

DEVELOPMENT OF A TRACTOR-TRAILED RICE CLEANING AND MILLING MACHINE

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ABSTRACT

The aims of the present research are to develop and evaluate tractor-trailed rice-milling machine. The factors affecting the performance of the developed milling-machine feeding rate, drum speed, grain moisture-content were studied. The performance measurements were productivity, total machine cleaning efficiency, total grain-losses, power required, specific energy and operational cost. The experimental results reveal that the highest values of productivity and machine efficiency were 1.35 Mg/h and 97.3 %. Meanwhile, the minimum required power and the specific energy were 16.82 kW and 14.55 kWh/Mg respectively for tractor-mounted rice milling machine after development, The minimum operating cost was 32.71 L.E/Mg These values were achieved under conditions of feed rate of 1.25Mg/h, drum speed of 800 rpm and moisture content of 14%.

1. INTRODUCTION

The rice crop is the most important crop planted in Egypt after wheat. The average of rice-grain productivity per feddan was 4 tons. El-Raie et al. (1996) studied some mechanical properties of grains such as natural angle of repose, solid friction, hardness, average speeds of grain movement over a flat swing screen. They also studied some aerodynamic properties of grains and straw such as drag coefficient, drag force, terminal velocity, Reynolds number and moisture of grain. They determined the terminal velocity of wheat, rice and barley. They found that the terminal velocity ranged from 5.85 to 9.71 m/s for wheat, from 7.89 to 8.55 m/s for rice varieties, and 7.49 to 9.95 m/s for barley. Koide and Nishiyama (2001) measured the milling power and milling energy during abrasive milling under five rotor revolutions of 800, 1000, 1400, 1600 rpm using a batch type abrasive milling machine. Result indicated that the milling power decreased with milling time.

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Radwan (2001) showed that the mechanical damage occurring in rice grains during the milling process depends not only on the milling machine design but also on the physical properties of rice. Experiments were conducted to study the milling quality and energy consumption for five local rice varieties (Giza-181, Giza-177 and Giza-178, Yasmien and Sakha-102) at different levels of moisture content. The experimental result showed that, grain variety and moisture content had profound effects on energy consumption and grain quality. **Sotanabadi and Hemmat (2007)** showed that excessive rotation of rice, when the grains revolve inside the milling chamber, increase breakage. Ease of grain movement in the milling chamber could minimize this problem by utilizing screw conveyor at the first part of rotor. In rotor of a conventional milling was equipped with a screw conveyor. The effects of two rotor types (modified and conventional rotors), three output rates of 421,654 and 915 kg/h and three blade distances from the agitator 11, 12 and 13mm were examined on indices of rice quality. Their results showed that only the effect of blade distance on percentage of breakage was significant and the effect of feed rate on all measured parameters was also significant. In addition, the interaction effects of rotor and blade distance, rotor type and feed rate on percentage of whole white rice and breakage were significant respectively. The milling performance index showed that the best condition for both rotors can be obtained at output rate of 421 kg/h and 11 or 12 mm blade distance from the agitator. For this adjustment the average of percentage of breakage in the modified and conventional rotors were 20.5 and 23, respectively. **Morad et al (2013)**, found that the highest values of machine productivity and overall machine efficiency were 1.08, 1.17 and 1.35 Mg/h; and 95.00, 95.38 and 95.66 % for Sakha-101, Giza-171 and Sakha-105 varieties, respectively, while the lowest values of required power and specific energy were 13.0, 13.4 and 13.8 kW; and 17.40, 15.68 and 13.85 kW.h/Mg, respectively, for the same rice varieties, furthermore the lowest values of both operational and criterion costs were 8.53, 7.87 and 6.82 L.E./Mg; and 35.96, 31.96 and 29.38 L.E./Mg, respectively, for the same rice varieties. From the experimented

results, it could be concluded that the optimum operating parameters for the developed milling machine were found at: Drum speed of about 800 rpm for Sakha-101 and 850 rpm for both Giza-171 and Sakha-105 varieties. Grain moisture content of about 14 % for Sakha-101 and 15 % for both Giza-171 and Sakha-105 varieties.

The objectives of this study are to

- Develop of a rice-grin milling machine.
- Study the effect of some performance factors of developed rice-milling machine such as feeding rate, drum speed and grain moisture-content on machine productivity, cleaning efficiency, grain-losses, power required and specific energy.
- Calculate the operational cost of using the developed rice-grain milling machine.

2. MATERIALS AND METHOD

The main experiments were carried out at private farm in Sharkia Governorate.

2.1. MATERIALS:

2.1.1. The used crop: was rice crop with variety of Sakha 101 was used.

2.1.2. Rice Milling Machines:

2.1.2.1 The rice-grain milling machine before modification.

The rice-grain milling machine before modification consists of the following parts: frame, three hitching points, milling unit (hopper, milling drum, concave) and fixed inclined-sieve. The photograph of the milling machine before modification was shown in Fig. 1.

2.1.2.2 The rice-grain milling machine after modification.

The rice-grain milling machine after modification consists of the following parts:

- **Frame:** It was made of I-section iron. The total length and width of frame are 1500 and 2850 mm respectively.
- **Ground wheels:** rubber wheel has diameter of 640 mm and width of 180 mm. The ground-wheel spacing is 2000 mm.



Fig. (1): Rice-grain milling machine before modification.

- **Draw-bar pull:** made of iron plate with length of 1120 mm, width of 100 mm and thickness of 100 mm. The edge of pull bar has a hole with diameter of 50 mm.

