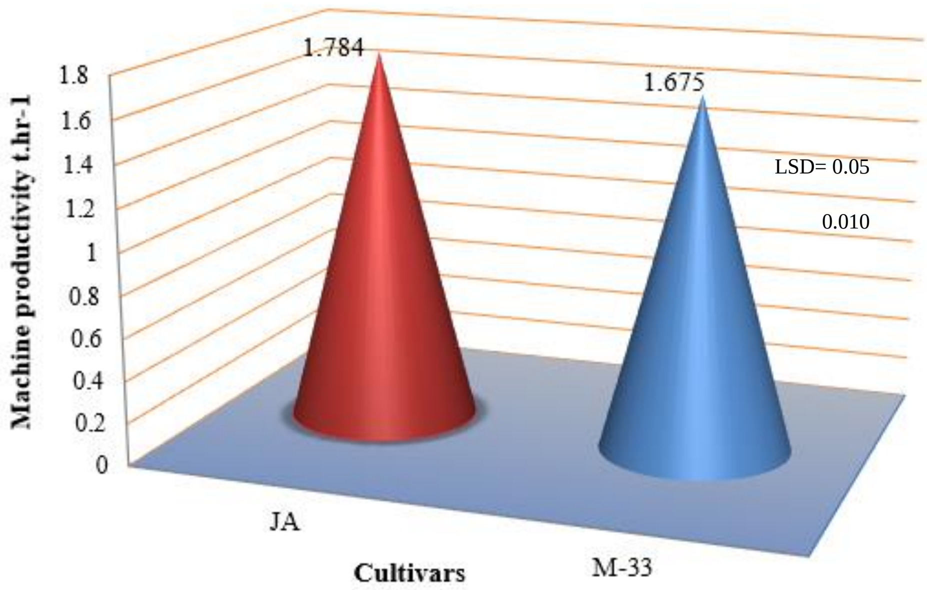


Figure 4 Effect of rice cultivars on machine productivity

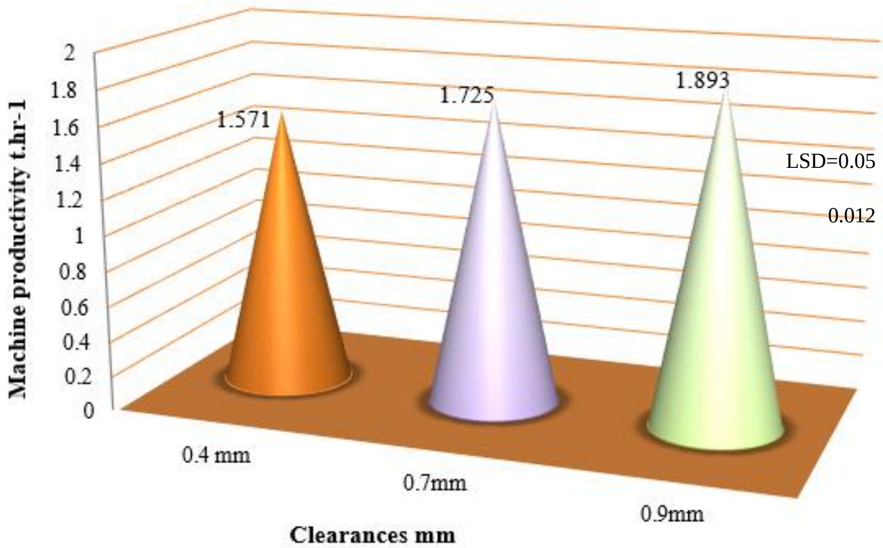


Figure 5 Effect of clearances on machine productivity

As it appears from the results of the statistical analysis, there is a highly significant effect, as it is clear from the Figure 5, increasing the clearances between cylinder leads to increase of the machine productivity, the results were 1.571, 1.725 and 1.893 t $hr^{-1}$ respectively, for different levels of clearances, when decreasing clearances, leads to an obstruction process husk of grain and this because of the grain adhesion (Chu et al., 2022).

The results shown of the statistical analysis, effect of the interaction between the machine type and clearance between cylinders on the machine productivity. It is evident from Figure 6, the significant superiority in the productivity of the machine for the machine type treatment S-KB40 as compared with the machine type treatment Y-ST50, and that the variation in the production values of the machine varies according to the clearances ratios between the husking cylinders. The highest significant differences were recorded between of the machine type at clearance 0.9mm, compared with clearance coefficients 0.5 and 0.7 mm, all the interactions were significantly different and the best results of 1.902 and 1.883 t $hr^{-1}$, were obtained from the overlap among machine type, and 0.9 mm clearance, for both machines types S-KB40 and Y-ST50 respectively (Salim et al., 2021), while lowest results of 1.636 and 1.505 t $hr^{-1}$, were obtained from the overlap among machine type, and 0.5 mm clearance, for both machines types S-KB40 and Y-ST50 respectively (Alsharifi, 2018).

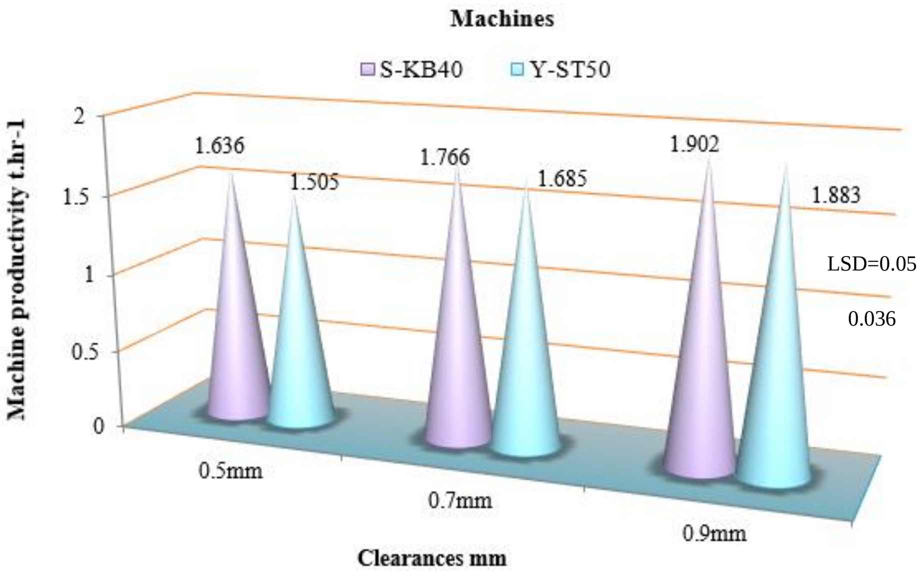


Figure 6 Effect of clearances and machines types on machine productivity

The results shown of the statistical analysis, effect of the interaction between the machine type and clearance between the cylinders on the machine productivity. It is evident from Figure 7, the significant superiority in the machine productivity for JA cultivar, as compared with the M-33 cultivar, and that the variation in the production values of the machine varies according to the clearances ratios between the husking cylinders. The highest significant differences were recorded between of the JA cultivar at clearance 0.9 mm, as compared with clearance coefficients 0.5 mm and 0.7 mm, all the interactions were significantly different and the best results of 1.999 and 1.786 t $hr^{-1}$, were obtained from the overlap among cultivars, and 0.9 mm clearance, for both cultivars AJ and M-33 respectively (Abu Khair et al., 2005; Aljibouri et al., 2021), while lowest results of 1.588 t $hr^{-1}$and 1.553 t $hr^{-1}$, were obtained from the overlap among machine type, and 0.5 mm clearance, for both cultivars AJ and M-33 respectively (Huang et al., 2001; Puri, and Sodhi 2014.

