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# A COMPARATIVE STUDY ON THE PERFORMANCE OF PICK-UP AND STATIONARY BALER FOR BALING RICE AND WHEAT STRAW

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## ABSTRACT

*The performance of the pickup baler in terms of field capacity, field efficiency, bale density, baling losses, size requirements for storing bales, power, energy and cost was investigated as a function of change in baler forward speed, and material moisture content during baling rice straw,and wheat straw under the following conditions:*

*Generally, by increasing the baler forward speed from (1.5 to 5.5 km/h) tends to increase the feed rate from (1.4 to 3.0 Mg/h), baler losses from (4.0 to 6.0%), bale density from (82.0 to 89.0 kg/ $m^3$ ), actual field capacity from (0.35 to 1.22 fed/h) and power required from (6.5 to 11.0 kW) during baling rice straw. The results also showed that by increasing the materials moisture content from (11.0 to 24.0 %) tends to increasing the feed rate from (1.4 to 2.5 Mg/h), baler losses from (4.0 to 7.0 %) and bale density from (82.0 to 100.0 kg/ $m^3$ ) during baling rice straw.*


## INTRODUCTION

The increase of any crop production in both quantity and quality dose not depend on the improvement of soil and plant condition, but also largely on using improved methods and technology to fulfil the agricultural processes in correct time, and keep down production cost. The continuous increase in the cost of removing field residues is considered from the policy of agricultural intensification in Egypt such care had to be taken to remove field residues to avoid severe dangerous such as losses, pollution of envionment, public health hazard, and possibility of fire eruption.

In general, straw, hay, and crop residues as field raw materials are used in animal nutrition. These materials are handled from the field as long loose material, chopped material or bales. Baling is essentially packaging operation performed to facilitate handling, transport, and storing.

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Many researchers and projects are running in the scope of field residues handling using the baling machine.

**Klenin and popov (1970)** stated that the density of materials pressed into bales varies from 100-300 kg/m$^3$ .In low denesity baling, it is permissible to press high moisture plants into bales.

**Mohsenin and Zaske (1976)** stated that the moisture content has the greatest influence on the stability of the bales represented by the axail expansion and thus on the final density of the bales.

**Anderson et al.(1981)** reported that windrow size had greater effect than field speed on baler feed rate. An increase in baler feed rate resulted in increased baler capacity and reduced baling losses.

**Kepner et al. (1982)** stated that some of the machine characteristics that affect the baler capacity are: size of the bales, number of plunger strokes per minute, capacity limitations of the pick-up and feed mechanisms, amount of power available, and durability of the machine. They also added that important operating factors, which affect baler capacity, include: size and uniformity of windrows, condition of the field surface, density of the bales, and skile of the operator.

**Jenkins et al. (1985)** stated that the moisture content is considered a major problem in feeding the straw, high moisture content contributed to reduce storage life of the bales.

**EL-Berry and Ahmed (1989)** indicated that the baling operation of wheat straw using a pickup baler was a function of baling rate (132.5 bales per hour with 0.118 m$^3$/bale on average), bales density (90 kg/m$^3$ on average), field efficiency of the machine (86%), and the machine operator experience. The unit fuel consumption of the operation was (2.3 L/ton on average).

**Morad (1996)** stated that bale density increased by increasing both baler feed rate and material moisture content during baling wheat straw. Baling power increased by increasing baler feed rate. He added that forward speeds between 3.0-4.5 km/h, baler feed rates between 1.6-2.3 ton/h, 2.6-3.8 ton/h and 4.2-6.0 ton/h, and material moisture content of between 20-25%, 12-16% and 15-20% for alfalfa, wheat straw and rice straw, respectively.

**Abd El-Mottaleb, (1996)** designed a combination equipment for removing, collecting, crushing, and baling field crop residues.The designed machine required less time, labour, cost and caused no soil compaction.

**EL-Danasory and Imbabi (1998)** studied the mechanical pickup and packing of wheat straw after harvesting with combine. Results indicated that baler capacity was affected by weight of straw yield and forward speed. Baler losses decreased by decreasing forward speed and decreasing period after harvesting. They also stated that the cost of using baler to pickup baling straw was less than the half cost of manual method.