First paddy rice-grain hopper: was made of sheet steel with 2 mm thickness. The hopper top has a square shape with dimensions of 500 x 500 mm. The hopper bottom has a triangular shape with dimensions of -240 x 550 x 460 mm length, width and height respectively. The slope of the hopper side-wall is 45 degree which more than the friction angle between rice grain and hopper wall (29 degree).

-**First conveying belt with buckets:** a vertical first-belt conveys the rice grain under hopper to the first sieves-unit. The first vertical conveying belt was made of rubber with width of 200 mm, thickness of 10 mm and length of 3600 mm. The 12 buckets were fixed with the belt by rivets. The buckets spacing is 150 mm.

-The first sieves-unit: consists of upper and lower sieves. The upper sieve separates the impurities such as plant stems and husks. The lower sieve separates the rice grain on the top and the grass seeds and small soil particles pass through its holes. The grass seeds and small soil clods drop on a solid sieve which exit it from the machine. Reciprocating-speed of the first sieves-unit is 335 rpm . The upper and lower sieves made of perforated iron-sheet with thickness of 1 .mm, length of 1950 mm, width of 600 and height 230 mm. The upper sieve has slotted holes with dimensions of 450 x 50 mm. The lower sieve has round holes with diameter of 2 mm. The first sieves-unit inclined angle 8 degree.

- Second paddy rice-grain hopper:

- The paddy rice-grain drops from first sieves-unit to the second hopper. The second hopper was made of sheet steel with 2 mm thickness. The hopper top has a square shape with dimensions of 400 x 300 mm. The hopper bottom has a triangular shape with dimensions of 50 x 310 x 290 mm. length, width and height respectively. The slope of the hopper side-wall is 45 degree which more than the friction angle between rice grain and hopper wall (29 degree).

- Second conveying belt with buckets: a vertical second-belt conveys the rice grain under from second hopper to the milling-unit. The second vertical conveying belt was made of rubber with width of 200 mm, thickness of 10 mm and length of 4500 mm. The 15 buckets were fixed with the belt by rivets. The buckets spacing is 150 mm.

- Milling unit: The milling unit was exist in the milling machine before modification. The milling unit consists of the following parts:

(a) Hopper: The paddy rice-grains after cleaning by first sieves units are dropped to the milling-unit hopper by the second conveying-belt. The hopper was made of sheet steel with 2 mm thickness. The hopper top has a square shape with dimensions of 460 x 460 mm and height of 430 mm. The hopper bottom has 150 mm height with side-wall slope of 45 degree.

(b) Milling drum:

(c) Concave:

- **The second sieves-unit:** consists of upper and lower sieves. The upper sieve separates the damage milled grains. The lower solid sieve separates exit the damaged grains from the machine and collected in a container. The upper and lower sieves made of perforated iron-sheet with thickness of 1 mm, length of 1500 mm, width of 500 and height 150 mm. The upper sieve has a holes diameter of 1.5 mm. The second sieves-unit inclined angle 6 degrees.

Reciprocating-speed of the second sieves-unit is 270 rpm.

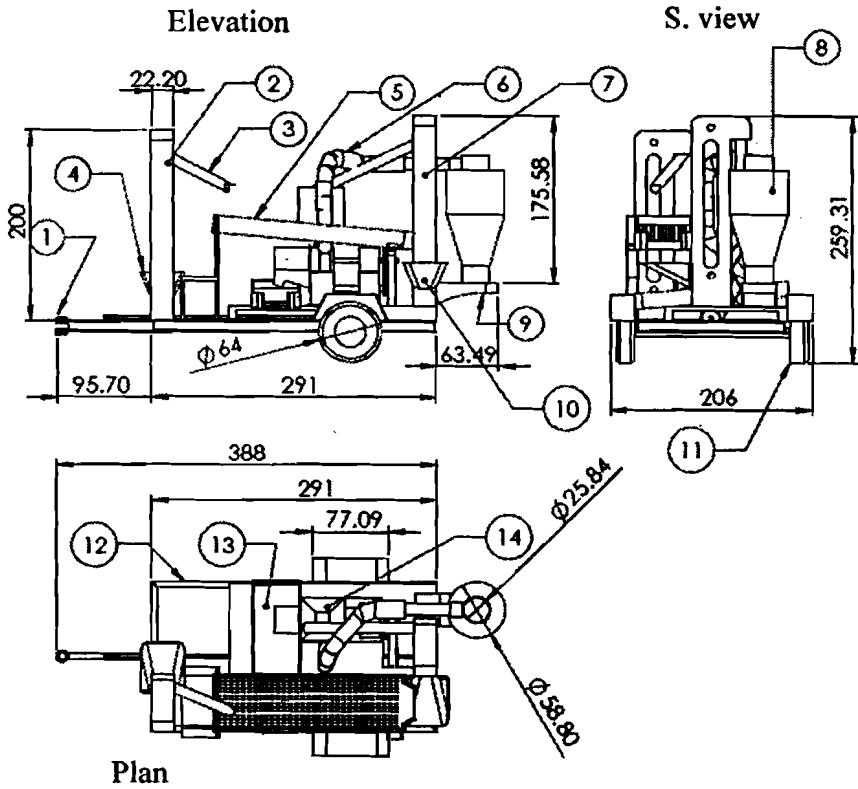
The photograph, isometric and views of the milling machine after modification are shown in Figs. 2, 3, and 4.