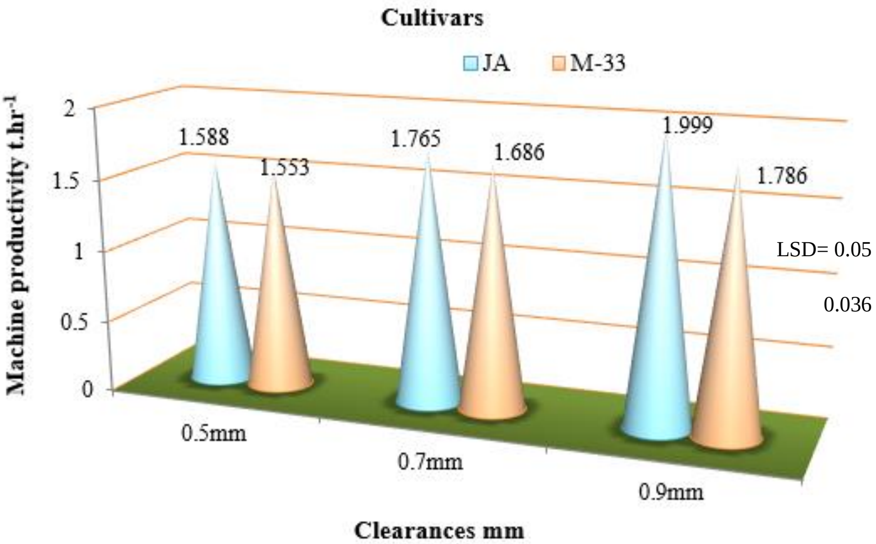


Figure 7 Effect of clearances and cultivars on machine productivity

The Figure 8, shows that the interaction between the machine type and the rice cultivars was significant, as it achieved the highest results in terms productivity were 1.827 t $hr^{-1}$ and 1.715 t $hr^{-1}$

respectively, When S-KB50 and Y-ST50 machines overlaps with the rice cultivar JA. While achieving the lowest productivity results were 1.748 t $hr^{-1}$ and 1.635 t $hr^{-1}$ respectively (Alsharifi et al., 2019a). When S-KB50 and Y-ST50 machines overlaps with the rice cultivar M-33.

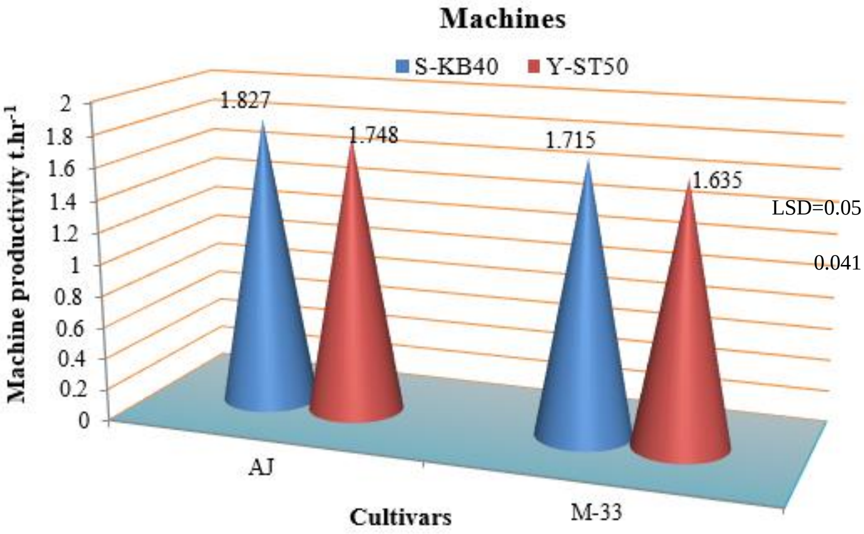


Figure 8 Effect of clearances and cultivars on machine productivity

### 3.2 Power required

Observed that the results in the statistical analysis for the Figure 9, for machine type factor was a highly significant effect on power required kW, it obvious that there were significant differences of the machine type, the Y-TS50 machine registered the highest values, while the treatment S-KB40 machine gave the lowest values, were 15.770 kW and 14.432 kW, respectively. The superiority of the power values in the S-KB40 machine compared to the Y-TS50 machine. The reason is due to the engineering design of the S-KB40 peeling machine and the worker skill, and this is consistent with (Singha, 2013).

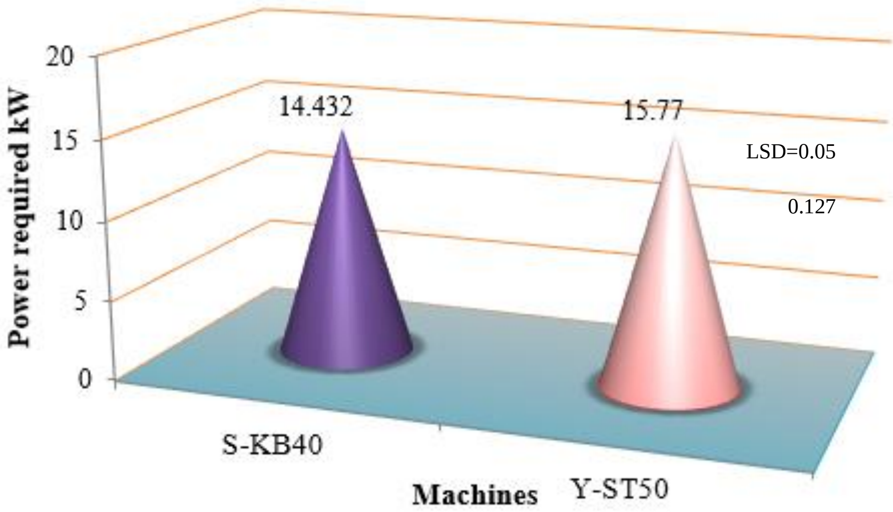


Figure 9 Effect of machine type on power required

While the effect of the rice cultivar on the power required values, as it appears from the results of the statistical analysis for Figure 10, there is a highly significant effect for two rice cultivars, that there are significant differences between all treatments. The treatment M-33 on record the highest value of 15.692 kW, while the treatment JA on record the lowest value of 14.510 kW, respectively. The reason for the high capacity in the JA variety is due to the physical characteristics of the variety in addition to the length and thickness of the grain. This is also consistent with (Alsharifi et al.,2017b).