**Morad et al., (2002)** evaluated the pick-up baler performance. Results revealed that baler pickup forward speeds of between 2-3 km/h are recommended to optimize feed rate and minimize both baler losses and cost. Also, material moisture contents of between 12 to 15%, 9 to 12% and 20 to 25% for baling rice straw, wheat straw and berseem are recommended to increase baler storage life.

**Atify et al.(2005)** tested performance of rectangular baler at three forward speeds.They found the highest values of the baler productivity and the tractor fuel consumption were obtained at 6.0km/h baler forward speed. However, the highest values of the bale density, energy requirements for baling, baler efficiency and the total cost of baling were obtained at 2.0 km/h baler forward speed.

**So, the objective of this study is to evaluate the performance of pick-up baler and stationary baler during baling of rice straw,and wheat straw taking into consideration the effect of baler forward speed, and material moisture content on baler capacity, bale density, size required for storing, baling energy, and cost of baling.**

## MATERIAL AND METHODS

Field experiments were carried out at Almorabin Village, Kafr EL-Sheikh Governorate to study the effect of four forward speeds (1.5,3.0,4.5 and 5.5 km/h), four material moisture contents (11,15,19 and 24%) and (7, 10, 13 and 16%) for rice straw, and wheat straw .

The experimental area was about 4 feddans divided into two equal plots 2 feddans each. ( summer season 2009 and winter season 2010 ).

Two different baling machines were used in this study, the specifications of the two machines were as follows Table 1 and Figs.1,2,3,and 4.

The following crops were used for baling, in this investigation variety wheat Sakha 69, plant height 120 cm, plant diameter 33 mm and plant population/ $m^2$ 422 – variety Rice Sakha 102, plant height 107 cm, plant diameter 5 mm, plant population/ $m^2$ 570.

**Table1 : Machines specifications**

| Item | Pickup baler | Stationary baler |
|---|---|---|
| **Type** | **Kader - Cicoria** | **Local** |
| **Made in** | Italia | Egypt |
| **Compression chamber** | 37 x 47 cm | 40x45 cm |
| **Cross section of bale** | 35.6 x 45.7 cm | 55 x 45.5 cm |
| **length** | Adjustable, (40 to 130cm ) | (50 to 200 cm) |
| **Pickup width** | 160 cm. | - |
| **Number of teeth** | 64 on four tooth bars | - |
| **Length, Width, Height** | 450, 240, 160 cm | 570, 114, 175 cm |
| **Feed opening** | Automatic | Manual |
| **Total mass** | 1400 kg | 1100kg |
| **P.T.O speed** | 540 rpm | 540 rpm |
| **Drive tractor Nasr** | 65 hp (48.5 kW) | 65 hp ( 48.5 kW) |

**Many measurments were determined in this work as follows:**

**1- Baler productivity and efficiency:**

The baler productivity was calculated using the following equation:

$$\mathbf{E.B.P} = \frac{1}{T_a} \quad \ldots\ldots 1$$

Where:

E.B.P = Effective baler productivity, fed/h,

Ta = Actual time consumed for baling per feddan, h/fed.

**2-The baler efficiency was calculated using the following equation:**

$$\zeta_b = \frac{E.B.P}{T.B.P} \times 100 \quad \ldots\ldots 2$$

where:

$\zeta_b$ = Baler efficiency, %

T.B.P = Theoretical baling productivity, fed/h.

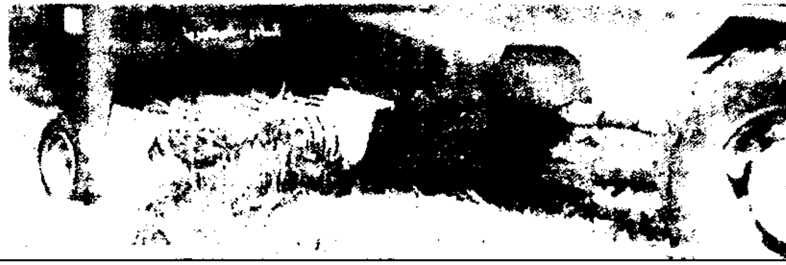


Fig. (1): Pick-up Baler during baling operation.

