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PERFORMANCE EVALUATION OF TWO LOCAL RICE THRESHING MACHINES

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ABSTRACT

Comparative study between two types of rice threshing locally manufactured machines (long-axial flow machine-"Barmeel" and spike teeth cylinder machine-"El-nassala") was carried out. Experiments were conducted in terms of total losses, purity percentage, power requirement and criterion cost as a function of change in both drum speed and input capacity.

Barmeel rice thresher was operated at different drum speeds of 21.51, 24.64 and 26.70 m/s. , and different input capacities of 1.80, 2.00, 2.25 and 2.50 ton/h.

El-nassala rice thresher machine was operated at different drum speeds of 18.30, 20.15 and 22.60 m/s., and different input capacities of 1.20, 1.40, 1.60 and 1.80 ton/h.

The experimental results reveal that both total losses and cost were minimum under the use of Barmeel rice thresher comparing with El-nassala rice thresher. But Barmeel rice thresher consumed more power comparing with El-nassala rice thresher.

- Drum speed of 24.64m/s., and input capacity of 2.25 ton/h. are recommended for operating Barmeel rice thresher.
- Drum speed of 20.15 m/s., and input capacity of 1.60 ton/h. are recommended for operating El-nassala rice thresher.

INTRODUCTION.

The ultimate purpose of threshing operation is to recover the seeds free from residues with minimum losses and maximum efficiency. Many investigations were carried out to study the variables affecting threshing machines

Dragos (1975) showed that the grain losses decreased when the cylinder peripheral speeds are in the range from 25 to 30 m/s for threshing wheat and barley. He also added that damage was generally low when the grain moisture content was high. Surya et al., (1982) concluded that running a combine at a relatively high cylinder speed with a relatively low concave clearance will result in low (optimal) machine losses in the high moisture range when the feed rate is correspondingly low.

Abou El-Kheir (1987) studied the effect of peripheral drum speed at the range of 3.14 to 6.91m/s on the two grain varieties (Mixed-balady and Giza 3)

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of faba beans. Experiments were run at the range of normal moisture level to determine both threshing and cleaning efficiencies. Results showed that both threshing and cleaning efficiencies increased and total losses decreased with the increase in drum speed.

Helmy (1988) compared between two threshing machines. Three cylinder speeds (11, 20.52 and 36.65m/s), five feed rates (0.06, 0.13, 0.19, 0.25 and 0.31kg/s) over ranges of 13.6 to 18.8% and 7 to 13.5% grain and straw moisture contents of wheat were used. The threshing efficiency, unit energy, total grain damage unthreshed grain and cut straw 99.1%, 1kw.h/t, 0.86 %, 6.5% and 22.5% respectively at 20.52m/s cylinder speed and 0.25kg/s feed rate for 18.8% and 13.5% grain and straw moisture contents are considered optimum conditions of the local threshing machines.

Morad (1997) investigated threshing machine performance in terms of grain losses, energy requirements, and threshing cost as a function of change in feed rate, cylinder speed, and grain moisture content during threshing wheat. From the obtained data it can be concluded that threshing losses as well as threshing cost can be minimized when the feed rate of 1ton/h, drum speed of 25m/s, and moisture content of 20% are considered for the used machine.

Awady,et.al.,(2000). Evaluated the performance of "Bermeel" rice thresher, the best performance was at 550 rpm, which gave minimum criterion cost and acceptable cleaning efficiency ranging from 95.61 to 96.98% and threshing capacity of 2.68t/h.

Chlebowski, (2000). Studied the effect of threshing parameters on amaranth grain contamination using a threshing drum on a specially designed research stand. Results showed that an increase in threshing drum speed from 15.7 to 30.1 m/second caused an increase in grain contamination by 10% on average. Threshing parameters (drum speed, concave clearance, type of concave and drum, and moisture content of the plants), as well as the moisture content of the amaranth feed, had a significant effect on amaranth grain contamination.