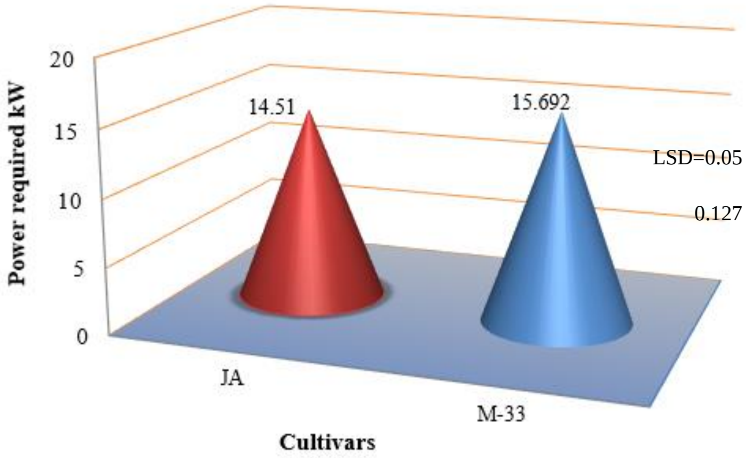


Figure 10 Effect of rice cultivars on power required

Appears from the results of the statistical analysis for the Figure 11, there is a highly significant effect, that there are significant differences between all treatments. The 0.5 mm clearance on record the highest value of 16.323 kW, followed by 0.7mm clearance which gave of 15.290 kW, while 0.9 mm on record the lowest value of 13.689 kW, respectively. The reason for the high power values is due to the convergence between the cylinders, with minimal effort on the rice grain inside the hulling chamber (Salim et al., 2021).

From Figure 12, the significant superiority for JA cultivar, as compared with the M-33 cultivar, that the variation in the power required machine values varies according to the clearances ratios between the husking cylinders. The highest significant differences were recorded between of the JA cultivar at clearance 0.9 mm, as compared with clearance coefficients 0.5 mm and 0.7 mm, all the interactions were significantly different and the best results of 12.848 kW and 14.533 kW, were obtained from the overlap among cultivars, and 0.9 mm clearance, for both cultivars AJ and M-33 respectively, while higher results of 15.865 kW and 16.781 kW, were obtained from the overlap among cultivars, and 0.5 mm clearance, for both cultivars AJ and M-33 respectively (Alsharifi et al., 2018).

The results shown of the statistical analysis for the Figure 13, effect of the commonality amongst the machine type and clearance between the cylinders on the power required. All the interactions were significantly different and the best results of 12.763 kW and 14.615 kW, respectively were obtained from the overlap among clearances and S-KB40 machine type (Taher ,2017), while higher results of 15.840 kW and 16.805 kW respectively, were obtained from the commonality amongst Y-ST50 machine type, for both clearances (Gbabo and Ndagi, 2014).

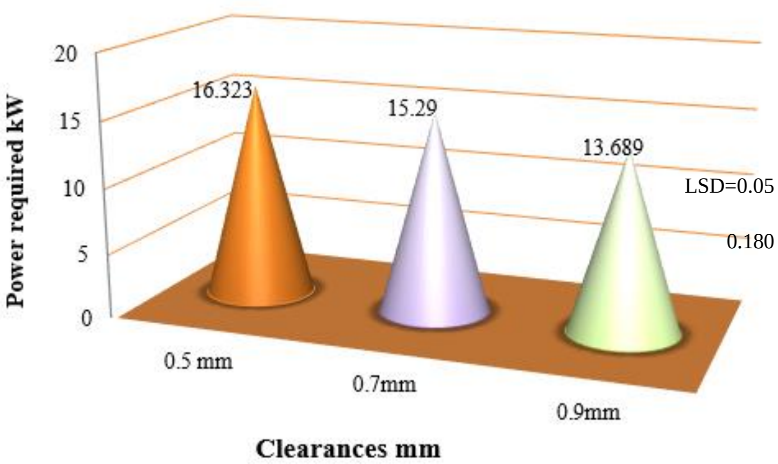


Figure 11 Effect of clearances on power required

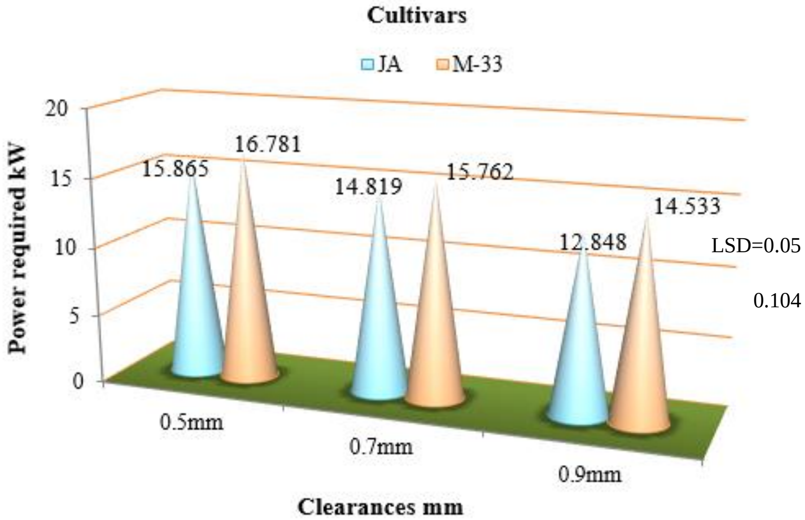


Figure 12 Effect of clearances and cultivars on power required

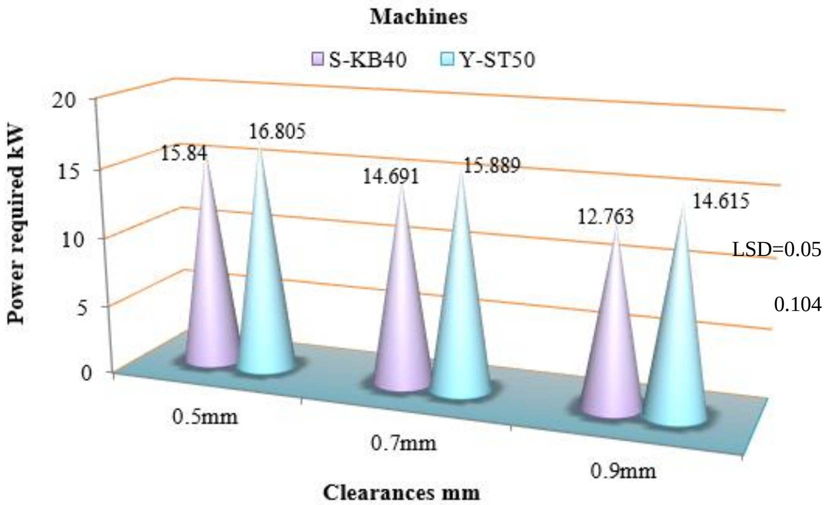


Figure 13 Effect of clearances and machines on power required

That the interaction between the machine type and the rice cultivars was significant, From Figure 14, when S-KB40 and Y-ST50 machines overlaps with the rice cultivar JA, achieved the minimal results in terms power required, were 13.913 kW and 14.950 kW respectively. While achieving the highest power required results were 15.176 kW and 16.472 kW respectively (Alsharifi et al., 2017a). When S-KB40 and Y-ST50 machines overlaps with the rice cultivar M-33.