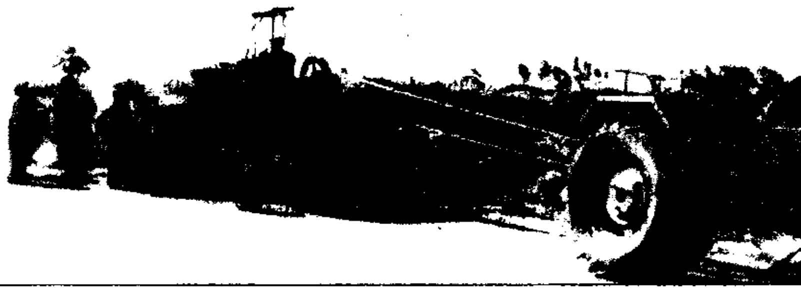
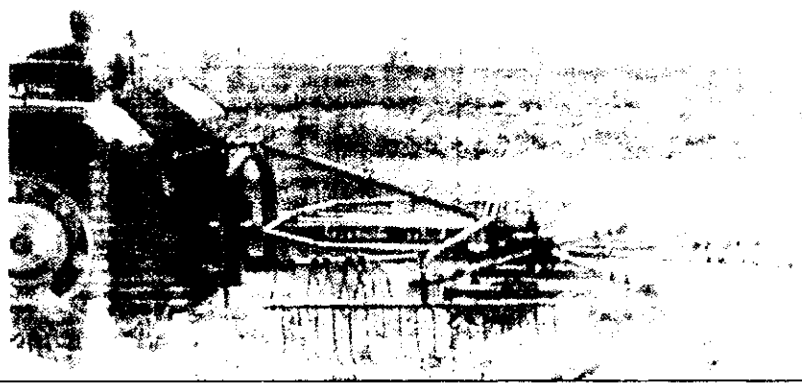


Fig. (2): Stationary Baler during baling operation.



baling Fig. (3): Mechanical raking of straw during operation.

**Baling power requirement(P.R):**

During the baling operation, fuel consumption was calculated by measuring the fuel required to refill the fuel tank after the working period by means of graduated glass cylinder. Baling power was estimated from the fuel consumed during the baling operation using the following formula:

$$P.R = \left\langle F_c \times \frac{1}{60\times 60} \right\rangle \times \rho_f \times L.C.V \times 427 \times \zeta_m \times \zeta_{th} \times \frac{1}{75} \times \frac{1}{1.36}, kW \quad \ldots\ldots\ldots 3$$

Where:

P.R = Power ,kW;

Fc = The fuel consumption ,L/h;

$\rho_f$ = Density of the fuel, kg/L(for solar fuel = 0.85kg/L);

L.C.V.= Lower calorific value of fuel, kcal/kg(average L.C.V. of solar fuel is 10000kcal/kg);

427 = Thermos-mechanical equivalent, kg.m./kcal;

$\zeta_{th}$ = Thermal efficiency of the engine,(considered to be about 40% for diesel engine);

$\zeta_m$ = Mechanical efficiency of the engine,(considered to be about 80%for diesel engine).

**4- Energy requirements for baling, (E.R):**

$$ER = \frac{baling \ \ Power,\ kW}{Actual \ \ field \ \ capacity \ fed/h}\ \mathbf{,kW.h/fed} \ldots\ldots\ldots\ldots\ldots 4$$

**5- Balerlosses:**

$$= \frac{Mass \ \ of \ harvested \ \ straw,\ kg/fed - Mass \ \ of \ bales,\ kg/fed}{Mass \ \ of \ harvested \ \ straw,\ kg/fed} \times 100 \ldots 5$$

$$\mathbf{6\text{-} Baledensity} = \frac{Bale \ \ mass,\ kg}{Bale \ \ volume,\ m^3}, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

$$\mathbf{7\text{-} Size\ requirements\ for\ storing\ bales} = \frac{S.Y.}{B.D.}, \ldots\ldots\ldots\ldots\ldots 7$$

Where:

S.Y = Straw yield per feddan,kg/fed.