2.1.2. Tractor.

A four wheel tractor of the standard type was used as a power source



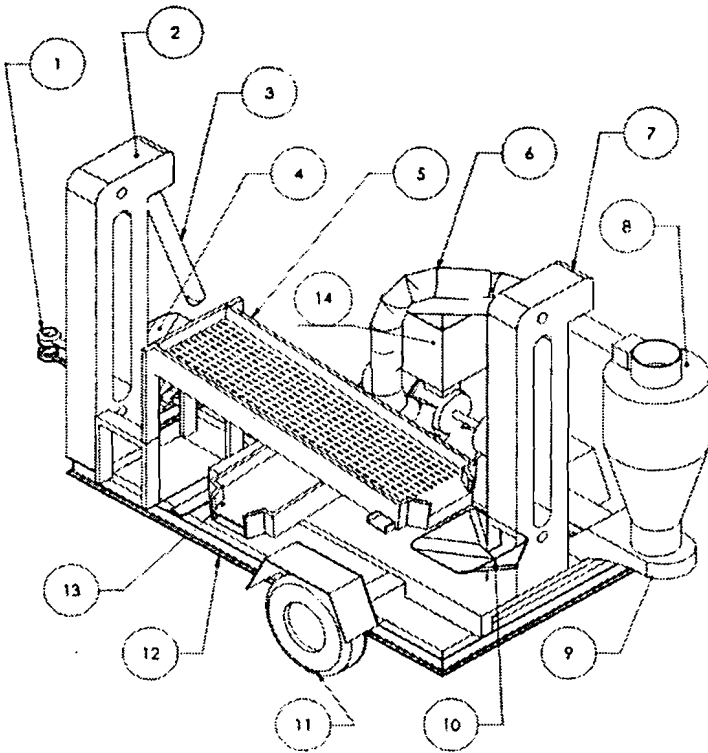
Fig.(2): Tractor-mounted rice milling machine after development.



All Dimensions in cm

- | | |
|--|---------------------------------------|
| 1-Draw-pull bar. | 2- First conveying belt with buckets. |
| 3-Out let of grain. | 4- First paddy rice-grain hopper. |
| 5-First sieves-unit. | 6-Conveying tube. |
| 7- Second conveying belt with buckets. | 8-Bran turning hopper. |
| 9- Bran out let. | 10- Second paddy rice-grain hopper. |
| 11-Ground wheel. | 12- Frame. |
| 13- Second sieves-unit. | 14- Milling-unit hopper. |

Fig.(3) : The three Views of the tractor-mounted rice milling machine after development



- | | |
|--|---------------------------------------|
| 1-Draw-pull bar. | 2- First conveying belt with buckets. |
| 3-Out let of grain. | 4- First paddy rice-grain hopper. |
| 5-First sieves-unit. | 6-Conveying tube. |
| 7- Second conveying belt with buckets. | 8-Bran turning hopper. |
| 9- Bran out let. | 10- Second paddy rice-grain hopper. |
| 11-Ground wheel. | 12- Frame |
| 13- Second sieves-unit. | 14- Milling-unit hopper. |

Fig.(4):Isometric of the tractor-mounted rice milling machine after development

with the following specifications: model Naser 65, Engine type diesel, 4 cylinders, Power at rated speed 65 hp (48 KW) P.T.O revolution, rpm 540-1000 and Mass 2250 (Kg). was used to operate the developed milling machine.

2.2. METHODS:

2.2.1. Experimental conditions:

Experiments were conducted under multi variables: four grain moisture contents (20, 18 ,16 and 14%) - four feeding rates (1, 1.25, 1.5 and 1.75 Mg) and four drum speeds (650, 800, 950 and 1050 rpm) for tractor-mounted rice milling machine after development.

2.3. MEASUREMENTS:

Evaluation of the performance of the used developed rice milling machine was based on the following indicators:

•Total grain losses:

Total grain losses includes both unshelled grain losses and broken grain losses. The percentage of total grain losses was calculated using the following equation:

$$\text{Total grain losses} = \text{unshelled grain losses} + \text{broken grain losses} \quad (1)$$

The percentage of unshelled grains (Unsh_g):

$$\text{Unsh}_g = \frac{\text{Mass of unshelled rice grains in the sample}}{\text{Total mass of the sample}} \times 100 \quad (2)$$

•The percentage of broken grains (Bg):

$$\text{Bg} = \frac{\text{Mass of broken rice grains in the sample}}{\text{Total mass of the sample}} \times 100 \quad (3)$$

•Machine efficiency (Me):

Machine efficiency was calculated using the following equation:

$$\text{Me} = \frac{\text{Output grain mass from milling operation in the sample}}{\text{Total mass of the sample}} \times 100 \quad (4)$$

•Machine productivity:

Machine productivity was determined by the following equation:

$$\text{Mp} = \frac{\text{Ms}}{t}, \text{ Mg/h} \quad (5)$$

Where: Mp = machine productivity, Mg/h.

Ms = mass of sample, Mg.

t = time consumed in the milling operation, h.

• Cleaning efficiency.

cleaning efficiency was calculated by the following:

$$\text{Cleaning efficiency, \%} = \frac{M - M_c}{M} \times 100 \quad (6)$$

Where: M= Mass of sample before cleaning, g

Mc= Mass of sample after cleaning, g

• Fuel consumption

Fuel consumption per unit time was determined by using a calibrated tank (Refilling method) to measure the volume of fuel consumed during the operation time.

• Required power

The following formula was used to estimate the required power. (Hunt, 1983).

$$RP = [f.c(1/3600)PE \times L.C.V \times 427 \times \eta_{thb} \times \eta_m \times 1/75 \times 1/1.36], kW \quad (7)$$

Solving equation the consumed energy can be calculated as following:

$$RP(\text{Diesel}) = 3.16 f.c. , kW \quad (8)$$

Where: f.c = The fuel consumption, (l/h).