El-Behery, et. al., (2000). Tested the feasibility of using El-Shams rice thresher as dual purpose machine to obtain seeds and stalks from flax (Linum usitatissimum) crop was tested. The threshing was performed using a range of drum speeds, feed crop rates and the lengths of conveyor chain tension at four different levels of capsule moisture contents. Results of the experiments indicated that for optimum performance, the threshing drum speed, feed rate and the length of conveyor tension should be approximately 31.43 m/s, 20 kg/min and 48 mm, respectively at 18.45% moisture content of capsules. Seed damage was not of an economically importance level (1.78%). The optimum fuel consumption values were 3.70 lit/h and 3.08 lit/ton. at 31.43 m/s drum speed and 20 kg/minute feed rate. The average cost of flax threshing was 16.23 L.E/t compared with 50 L.E/t for manual threshing.

So, the objectives of this research are to carry out a comparison between two types of rice threshers (long-axial-flow machine, "Barmeel" rice thresher). and (spike teeth cylinder, "El-nassala" rice thresher machine). and optimize some operating parameters such as feeding rate and drum speed which affect their performance.

MATERIALS AND METHODS

Experiments were carried out at a small farm, Donasher, Mahala, Garbiah, Governorate, during threshing rice variety (SAKA101 short grain japonica).at moisture content of 16% .

All experiments were conducted using two types of rice thrashing locally manufactured machines. Both machines consist of two components: threshing and winnowing unites of grain.

Machines specification.

- Barmeel rice thresher(Fig.1).

The thrashing unit consists of a drum (375cm length and 100cm. diameter) is beater type with 104 free chain flails (48cm. long, 3cm. width and 1cm. thickens) the concave consists of three parts for fine and coarse separation, made of perforated sheet metal of 100x162 cm.

The winnowing unit is suction type air-screen cleaner. It consist of screen and suction housing is centrifugal with radial straw thrower blades.

- El-nassala rice thresher(Fig.2).

The thrashing unit consists of a drum and concave with holes. thrashing drum (120cm length and 60cm. diameter) is spike teeth type. The dimensions of the tooth are 10mm. thickness and 3.5cm. length . The spacing between two teeth is 50mm. The concave has round holes (18mm. hole diameter) and fitted with teeth similar to those on the drum.

The winnowing unit consists of a fan, screen, and air elevator. Holes of the screen are of 14mm. Diameter.

The general specifications of the two used machines are tabulated in Table(1)

Table (1) The general specifications of tow threshing machines

Machine type	Overall dimension	Drum type	Power driven
Barmeel thresher.	559 x 223 x155	Flails chine	PTO:540rpm, 50kW
El-nassala	385x 190 x 250	spike teeth	PTO:540rpm, 50kW

Threshing by Barmeel rice thresher was carried out at different drum speeds of 21.51, 24.64 and 26.70 m/s. and different input capacities of 1.80, 2.00, 2.25 and 2.50 ton/h. at a constant grain moisture content of 16%

Threshing by El-nassala rice thresher was carried out at different drum speeds of 18.30, 20.15 and 22.60 m/s., and different input capacities of 1.20, 1.40, 1.60 and 1.80 ton/h. at a constant grain moisture content of 16%

All treatments were replicated three times to give more reliable averages.