B.D. = Bale density,kg/$m^3$

**8- Cost of baling:**

Cost of baling was estimated considering the conventional way of estimating both fixed and operating costs according to **EL-Awady (1978).**

$$C = \frac{P}{h}\left(\frac{1}{L}+\frac{i}{2}+\alpha + r\right) + (0.9w \times f \times u) + b, \quad\text{.................................8}$$

where;

**C**= cost per hour of operation, L.E/h;

**P** = estimated price of the machine, 50000 L.E for pick- up baler and 10000 L.E for stationary baler machine

**h** = estimated yearly hour operation ,1000 for baling machine;

**L** = life expectancy of the machine, 10 years;

**I** = annual interest rate, 10%;

**α**= annual taxes and overheads, 2%;

**r** = annual repair and maintenance rate, 18%;

**0.9** = correction factor for rated load ratio and lubrication;

**w** = engine power, 65 hp;

**f** = specific fuel consumption, L/hp.h;

**b** = hourly labor wage, 3 L/hp.h;

**u** = fuel price, 0.75 L.E/L.

$$\textbf{Operating cost (L.E./fed.)} = \frac{\text{Machine cost L.E./h}}{\textit{Actual capacity , fed / h}}, \quad\text{..........9}$$

The criterion cost was determined using the following equation **EL-Awady,et al (1982):**

**Criterion cost/fed = Operating cost/fed + Product losses cost/fed,**.10

Bale density and baling power were measured at various forward speed of baler, various material moisture content and various baler feed rate. The different feed rates were obtained by changing baler forward speed. Material moisture content was determined on dry basis with the oven methods at 105 $C^0$ for 24 hours.

## RESULTS AND DISCUSSION

The discussion will cover the results obtained under the following headings.

**1-Performance of the Pick-up baler:**

**1-1: Effect of forward speed on field capacity and field efficiency :**

By increasing the baler forward speed from 1.5 to 5.5 km/h, at moisture content of 11, and 7 % ( for rice straw, and wheat straw), increased field capacity from 0.35 to 1.22 fed/h. while the field efficiency decreased from 90 to 70% under the same previous conditions as shown in Figs. 5 , 6 and Table 2. The major reason for the reduction in field efficiency, as the forward speed increased is due to the less theoretical time consumed in comparison with the other items of time losses.

**1-2: Effect of forward speed on power required and energy requirements.**

Increasing the baler forward speed from 1.5 to 5.5 km/h tended to increase power required from ( 6.5 to 11 kW), and ( 6.3 to 10.4 kW)) during baling rice straw, and wheat straw at material moisture content of 11, and 7 %. That is followed with a reducation in energy requirements from ( 18.57 to 9.02 kW.h/fed ), and ( 18.00 to 8.52 kW.h/fed) under the same previous conditions as show in Figs. 7, 8 and Table 2. The other material moisture content take the same trends.

An increase in baling power by increasing baler forward speed (baler feed rate) is attributed to the excessive material in the bale chamber, which increase the load on the baler plunger and other baler parts. The decrease of energy requirements by increasing forward speed (baler feed rate ) is attributed to the increasing of field capacity, results in low values of energy per feddan.

**1-3: Effect of forward speed and material moisture content on baler losses:**

Results obtained in Fig. 9 and Table 2 showed that baler losses increased as the forward speed increased. Baler losses increased from (4.0 to 6.0%), and (3.5 to 5.5%) by increasing the forward speed from 1.5 to 5.5

km/h during baling rice straw, and wheat straw at moisture content of 11, and 7 %. The other moisture contents take the same trends. Also, increasing material moisture content from (11 to 24%), and (7 to 16%) increased baler losses from (4.0 to 7.0%), and (3.5 to 7.6%) during baling rice straw,and wheat straw at forward speed 1.5 km/h.The other forward speeds take the same trends.