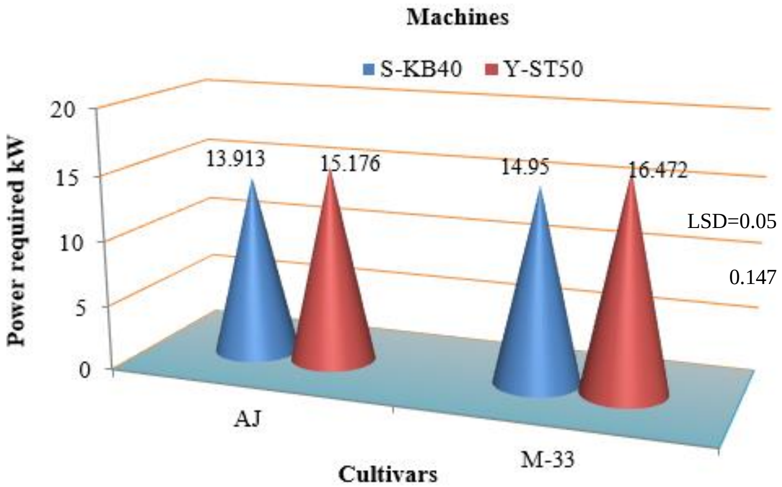


Figure 14 Effect of cultivars and machines on power required

### 3.3 Husking efficiency

From Figure 15, the treatment of the machine type (S-KB40) on record the higher ratio of 77.151%. In contrast, the Y-ST50 treatment gave the lowest ratio of 75.424%, respectively. The superior efficiency ratio for the S-KB40 machine compared to the Y-ST50 machine is due as to the engineering part for the designed hulling chamber, according to the rice grain size (Eliçin et al., 2022).

As for the effect of the rice variety on the husking efficiency values, as it appears from the results of the statistical analysis for Figure 16, there is a highly significant effect, that there are significant differences between all treatments. The cultivar JA on record the higher ratios of 77.151%, while the treatment cultivar M-33 on record the lowest ratios of 75.104%, respectively. The reason for the high husking efficiency is attributed to the JA variety, the extent of his handling of the peeling machine related to the length and thickness of the grains. (Alwan et al., 2016c).

Shows from the results of the statistical analysis for the Figure 17. The increasing of the clearance leads to the decrease of the efficiency and the results were 79.144%, 76.273% and 73.445% respectively. The reason for this is due to the increase in the peeling chamber gap through which the rice grain passes, and this allows the freedom of movement of the grain to extract the shell without any pressure on the grain when increasing the clearance (Alsharifi et al., 2019a).

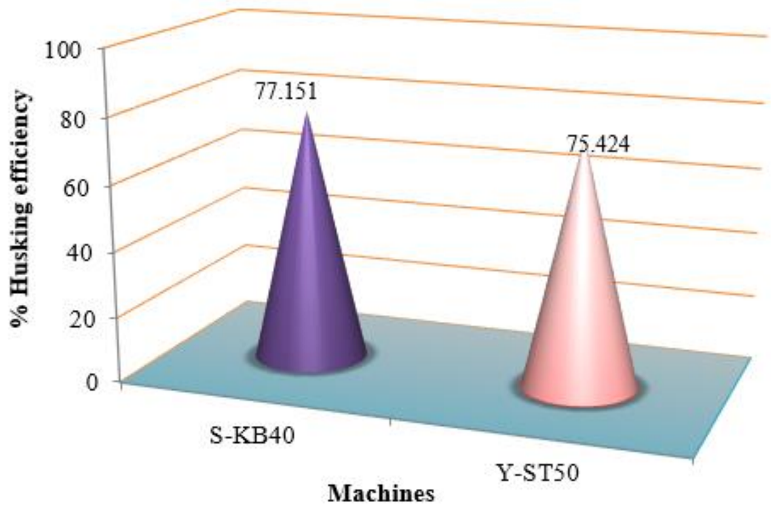


Figure 15 Effect of machine type on husking efficiency

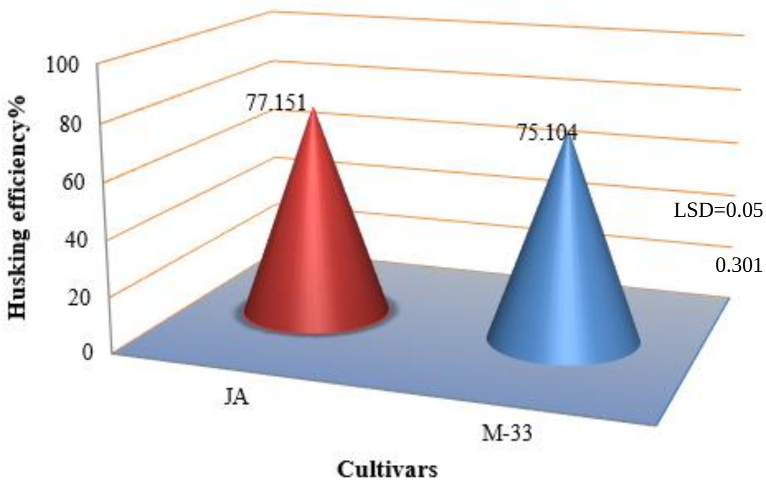


Figure 16 Effect of rice cultivars on husking efficiency

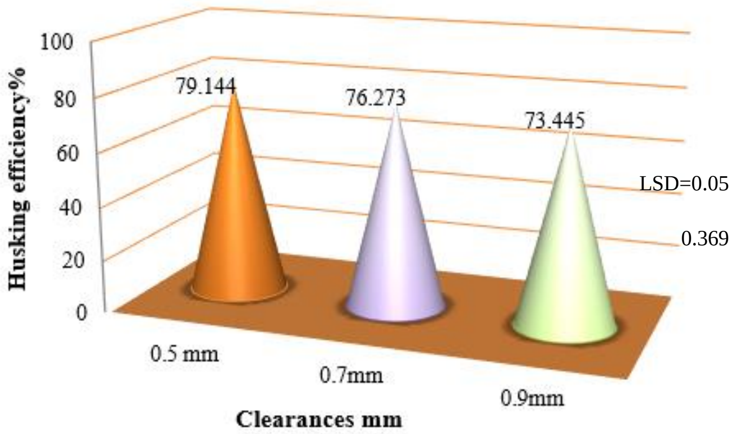


Figure 17 Effect of clearances on husking efficiency

From Figure 18, the significant superiority in the machine's efficiency to treat the S-KB40 machine type, as compared with the treatment of the Y-ST50 machine type, and that the variation in the threshing efficiency values varies according to the distance between the threshing cylinders. The highest significant differences were on record between the machine type at 0.5 mm clearance, and the lowest proportions with the clearance coefficients 0.7 mm and 0.9 mm. In general, the highest values were for the clearance treatment of 0.5 mm and were results 80.273% and 78.015% respectively, for the S-KB40 machine type (Alsharifi et al., 2019b), while the lowest ratios were results 73.955% and 72.935% respectively, for the 0.9 mm clearance treatment and the Y-ST50 machine type. The reason for this difference in values is due to the overlap between the S-KB40 and Y-ST50 machine type, and the clearance between the husking cylinders was more effective as a result of designing the peeling room to suit its clearance without stressing the grains during the manufacturing stage (Alsharifi et al., 2018).