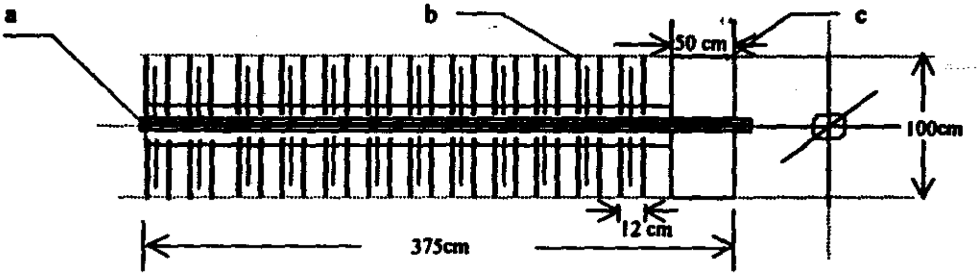

Fig. (1) Drum of Barmeel thresher

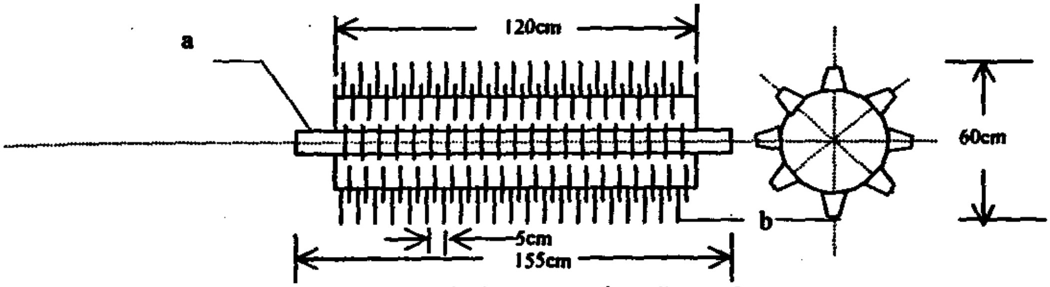

Fig. (2) Drum of El-nassala thresher.

The performance of the two types of rice threshing locally manufactured machines was evaluated taking into consideration the following indicators:

1- Broken grain percentage (Br %) :

Broken rice was measured by the following formula:

$$Br\% = \frac{W_b}{W_t} \times 100$$

Where: W_b mass of the broken in the sample, g.

W_t mass of the total sample, g.

2-Unthreshed paddy percentage (U_{nt}%)

The unthreshed paddy was measured by the following formula:

$$U_{nt}\% = \frac{W_{unt}}{W_t} \times 100$$

Where: W_{unt} mass of unthreshed paddy in the sample, g.
W_t mass of total sample

3- Husked percentage (h%) :

Husked percentage was measured by the following formula:

$$h\% = \frac{W_h}{W_t} \times 100$$

Where W_h mass of the husked paddy in the sample, g.
W_t mass of the total sample, g.

4- Total losses percentage (T_L %)

The total losses sample consists of husked paddy, broken, unthreshed paddy and paddy mixed with the straw from straw outlet. It was measured by the following formula:

$$T_l\% = \frac{W_h + W_{pm} + W_b + W_{unt}}{W_t} \times 100$$

Where: W_h mass of the husked paddy in the sample, g.
W_b mass of the broken grin in the sample, g.
W_{unt} mass of unthreshed paddy in the sample, g.
W_{pm} mass of paddy mixed with the straw from straw outlet discharge, g.
W_t mass of the total sample, g.

5- purity percentage (P %)

The paddy sample consists of fine straw, clay, fine stone and fine materiel all of these effect on purity percentage. It was measured by the following formula:

$$P\% = \frac{W_t - (W_{sm} + W_c + W_f)}{W_t} \times 100$$

Where: W_f mass of the fine materiel in the sample, g.
W_{sm} mass of straw mixed with the threshed paddy from out let discharge, g.
W_c mass of the clay and stone in the sample, g.
W_t mass of the total sample, g.

6-power requirements:

Estimation of the required power to operate each machine was carried out by accurately measuring the decrease in fuel level in the fuel tank immediately after executing each operation .

The required power was calculated by using the following formula: (Barger, et al. 1963). $p(hp) = w_f \times c.v. \times \eta_{th} \times {427}/{75}$

where: W_f – rate of fuel consumption (kg/sec) C.V-calorific value of fuel in kcal/kg. (average C.V of solar fuel is 10000kcal/kg)

427-thermo mechanical equivalent , kg.m/kcal.

η_{th} -thermal efficiency of the engine (considered to be 30% for diesel engines).

7-Criterion cost :

The cost of mechanical processes was calculated by using the fixed and variable cost method. The operational cost was determined by using the following equation

Operational cost (L.E./fed)= Hourly cost (L.E./h)/ input capacity (ton/h)

While criterion cost, that takes grain losses cost into consideration, was determined as follows:

Criterion cost (L.E./ton) = operational cost (L.E./ton) + grain losses cost (L.E./ton)

RESULTS AND DISCUSSION

Evaluation of the overall performance of Barmeel and El-nassala threshers will be discussed under the following items:

Effect of some operating parameters on threshers Performance types

Grain threshing is a function of different variables such as input capacity, drum speed and others.

Broken grains

The obtained results reveal that both input capacity and drum speed affected deeply on the percentage of broken grains. (Fig.3) Regarding Barmeel thresher, increasing input capacity from 1.80 to 2.50 ton/h., at constant drum speed of 24.64 m/s., decreased broken grains by 52.96 %.,due to the excessive plants in the threshing chamber which protects grains from impacting forces.