PE = The density of fuel, (kg/l), (for Diesel = 0.85).

L.C.V = The lower calorific value of fuel, (11.000 k.cal/kg).

η_{thb} = Thermal efficiency of the engine (35 % for Diesel).

427 = Thermo-mechanical equivalent, (kg.m/k.cal).

η_m = Mechanical efficiency of the engine (80 % for Diesel).

• Specific energy:

Specific energy for the milling operation can be calculated as follows:

$$\text{Specific energy} = \frac{\text{Required power}}{\text{Machine productivity}}, kW.h/Mg \quad (9)$$

• Criterion cost:

The criterion cost required for the threshing and cleaning operation was estimated using the following equation (Awady, 1982):

$$\text{Criterion cost} = \text{operating cost} + \text{grain losses cost}, L.E./Mg \quad (10)$$

• Operational cost:

The operational cost was determined from the following formula:

$$\text{Operating cost} = \frac{\text{Machine cost}}{\text{Machine productivity}}, L.E./Mg \quad (11)$$

The machine cost is determined by using the fixed and variable costs calculation.

3. RESULTS AND DISCUSSION

The obtained results will be discussed under the following items.

3.1: Effect of different operating parameters on the productivity of the developed rice milling machine.

Representative values of machine productivity versus feed rate, drum speed and grain moisture content were illustrated in Fig.(5) Concerning to the effect of feed rate on the machine productivity. Increasing feed rate from 1.0 to 1.75 Mg/h, machine productivity increased from 0.775 to 1.25Mg/h at constant drum speed of 800 rpm, and constant moisture content of 14%.

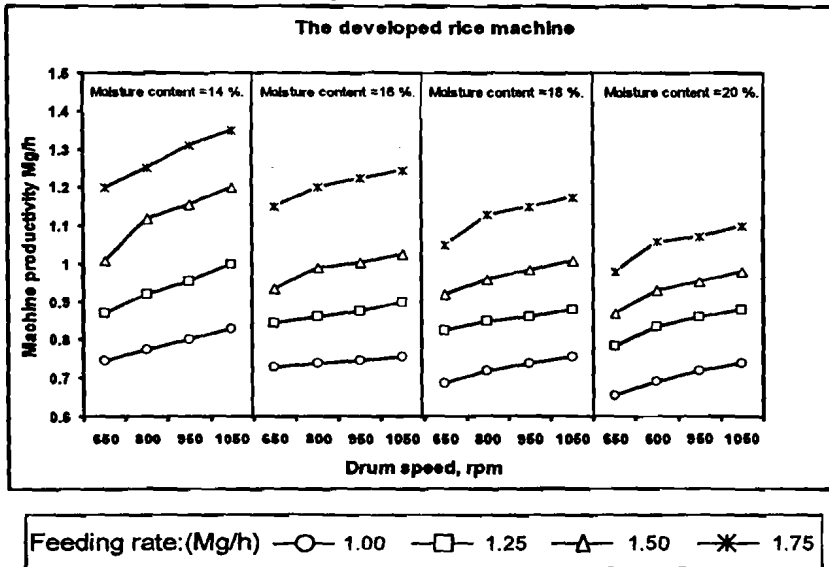


Fig.(5): Effect of different operating parameters on the productivity of the developed rice milling machine.

Regarding the effect of drum speed on machine productivity increasing drum speed from 650 to 1050 rpm, machine productivity increased from 0.870 to 1.00 Mg/h at constant feed rate of 1.25 Mg/h and grain moisture content of 14 %. Concerning the effect of grain moisture content on machines productivity, increasing grain moisture content from 14 to 20 %, the machines productivity decreased from 0.920 to 0.835 Mg/h at constant feed rate of 1.25 Mg/h and constant drum speed of 800 rpm. The machine productivity increased by increasing grain moisture content is due to the increase in weight of grains.

3.2 Effect of different operating parameters on efficiency of the developed rice milling machine.

Representative values of machine efficiency versus feed rate, drum speed and grain moisture content were presented in Fig.(6) Concerning the effect of feed rate on overall machine efficiency, increasing feed rate from 1.00 to 1.25 Mg/h the machine efficiency increased from 96.90 to 97.30 % , .

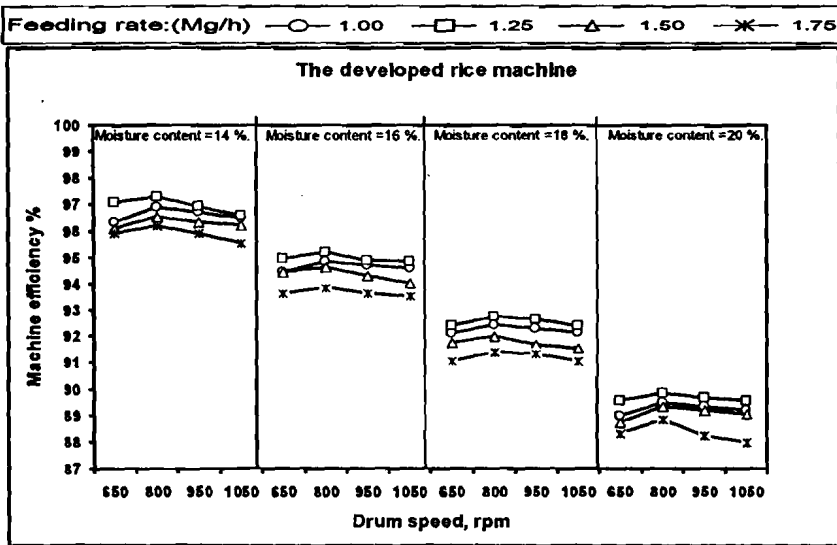


Fig.(6): Effect of different operating parameters on the efficiency of the developed rice milling machine