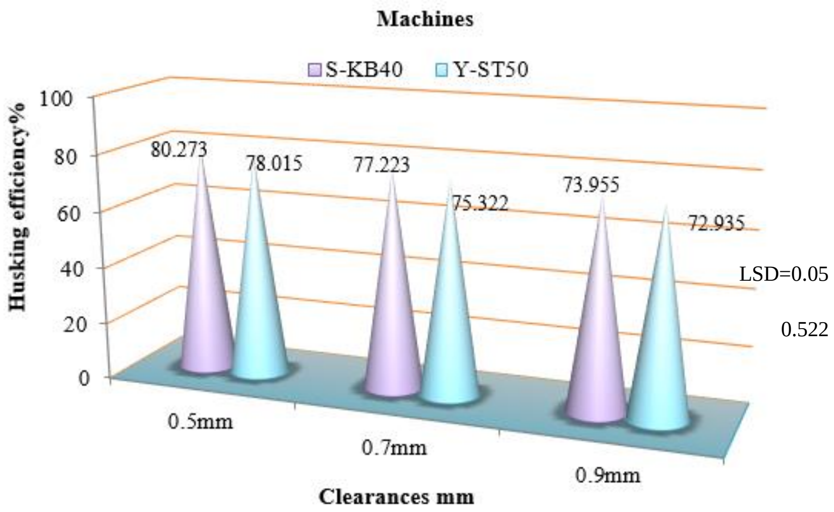


Figure 18 Effect of clearances and machines on husking efficiency

To infer from the Figure 19, the highest significant difference was observed between the rice cultivar with 0.5 mm clearance, while the least variation was when the treatment was 0.7 mm and 0.9 mm. The clearance 0.5 mm, the highest values of 80.545% and 77.743% respectively, for two cultivars of rice M-33, JA. While the lowest values were at clearance 0.9 mm were 73.955% and 72.935% respectively, for two cultivars of rice M-33 and JA.

That the interaction between the machine type and the rice cultivars was significant. From Figure 20, when S-KB40 and Y-ST50 machines overlaps with the rice cultivar M-33, achieved the minimal results in terms efficiency, were 75.403% and 74.806% respectively. While achieving the highest efficiency results were 78.878% and 76.042% respectively.

When S-KB40 and Y-ST50 machines overlaps with the rice cultivar JA. (Aljibouri and Alsharifi, 2019).

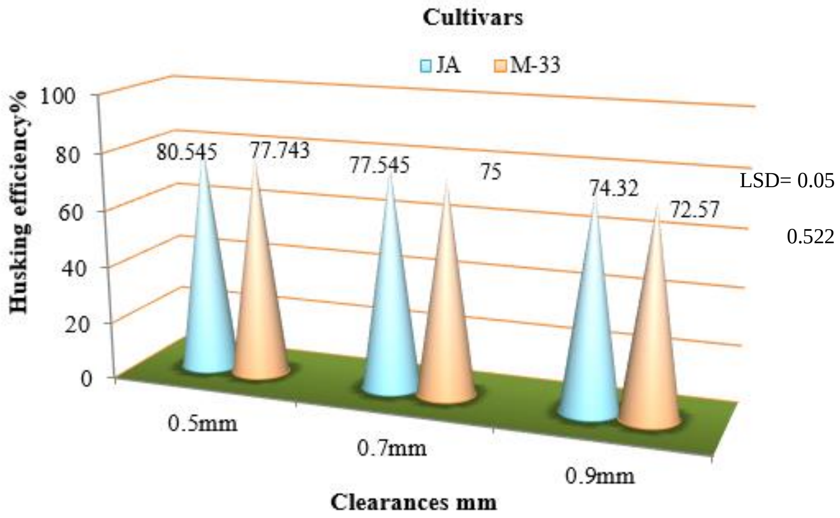


Figure 19 Effect of clearances and cultivars on husking efficiency

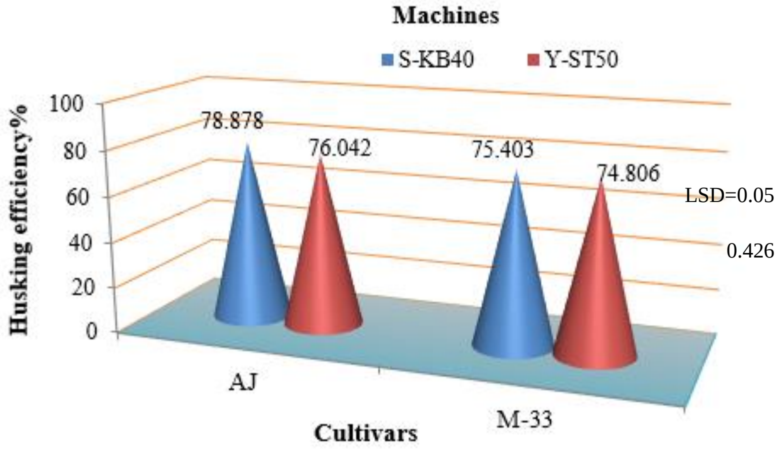


Figure 20 Effect of cultivars and machines on husking efficiency.

## 3. 4 Broken rice

The results shown in the statistical analysis table of the Figure 21, that there is a highly significant effect of the type of machine factor in the broken rice ratios, there are significant differences, as the treatment of the machine type Y-ST50 on record the highest broken ratio of 7.763%. In contrast, the S-KB40 treatment gave the lowest broken ratio 6.816%, respectively. The superiority of the broken rice ratio in the S-KB40 machine, compared to Y-ST50 machine type, due to homogeneity of machine work performance S-KB40 represented by the automated design of the peeling room by giving the lowest fracture ratios (Ali and Shatti, 2006: Alsharif ,2018).

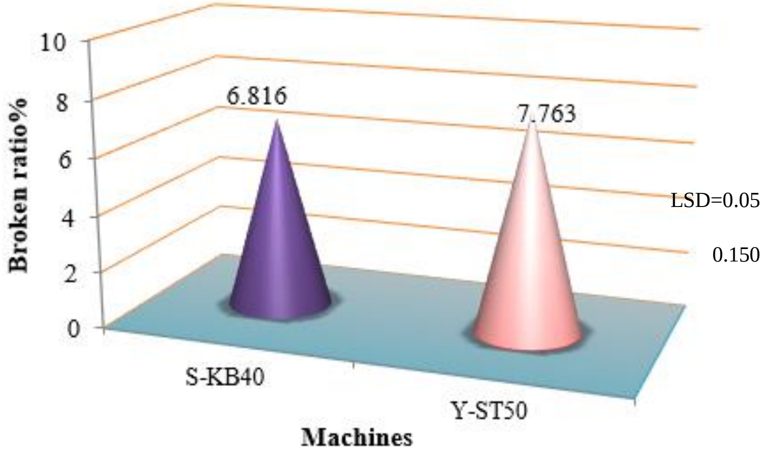


Figure 21 Effect of machine type on broken rice ratio

Shown in Figure 22. The clearance at 0.9 mm showed the minimal broken rice ratio of 6.304%, while the top broken rice ratio of 8.215% was for 0.5 mm clearance. Increasing the clearance inside the husking chamber gave freedom of movement of the grains while extracting the husks from them, it decreased its receding and friction in the husking chambers, and thus the broken rice ratio decreased (Chung et al., 2003; Alsharifi et al., 2017b).