While increasing drum speed from 21.51 to 26.70 m/s., at constant input capacity of 2.25 ton/h., increased broken grains by 56.20 %.,due to the high impacting force applied to the rice plant by drum.

The same trend was noticed with the use of El-Nassala thresher. Results show that increasing input capacity from 1.20 to 1.80 ton/h., at constant drum speed of 20.15 m/s. decreased broken grain by 43%. While increasing drum speed from 18.30 to 22.60 m/s., at constant input capacity of 1.60 ton/h, increased broken grain by 25%

Unthreshed grains

Fig. (4) shows the relationships between unthreshed grains and both input capacity and drum speed. Relating to Barmeel thresher increasing input capacity from 1.80 to 2.50 ton/h., at constant drum speed of 24.64 m/s.

increased unthreshed grains by 44.18% due to the excessive plants in the threshing chamber, as a result, the material leaves the device without well threshing.

While increasing drum speed from 21.51 to 26.70 m/s., at constant input capacity of 2.25 ton/h, decreased unthreshed grains by 49.01 % due to the high stripping and impacting force that tends to improve threshing operation.

The same trend was noticed with the use of El-Nassala thresher. Results show that increasing input capacity from 1.20 to 1.80 ton/h., at constant drum speed of 20.15 m/s. increased unthreshed grains by 73%. While increasing drum speed from 18.30 to 22.60 m/s., at constant input capacity of 1.60 ton/h, decreased unthreshed grains by 44%.

husked paddy

(Fig.5) Shows the effect of both input capacity and drum speed on husked paddy. Barmeel thresher, results show that husked paddy values decreased by increasing input capacity up to2.50 ton/h,. While values of husked paddy increased by increasing drum speed up to 26.70 m/s,.

As to El-Nassala thresher, obtained data show that husked paddy values increased by increasing input capacity up to1.80 ton/h,. At the same time values of husked paddy increased by increasing drum speed up to 22.60 m /s,

Total losses.

The most critical indicator in selecting optimum operating parameters is total losses (Fig.6) Shows the effect of both input capacity and drum speed on total losses.

Concerning Barmeel thresher, results show that total losses values decreased by increasing input capacity up to2.25 ton/h, any further increase up to 2.50 ton/h total losses values decreased. While values of total losses increased by increasing drum speed up to 26.70 m/s,.

As to El-Nassala thresher, obtained data show that total losses values increased by increasing input capacity up to1.60 ton/h, any further increase up to1.80 ton/h total losses values decreased. At the same time values of total losses increased by increasing drum speed up to 22.60 m /s,

purity percentage

The chief reason for cleaning rice grain is to remove foreign material such as chaff, fine broken, straw, clods and stones. The purity percentage as a function of cleaning efficiency depends on adjustment of air velocity, input

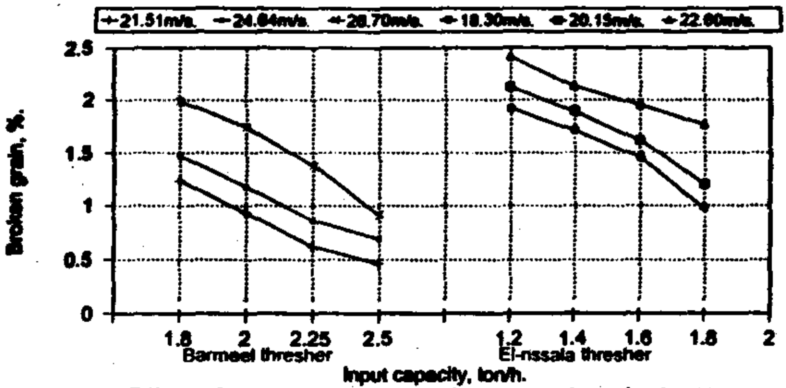

Fig. 3: Effect of input capacity and drum speed on the broken grain using two threshing machines .