Any further increase in feed rate more than 1.25 up to 1.75 Mg/h decreased machine efficiency from 97.30 to 96.20 % at constant drum speed of 800 rpm and grain moisture content of 14 %. Regarding the effect of drum speed on machine efficiency, increasing drum speed from 650 to 800 rpm the overall machine efficiency increased from 97.10 to 97.30 % , . Any further increase in drum speed more than 800 up to 1050 rpm decreased machine efficiency from 97.30 to 96.60 % at constant feed rate of 1.25 Mg/h and grain moisture content of 14 %. The increase in machine efficiency in the range from 650 to 800 rpm is attributed to the high stripping and impacting forces applied to the grains, that tend to improve milling operation. While the vice versa is noticed in the range from 800 to 1050 rpm due to the increase in grain losses.

Concerning the effect of grain moisture content on machine efficiency, increasing grain moisture content from 14 up to 20% decreased machine efficiency from 97.30 to 89.85 % at constant drum speed of 800 rpm and feed rate of 1.25 Mg/h at the same previous conditions. Values of grain moisture content more or less than the optimum value tend to decrease machine efficiency because of increasing the total grain losses.

3.3 Effect of different operating parameters on the cleaning efficiency of the developed rice milling machine.

From the pre experiments, in materials and method chapter and also the optimum sieve speed for the rice grains, sieve speed cleaning final for the rice and sieve inclination were determined and adjusted at 350 rpm, 270 rpm and 10 deg, respectively to be suitable for operating the cleaning unit attached with the rice milling machine to maximize its efficiency and rice quality. Representative values of machine cleaning efficiency versus feed rate, drum speed and grain moisture content are represented in Fig.(7) Concerning the effect of feed rate on cleaning efficiency, increasing feed rate from 1.00 to 1.25 Mg/h, the cleaning efficiency increased from 97.40 to 98.05 %, . Any further increase in feed rate more than 1.25 up to 1.75 Mg/h decreased cleaning efficiency from 98.05 to 97.35 % at constant drum speed of 800 rpm and grain moisture content of 14 %.

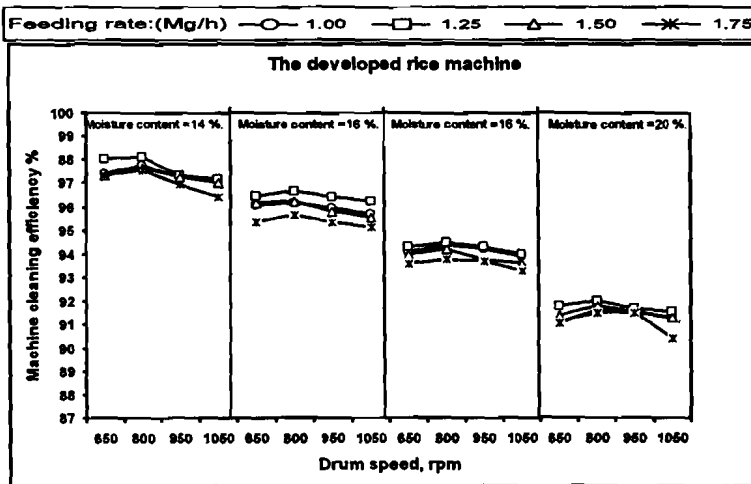


Fig.(7): Effect of different operating parameters on the cleaning efficiency of the developed rice milling machine.

Regarding the effect of drum speed on cleaning efficiency, increasing drum speed from 650 to 800 rpm the machine cleaning efficiency increased from

97.40 to 97.75 %, . Any further increase in drum speed more than 800 up to 1050 rpm decreased cleaning efficiency from 97.40 to 97.05 % at constant feed rate of 1.25 Mg/h and grain moisture content of 14 %.

The increase in the efficiency of the cleaning device in the range of 650-800 rpm at feeding rate of 1.25 Mg/h and moisture content of 14% which were considered the most appropriate factors with a sieve grain main speed due to the disposal of a greater amount of impurities present with the grain as well as the disposal of a greater amount of broken grain through a sieve final cleaning of the rice grains after the milling process and vice versa at high speeds of 800-1050 rpm, due to the increase in grain losses.

Concerning the effect of grain moisture content on cleaning efficiency, increasing grain moisture content from 14 up to 20%, decreased cleaning efficiency from 98.10 to 92.00 % at constant drum speed of 800 rpm and feed rate of 1.25 Mg/h, at the same previous conditions. This is due to the high moisture content of grain impurities stick and are difficult to be separated as well as increasing broken grain at high- drum speed.

3.4 Effect of different operating parameters on total grain losses of the developed rice milling machine.

Representative values of unshelled grains, broken grains and total grains losses versus feed rate, drum speed and grain moisture content are illustrated in Fig.(8).