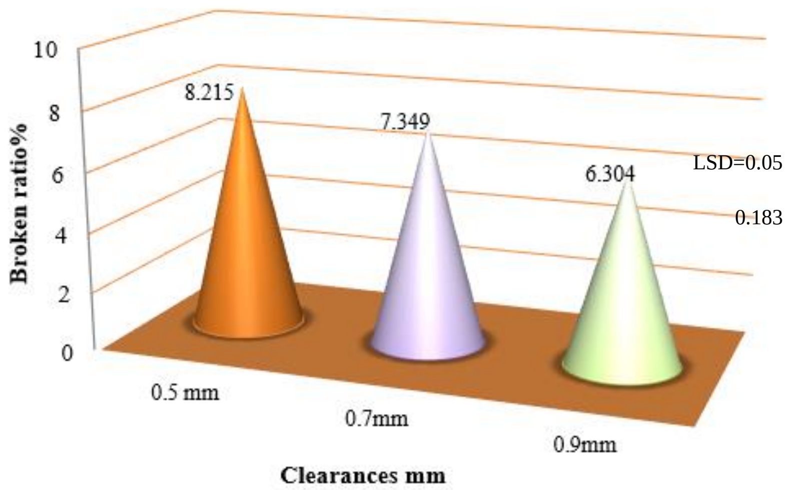


Figure 22 Effect of clearances on broken rice ratio

As for the effect of the rice variety on the values of broken rice, as it appears from the results of the statistical analysis of the Figure 23. The cultivar JA was significantly superior to the cultivar M-33, and the results were 6.772% and 7.807%. In this study is a guide to the suitability of rice cultivar with the study factors by giving the best fraction ratios for rice grains (Chu et al., 2022).

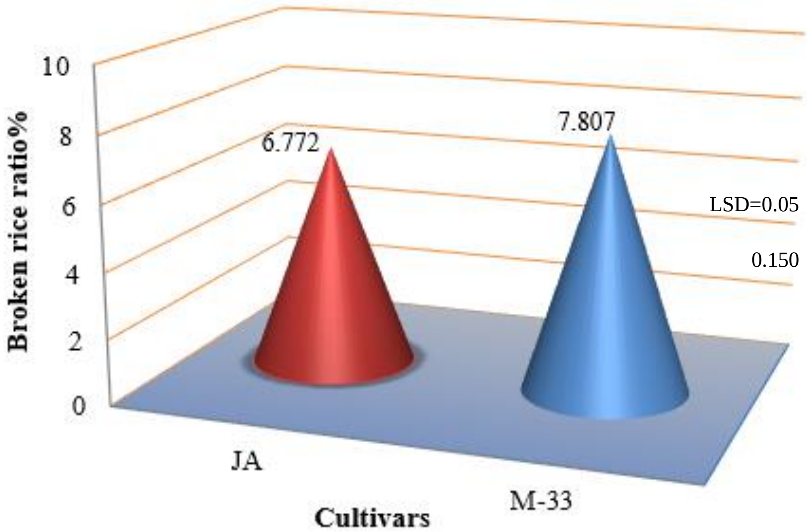


Figure 23 Effect of cultivars on broken rice ratio

That the interaction between the machine type and the rice cultivars was significant, From Figure 24, when S-KB40 and Y-ST50 machines overlaps with the rice cultivar M-33, achieved the high results in terms broken ratio, and were ratios 7.341% and 8.273% respectively. While achieving the minimal results were 6.291% and 7.253% respectively, when S-KB40 and Y-ST50 machines overlaps with the rice cultivar JA. Because of the compatibility between the S-KB40 machine type and JA cultivar, the percentage of mechanical impact decreased during the peeling process, and thus the broken rice ratio decreased

(Shwetha et al., 2011).

Figure 25, shown that the higher significant difference was amongst the machine type, at 0.9mm clearance, as compared with the 0.5 and 0.7mm clearances. The 0.9 mm clearance on record the lowest ratios of 5.855% and 6.754% respectively, for both machine type S-KB40 and Y-ST50. While the higher ratios were at clearance 0.5 mm were 7.646% and 8.785% respectively, for both machine type S-KB40 and Y-ST50. Because of the compatibility between the S-KB40 machine type and 0.9 mm clearance, the percentage of mechanical impact decreased during the peeling process, and thus the broken rice ratio decreased (Alsharifi et al., 2019a).