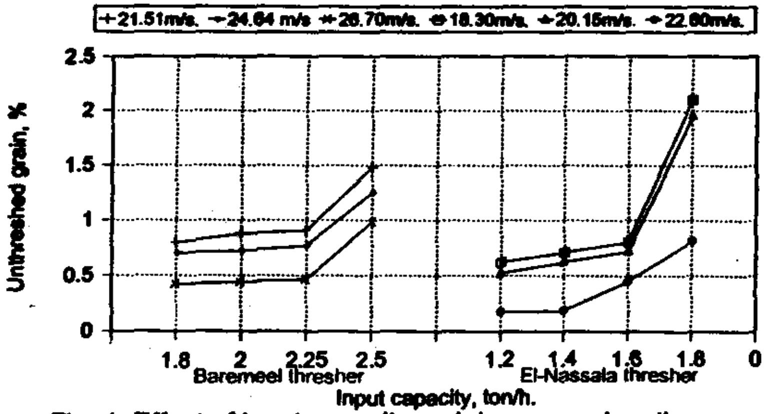

Fig. 4: Effect of input capacity and drum speed on the unthreshed grain using two threshing machines .

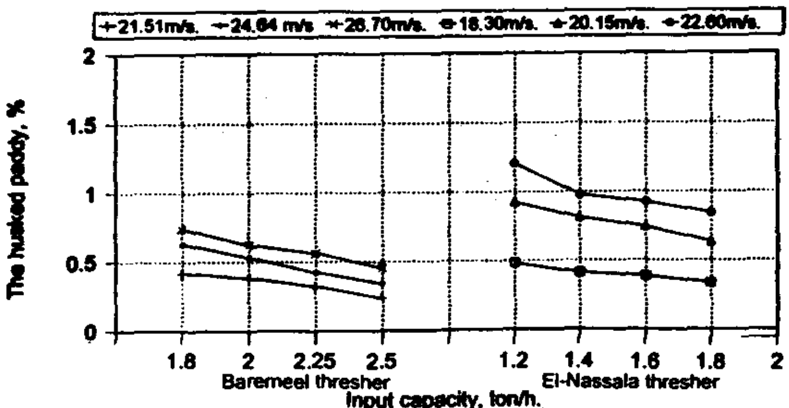

Fig. 5: Effect of input capacity and drum speed on the husked paddy using two threshing machines .

capacity, proportions of short straw and others. (Fig.7) Shows the effect of both input capacity and drum speed on purity percentage. Barmeel thresher, results show that purity percentage values decreased by increasing input capacity up to2.50 ton/h,. While values of purity percentage increased by increasing drum speed up to 26.70 m/s,.

As to El-Nassala thresher, obtained data show that purity percentage values increased by increasing input capacity up to1.80 ton/h,. At the same time values of purity percentage increased by increasing drum speed up to 22.60 m /s,

Effect of some operating parameters on threshing power.

Threshing power is highly affected by both input capacity as well as drum speed Fig.(8). With regard to Barmeel thresher, results show that threshing power values slightly increased by increasing input capacity. Increasing input capacity from 1.80 to 2.50 ton/h, at constant drum speed of 24.64 m/s, increased threshing power by 14.12 % due to the excessive load of rice plants in the threshing unit, that resist the drum resulting in more fuel and power.

Results also show that threshing power values greatly increasing by increasing drum speed. Increasing drum speed from 21.51 to 26.70 m/s., at constant input capacity of 2.25 ton/h, increased threshing power by 28.08 kW due to the increase of fuel consumption by increasing drum speed that tends to increase power.

The same trend was noticed with the use of El-Nassala thresher.

Comparing Barmeel rice thresher with El-Nassala rice thresher, the same results show that Barmeel rice thresher consumed significantly more power. So such care had to be taken to develop this machine to reduce its power consumption.

-Effect of some operating parameters on threshing cost

The relationships between the threshing cost and several operating parameters are illustrated in (Fig.9)

Concerning Barmeel thresher, results show that increasing input capacity from 1.80 to 2.25 ton/h., at drum speed of 24.64 m/s., decreased threshing cost by18.63%. any further increase up to 2.50 ton/h threshing cost increased due to the increase in grain losses cost.

While increasing drum speed from 21.51 to 26.70 m/s., at constant input capacity of 2.25 ton/h, threshing cost decreased by12.35%.