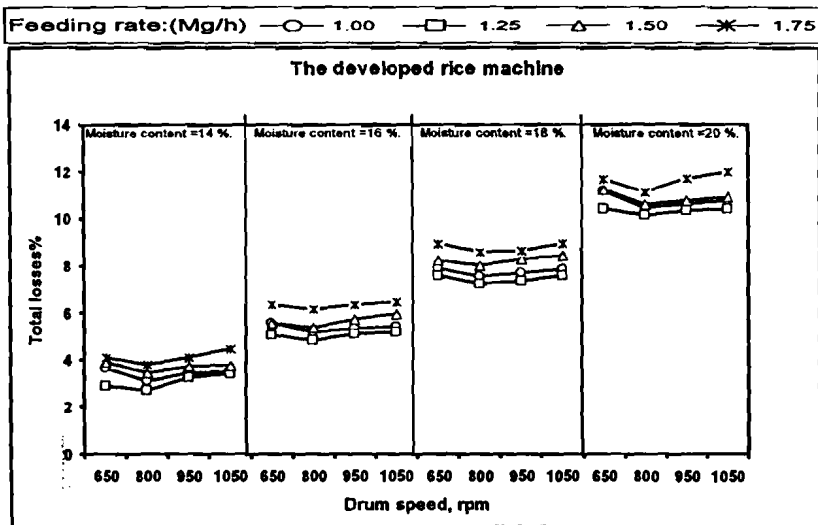


Fig.(8): Effect of different operating parameters on total grain losses of the developed rice milling machine.

Concerning the effect of feed rate on the total grain losses, increasing feed rate from 1.0 to 1.25 Mg/h, the total grain losses decreased from 3.10 to 2.70%. Any further increase in feed rate more than 1.25 up to 1.75 Mg/h increased total grain losses from 2.70 to 3.80 % at constant drum speed of 800 rpm and grain moisture content of 14 %. Increasing feed rate led to increase unshelled grains due the excessive

grains in the milling unit, consequently the material leave the device without adequate milling that tends to increase unshelled grains. So, the total grain losses including both broken grains and unshelled grains are essential to establish optimum working conditions. Relating to the effect of drum speed on the total grain losses, Fig.(8) shows that, increasing drum speed from 650 to 800 rpm, the total grain losses decreased from 2.90 to 2.70 % .

Any further increase in drum speed more than 800 up to 1050 rpm increased total grain losses from 2.70 to 3.40 % at constant feed rate of 1.25 Mg/h and grain moisture content of 14 %. The increase in broken grains by increasing drum speed is due to the high impacting force applied to the grains by the drum slices. While the decrease in unshelled grains by increasing drum speed is attributed to the high stripping and impacting forces applied to the grains, that tended to improve milling operation and decrease unshelled grains. With respect to the effect of grain moisture content on the total grain losses, results in Fig.(8) show that, increasing grain moisture content from 14 to 16 % the total grain losses increased from 2.70 to 4.80 % . Any further increase in grain moisture content more than 14 up to 20 % increased total grain losses from 2.70 to 10.15 % at constant drum speed of 800 rpm and feed rate of 1.25 Mg/h. Higher values of grain moisture content more than the optimum value 2.70 % , tend to increase the total losses because of increasing unshelled grains by increasing grain moisture content. On the other side, the lower values of grain moisture content less than the optimum value 2.70 , tend to increase total grain losses due to the increase in broken grains by decreasing grain moisture content.

3.5 Effect of different operating parameters on required power of the developed rice milling machine.

Values of both required power and specific energy versus feed rate, drum speed and grain moisture content are represented in Fig.(9) and Fig.(10) Relating to the effect of feed rate on required power and specific energy,

increasing feed rate from 1.00 to 1.75 Mg/h, the required power increased from 16.82 to 18.62 kW, while the specific energy decreased from 21.70 to 14.55 kW.h/Mg, at constant drum speed 800 rpm and grain moisture content of 14 %. As to the effect of drum speed on required power and specific energy, increasing drum speed from 650 to 1050 rpm, the required power increased from 17.10 to 18.30 kW, while the specific energy decreased from 19.65 to 18.30 kW.h/Mg, at constant feed rate of 1.25 Mg/h and grain moisture content of 14 %.

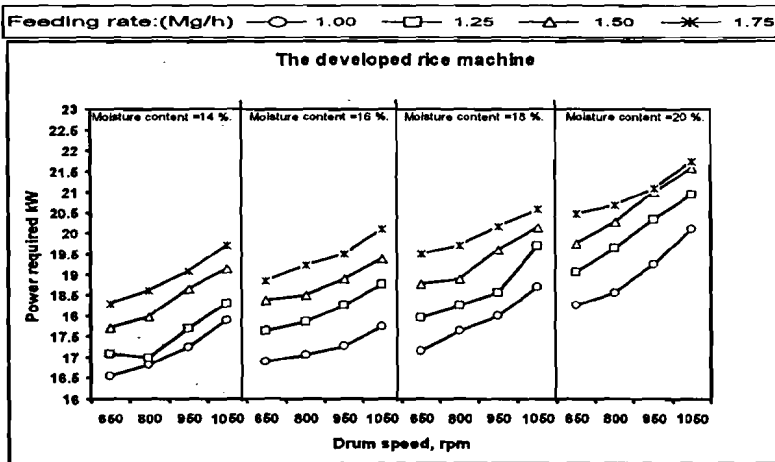


Fig.(9): Effect of different operating parameters on required power of the developed rice milling machine.