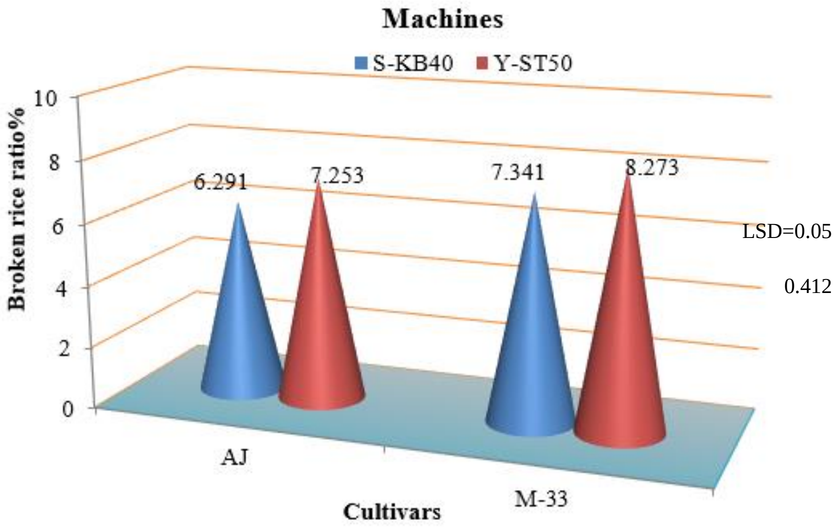


Figure 24 Effect of machines and cultivars on broken rice ratio

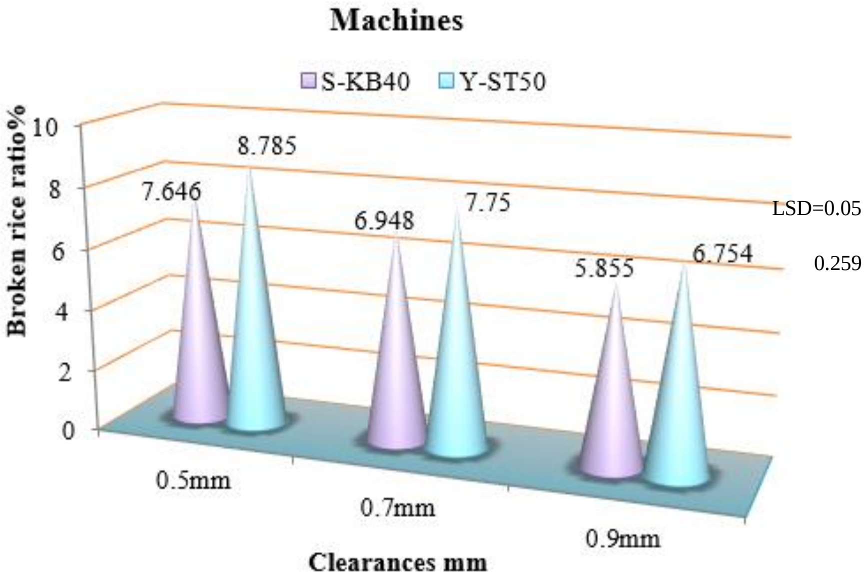


Figure 25 Effect of machines and clearances on broken rice ratio

Figure 26, shown that the significant variation was amongst the rice cultivars and clearances. The 0.9mm clearance done the minimal ratios of 5.982% and 6.626% respectively, due to interference for both rice cultivars JA and M-33 and clearance. While the higher ratios were at clearance 0.5 mm were 7.650% and 8.780% respectively, for both machine type S-KB40 and Y-ST50 and clearances. The reason for this is due to the characteristics of the variety, including the thickness and the length of the grain that is proportional to the clearance, which gave the lowest broken ratios (Aljibouri et al., 2021; Hamzah et al., 2021).

### 3.5 Head rice

Figure 27, It is particular that the rice head ratio of the S-KB40 machine 59.724% is significantly better thanY-ST50 machine 57.291%. The superior value of rice heads in the S-KB40 machine compared to the Y-ST50 machine is due to lack of mechanical effect on rice grains, which led to a decrease in the breakage ratio and an increase in the whole grain (Alsharifi, 2022).

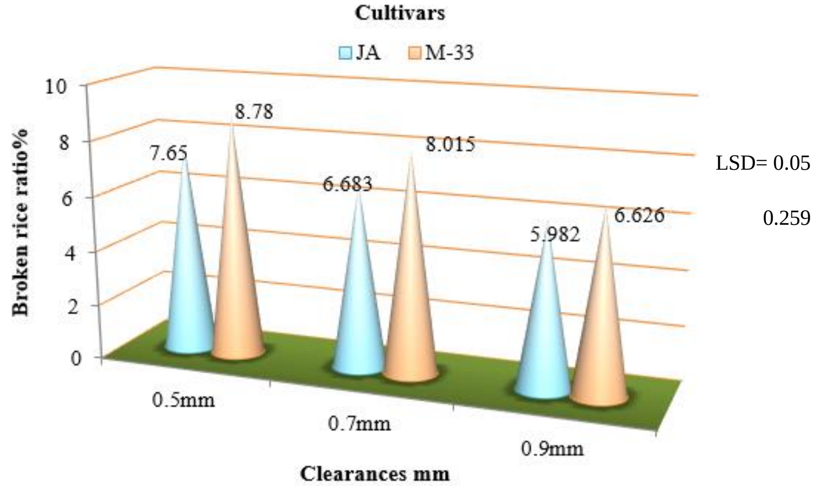


Figure 26 Effect of cultivars and clearances on broken rice ratio

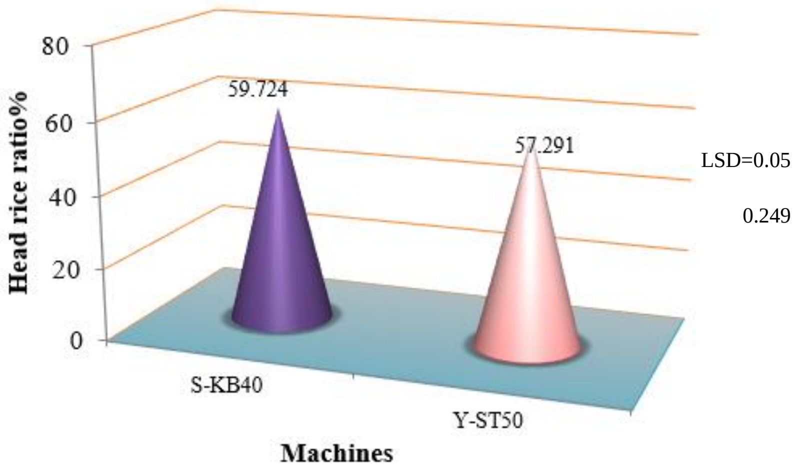


Figure 27 Effect of machine type on head rice ratio

Figure 28, It is particular that the rice head ratio of the JA cultivar of 59.853% is significantly better than M-33 of 57.162%. The superior value of rice heads in the JA cultivar compared to the M-33 cultivar is due to the JA cultivar bears the working conditions it is exposed to during the husk extraction stages from rice grains (Alwan et al., 2016a).

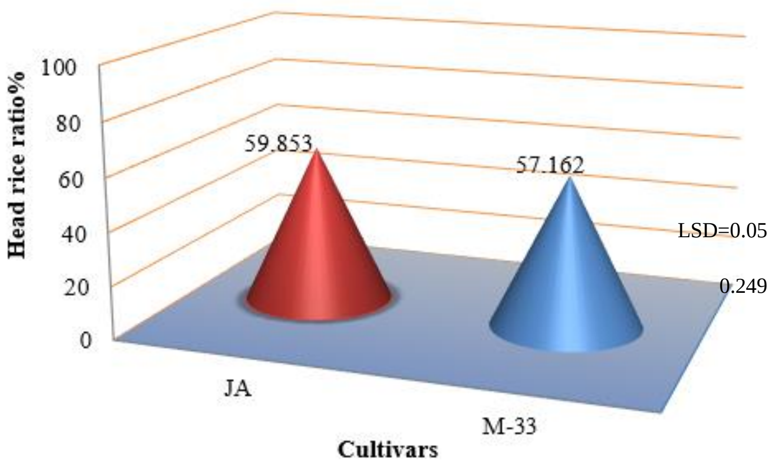


Figure 28 Effect of rice cultivars on head rice ratio

Shown in Figure 29, and table of the F- test. Appendix 4. The clearance at 0.9 mm showed the high head rice ratio of 61.563%, while the minimal head rice ratio of 54.851% was for 0.5mm clearance. Increasing the clearance inside the husking chamber gave freedom of movement of the grains while extracting the husks from them, it decreased its receding and friction in the husking chambers, and thus the broken rice ratio decreased and increasing head rice ratio (Eli çin et al., 2022).