As to El-Nassala thresher, results show that increasing input capacity from 1.20 to 1.60 ton/h, at drum speed of 20.15 m/s., decreased threshing cost by 20.06% any further increase up to 1.80 ton/h threshing cost increased. While increasing drum speed from 18.30 *to*22.60 m/s., at constant input capacity of 1.60 ton/h, threshing cost decreased by 7.04%.

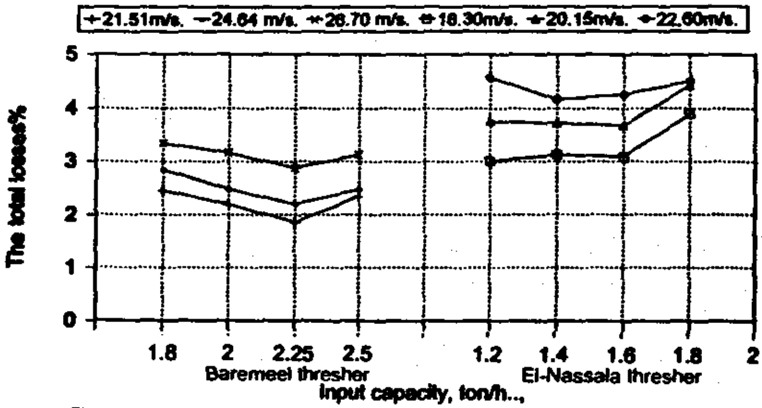

Fig. 6: Effect of input capacity and drum speed on the total losses using two threshing machines .

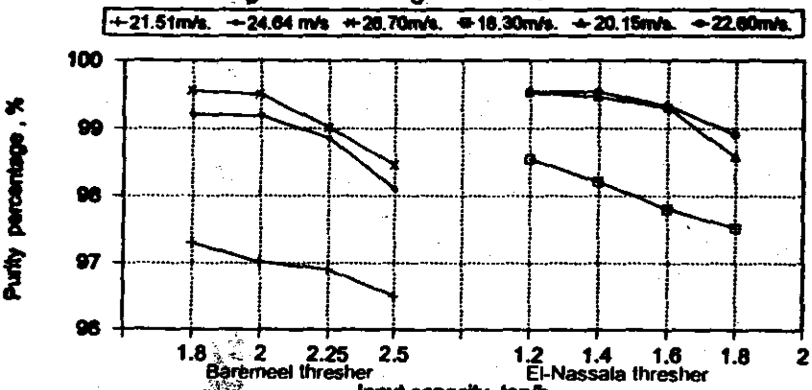

Fig. 7: Effect of input capacity and drum speed on the purity percentage using two threshing machines .

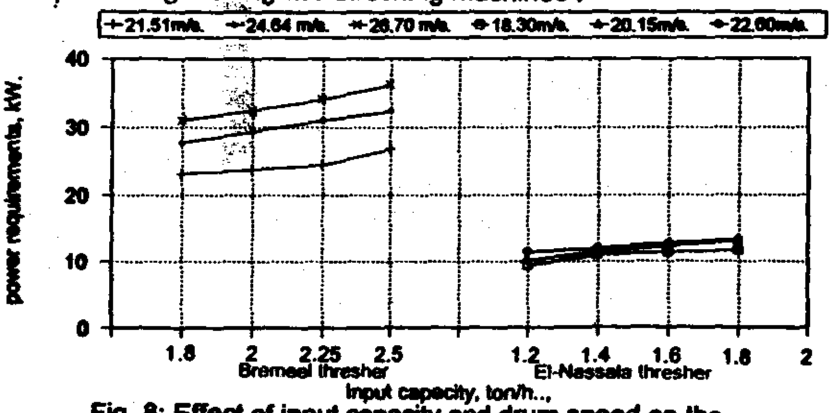

Fig. 8: Effect of input capacity and drum speed on the power requirements using two threshing machines .