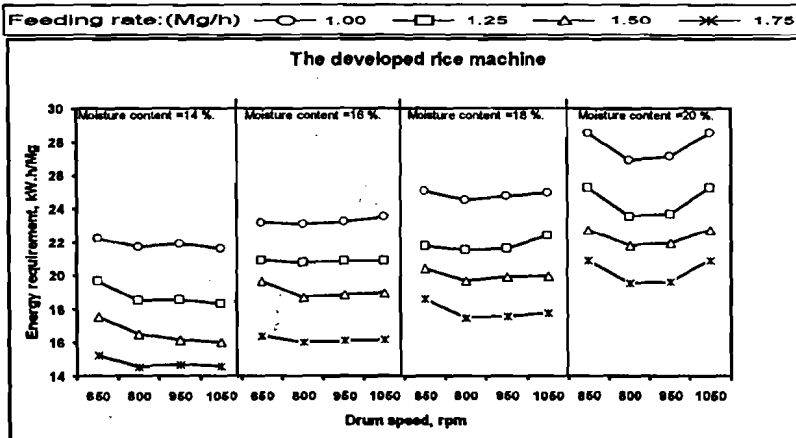


Fig.(10):Effect of different operating parameters on energy requirement of the developed rice milling machine.

Power increased by increasing drum speed mainly because the increase in drum speed is frequently accompanied by appreciable increase in fuel consumption, that tends to increase required power. In relation to the effect of grain moisture content on required power and specific energy, obtained results show that increasing grain moisture content from 14 to 20 %, the required power increased from 17.00 to 19.63 kW, while the specific energy increased from 18.47 to 23.50 kW.h/Mg, at constant drum speed of 800 rpm and feed rate of 1.25 Mg/h. The increase in both power and specific energy by increasing grain moisture content is attributed to the excessive load of grains on the machine devices which consumed more energy.

3.6 Effect of different operating parameters on operational and criterion cost of the developed rice milling machine.

A complete cost analysis was made at different operating conditions and related with machine productivity. The resulting operating cost was found to be affected by both feed rate and power.

Representative values of criterion cost versus feed rate, drum speed and grain moisture content are present in Fig.(11) and Fig.(12) The criterion cost was the sum of operational cost and grain losses cost. Concerning to the effect of feed rate on the criterion cost, increasing feed rate from 1.00 to 1.25 Mg/h the criterion cost decreased from 38.83 to 32.71 L.E/Mg .

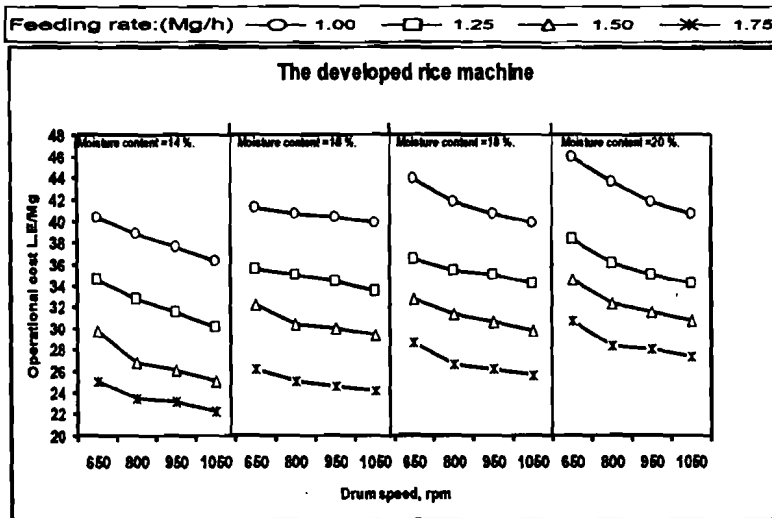


Fig.(11): Effect of different operating parameters on operational cost of the developed rice milling machine.

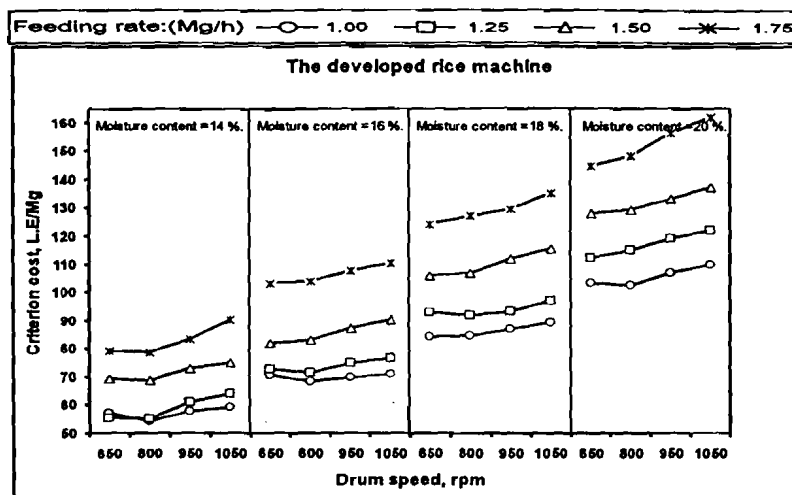


Fig.(12): Effect of different operating parameters on criterion cost of the developed rice milling machine.

Any further increase in feed rate more than 1.25 up to 1.75 Mg/h increased criterion cost from 32.71 to 78.74 L.E/Mg, at constant drum speed of 800 rpm and grain moisture content of 14 %. Relating to the effect of drum speed on the criterion cost, increasing drum speed from 650 to 800 rpm the criterion cost decreased from 57.29.75 to 54.94 L.E/Mg . Any further increase in drum speed more than 800 up to 1050 rpm increased criterion cost from 54.94 to 64.10 L.E/Mg at constant feed rate of 1.25 Mg/h and grain moisture content of 14 %.

With Regard to the effect of grain moisture content on the criterion cost, increasing grain moisture content from 14 to 20% the criterion cost increased from 54.94 to 114.85 L.E/Mg.

Both higher and lower values of drum speed, feed rate and grain moisture content more or less than the optimum value tend to increase criterion cost due to the increase in total grain losses.