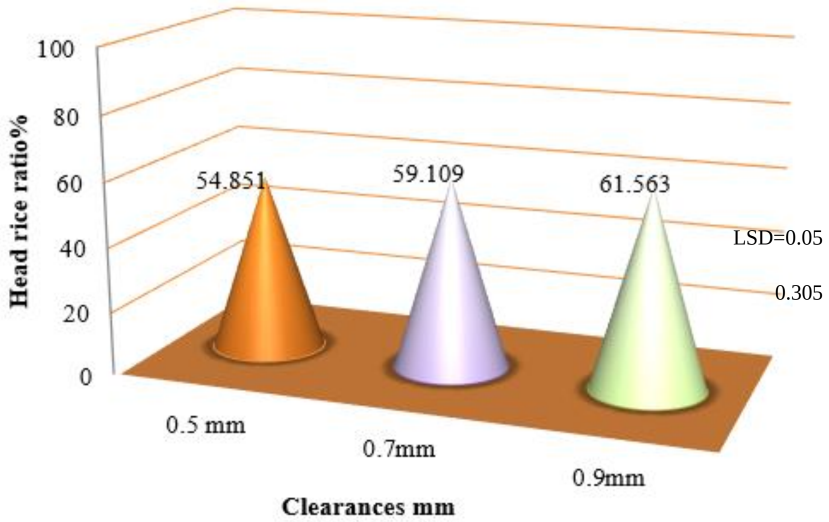


Figure 29 Effect of clearances on head rice ratio

That the interaction between the machine type and the rice cultivars was significant, From Figure 30, when S-KB40 and Y-ST50 machines overlaps with the rice cultivar M-33, achieved the minimal results in terms head rice ratio, and were ratios 57.615% and 56.628% respectively. While achieving the high results were 61.754% and 57.953% respectively, when S-KB40 and Y-ST50 machines overlaps with the rice cultivar JA. The reason for this is due to the mechanical compatibility of the peeling chamber with S-KB40 machine and the JA cultivar, Thus, the percentage of cracked and breakage of rice grains decreased and the head rice ratio increased (Alsharifi et al., 2017a).

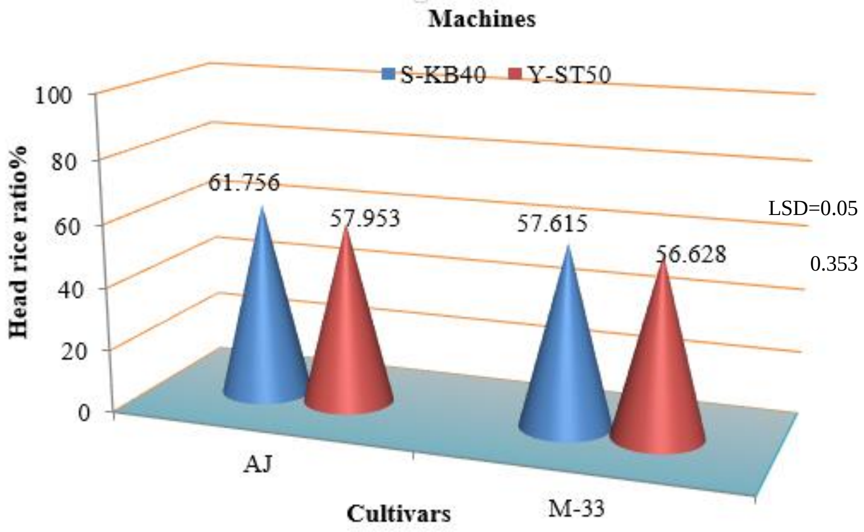


Figure 30 Effect of machines and cultivars on head rice ratio

From Figure 31. The better ratios of 62.655% and 60.471% and was obtained by S-KB40 and Y-ST50 type machines at 0.9mm clearance. While minimal ratios of 55.802% and 53.900%, due to interference between the type machines S-KB40 and Y-ST50 at 0.5mm clearance. It is caused by a decrease in breakage rates and an increase in head rice ratios with the use of S-KB40 machine type at 0.9 mm clearance (Alsharifi et al., 2017b).

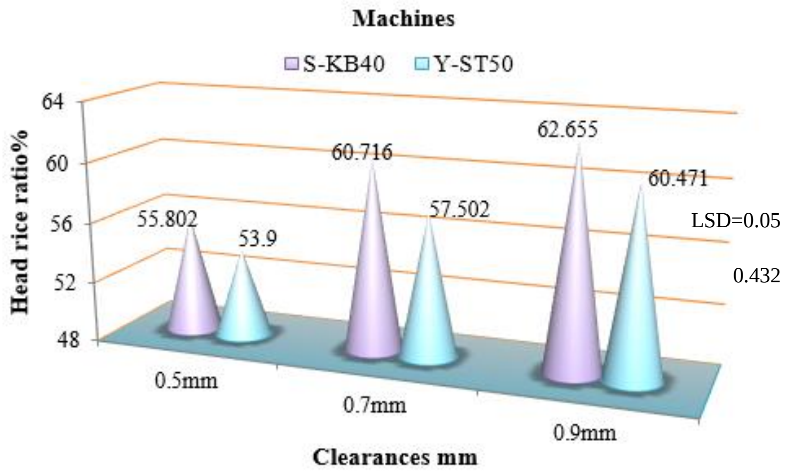


Figure 31 Effect of machines and clearances on head rice ratio

From Figure 32. The better ratios of 63.134% and 59.992% and was obtained by JA and M-33 cultivars at 0.9 mm clearance. While minimal ratios of 55.570% and 54.132%, due to interference between the JA and M-33 cultivars at 0.5mm clearance. It is caused by a decrease in breakage ratios and an increase in head rice ratios with JA cultivar at 0.9 mm clearance.

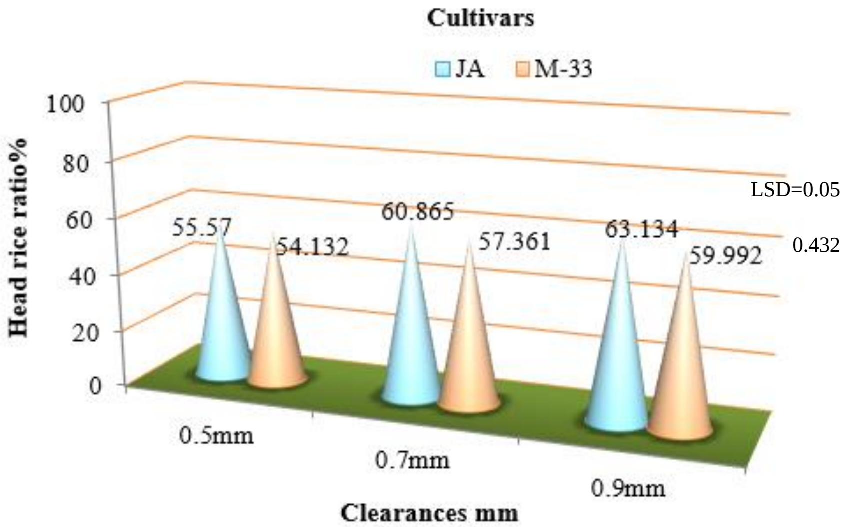


Figure 32 Effect of cultivars and clearances on head rice ratio

## 4 Conclusions

The S-BK40 type machine is significantly better than the Y-ST50 type machine in all studied conditions. The 0.9 mm clearance was significantly superior to the other two clearances of 0.5 and 0.7 mm. The results showed better conditions for the overlap between the S-KB40 type machine and JA cultivar and also for the overlap between the S-KB40 type machine and 0.9 mm clearance compared to the overlap of the Y-ST50 type machine with other clearances. The best result was obtained by S-KB40 type machine at 0.9 mm clearance for both two cultivars JA and M-33.

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