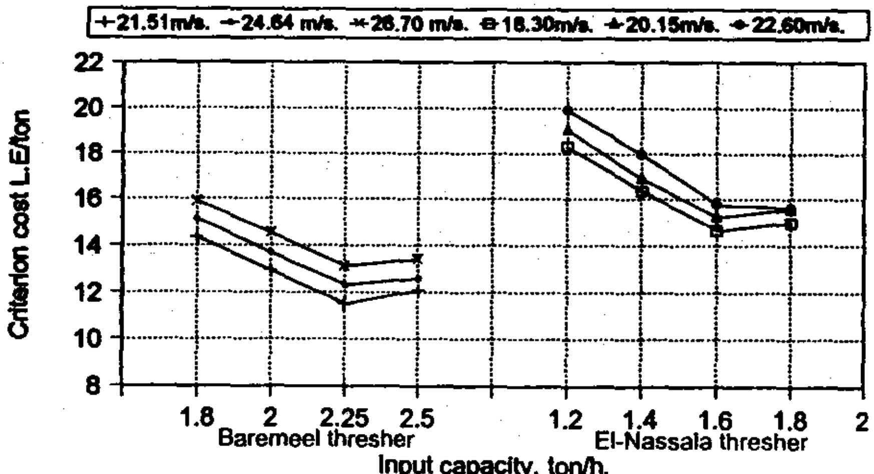

Fig. 9: Effect of input capacity and drum speed on the criterion cost using two threshing machines .

It is clear from the previous results that the use of Barmeel rice thresher decreases both total losses and threshing cost comparing with El-Nassala rice thresher.

CONCLUSIONS

The optimum operating parameters for operating rice threshing machine model (El-nassla) can be obtained by adjusting the machine to drum speed of 20.15m/s., and using 1.60 ton/h. input capacity.

The optimum operating parameters for operating rice threshing machine model (Barmeel) can be obtained by adjusting the machine to 24.64m/s. drum speed and by using 2.25 ton/h. input capacity.

It is recommended to make more studies on rice thresher model (Barmeel) to reduce its power consumption.

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المستخلص العربي

تقييم أداء نوعين من آلات دراس الأرز محلية الصنع

*طارق فوده

تم إجراء هذا البحث بهدف إعطاء المواصفات الفنية لأكثر النظم شيوعا لدراس الأرز في الفترة الحالية . استخدم في النظام الأول ماكينة دراس محلية الصنع (البرميلية) وفي النظام الثاني ماكينة دراس محلية الصنع (النسالة) كما تم استخدام أرز قصير الحبة (سخا ١٠١)

النظام الأول ماكينة دراس محلية الصنع (البرميلية) تم دراسة العوامل التالية:

- معدل التلقيم تحت مستويات (١,٨٠ , ٢,٠٠ , ٢,٢٥ و ٢,٥٠ طن/س.)
- السرعة الخطية لعمود الدراس تحت مستويات (٢١,٥١ , ٢٤,٦٤ و ٢٦,٧٠ م / ث.)

النظام الثاني ماكينة دراس محلية الصنع (النسالة) تم دراسة العوامل التالية:

- معدل التلقيم تحت مستويات (١,٢٠ , ١,٤٠ , ١,٦٠ و ١,٨٠ طن/س.)
- السرعة الخطية لعمود الدراس تحت مستويات (١٨,٣٠ , ٢٠,١٥ و ٢٢,٦٠ م / ث.)

أظهرت النتائج أن : أنسب ظروف تشغيل

I- ماكينة دراس محلية الصنع (البرميلية):

عند معدل تلقيم ٢,٢٥ طن/س وسرعة عمود الدراس ٢٤,٦٤ م / ث أعطت النتائج التالية ، نسبة الكسر ٠,٨٦ % , نسبة الأرز الغير مدروس ٠.٧٧ % , نسبة الفواقد الكلية ٢,١٩ % , القدره المستهلكة ٣١,٠٥ كيلووات وكانت تكلفة دراس الطن ١٢,٣١ جنيه / طن

II- ماكينة دراس محلية الصنع (النسالة):

عند معدل تلقيم ١,٦٠ طن/س وسرعة عمود الدراس ٢٠,١٥ م / ث أعطت النتائج التالية ، نسبة الكسر ١,٦٢ % , نسبة الأرز الغير مدروس ٠,٧٢ % , نسبة الفواقد الكلية ٣,٦٨ % , القدره المستهلكة ١٢,٢٧ كيلووات وكانت تكلفة دراس الطن ١٥,٢٢ جنيه / طن

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