4. CONCLUSION

- From the obtained results, the following conclusions can be taken: The highest values of machine productivity and machine efficiency were 1.350 Mg/h; and 97.30 %, respectively.
- The highest values of machine cleaning efficiency were 98.05 %, was achieved under speeds of sieve cleaning primary, sieve cleaning final, and drum speeds 335, 270, and 800 rpm respectively.

- The lowest values of required power and specific energy , were 16.54 kW; and 14.60 kW.h/Mg, under conditions of feed rate of 1.25Mg/h, drum speed of 800 rpm and moisture content of 14%.
- The lowest values of both operational and criterion costs were 22.29 L.E./Mg; and 90.17 L.E./Mg, under conditions of feed rate of 1.25Mg/h, drum speed of 800 rpm and moisture content of 14%.

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الملخص العربي

تطوير آلة معلقة خلف الجرار لتنظيف وتبييض الأرز.

د. عادل أحمد الجيزاوي*

يعتبر محصول الأرز من أهم المحاصيل المنزرعة في مصر بعد القمح كما انه اعلي المحاصيل من حيث الإنتاجية حيث تصل إنتاجية الفدان في المتوسط إلي ٤ طن تقريبا ومع ذلك فان الفاقد من المحصول أثناء عملية الضرب يعتبر كبير إلي حد ما حيث انتشرت المضارب الثابتة وكذلك المضارب المعلقة خلف الجرار

*باحث - معهد بحوث الهندسة الزراعية - مركز البحوث الزراعية مصر.

وتقوم هذه المضارب بعملية بدون أساس علمي مما ينتج عنه فوائد كثيرة متمثلة في الحبوب المكسورة والحبوب غير المكسورة وبالتالي تقل القيمة النقدية للمنتج من الأرز الأبيض. وكان من أهداف هذه الدراسة:

- الهدف الرئيسي هو تطوير آلة ضرب الأرز المعلقة خلف الجرار لتكون آلة متعددة الأغراض لتنفيذ عمليات التغذية والغرلة والتبييض ميكانيكياً .
- دراسة عوامل أداء آلة ضرب الأرز مثل معدل التغذية، وسرعة الدرفيل و تأثير محتوى الرطوبة على الإنتاجية، وكفاءة تنظيف الحبوب و خسائر الحبوب ، والطاقة المطلوبة و الطاقة المحددة.

- دراسة تكاليف التشغيل لآلة ضرب الأرز.

* تم تصنيع وحدة تغذية أولية تنقل حبوب الأرز إلى وحدة الغرلة الرئيسية الخاصة بالحبوب قبل عملية الضرب ثم وحدة تغذية نهائية تنقل حبوب الأرز بعد الغرلة إلى قادوس آلة ضرب وتبييض الأرز وأخيراً وحدة غرلة نهائية لتنظيف الأرز الأبيض الناتج من عملية الضرب وتم تثبيت آلة ضرب الأرز والوحدات السابقة على مقطورة مزودة بعجلتين متصلة بالجرار . ومصدر القدرة لهذه الآلة هو عمود الإدارة الخلفي للجرار (جرار نصر ٦٥ حصان -٤٨ كيلوات)

أجريت التجارب الرئيسية على آلة ضرب الأرز المطورة وهي تتكون من قادوس ملحق به سير سقاية لنقل الحبوب الى غربال ذو حركة ترددية يوضع فيه حبوب الأرز ليقوم بعملية تنظيف ابتدائية ثم تنقل الحبوب بعد التنظيف إلى قادوس ملحق به سير سقاية آخر يعمل على نقل الحبوب إلى قادوس آلة ضرب الأرز حيث تتم عملية التغذية ألياً وبعد ذلك يتم استقبال الأرز من خلال فتحة في آخر المضرب حيث يمر على غربال شبكي ذو حركة ترددية للتخلص من الحبوب المهروسة والشوائب كعملية تنظيف نهائية . تم عمل العديد من التجارب الأولية لاختيار السرعة المناسبة لغربال الحبوب الرئيسي وغربال الأرز الأبيض الناتج من عملية الضرب. وقد تم تقييم الآلة المطورة من خلال بعض عوامل التشغيل وذلك عن طريق استخدام ٤ سرعات للدرفيل - ٤ معدلات تليم - ٤ محتوى رطوبة للحبوب المستخدمة وذلك للوصول الى معدلات التشغيل المثلى مما يعطى اعلى جودة وأقل تكلفة وريحية عالية.

وقد أوضحت النتائج المتحصل عليها أن أفضل القيم المتحصل عليها أثناء التشغيل كانت كالتالي

* أعلى إنتاجية وكفاءة لآلة ضرب الأرز كانت ١.٣٥٠ ميجاجرام/الساعة و ٩٧.٣ % .
* أعلى كفاءة تنظيف كانت ٩٨.٠٥% عند سرعة درفيل ٨٠٠ لفة/الدقيقة ومحتوى رطوبة ١٤% وسرعة غربال الحبوب وغربال الأرز ٣٣٥ و ٢٧٠ على التوالي.
* أقل قدرة وطاقة نوعية كانت ١٦.٥٤ كيلو وات و ١٤.٦٠ كيلو وات. ساعة/ميجاجرام على الترتيب.

* أقل تكاليف تشغيل كانت ٣٢.٧١ جنيه/ميجاجرام وأقل تكاليف حديدية كانت ٥٤.٩٤ جنيه/ميجاجرام. عند سرعة درفيل ٨٠٠ لفة/الدقيقة ومحتوى رطوبة ١٤% ومعدل تغذية ١.٢٥ ميجاجرام/الساعة.