### 1-4: Effect of material moisture content on bale density and size for storing bales:

It is remarked that both bale density and size required for storing bales are primarily functions of the type of material and it is moisture content, Figs. 10, 11 and Table 2. Increasing material moisture content from (11 to 24%), and (7 to 16%) during baling rice straw, and wheat straw at forward speed 1.5 km/h increased bale density from (82.0 to 100.0kg/m$^3$), and (80.0 to 95.0 kg/m$^3$). Resulting in decrease of size for storing bales from (36.6 to 30.0 m$^3$/fed), and (37.5 to 31.6 m$^3$/fed) under the same previous conditions. The other forward speed takes the same trends.The increase in bale density by increasing material moisture content at a given adjustment is attributed to the additional water, that tends to increase bale weight and consequently bale density.

### 1.5: Effect of material moisture content on power required:

Increasing material moisture content from (11 to 24%), and (7 to 16%) at forward speed 1.5 km/h during baling rice straw, and wheat straw tends to decrease power required from (6.5 to 5.0 kW), and (6.3 to 4.6 kW), Table 2.

The reduction in baling power by increasing material moisture content to a certain limit can be attributed to the actual force required for baling materials of higher moisture content is less than that required for materials of lower moisture content due to their elastic conditions. This is in agreement with **ELShal, 2001** who stated that dry material have a considerably lower modulus of elasticity and lower coefficient of friction than do materials with a higer moisture content and thus require more power to produce resistance force.

**1-6: Effect of baler forward speed on feed rate, bale density and size for storing bales:**

Material feed rate is considered the most important parameter affecting the baler performance Fig. 12 and Table 2. The effect of baler forward speed on the baler performance is discussed as follwing:

Increasing baler forward speed from 1.5 to 5.5 km/h tends to increase feed rate from (1.4 to 3.0 Mg/h), and for (0.7 to 2.5 Mg/h) during baling rice straw, and wheat straw at moisture content of 11, and 7 % increased bale density from (82.0 to 89.0 kg/ $m^3$), and from (80.0 to 87.0 kg/ $m^3$ ). Resulting in decrease of size for storing bales from (36.6 to 33.7 $m^3$/fed), and (37.5 to 34.5 $m^3$/fed), under the same previous conditions. The other baler forward speed takes the same trends.An increase in bale density by increasing material feed rate is attributed to the excessive weight of material in the bale chamber. This is in agreement with ELShal, 2001 who stated that for a given adjustment there was an increase in density as the baler feed rate increased.

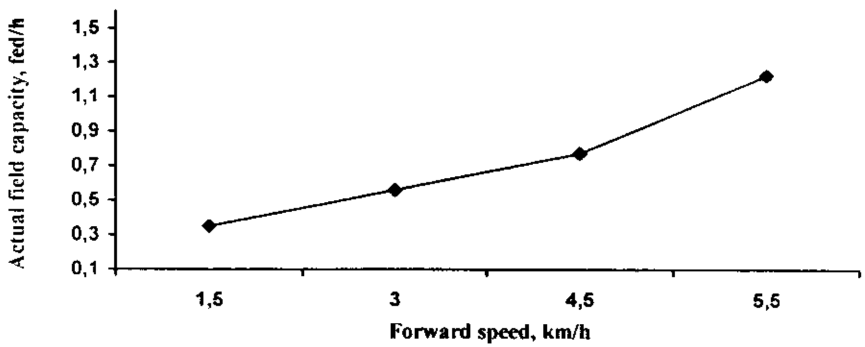



**Fig.5: Effect of forward speed on actual field capacity.**

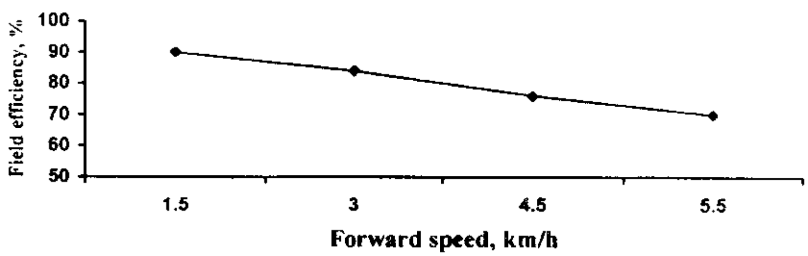



**Fig.6: Effect of forward speed on field efficiency.**

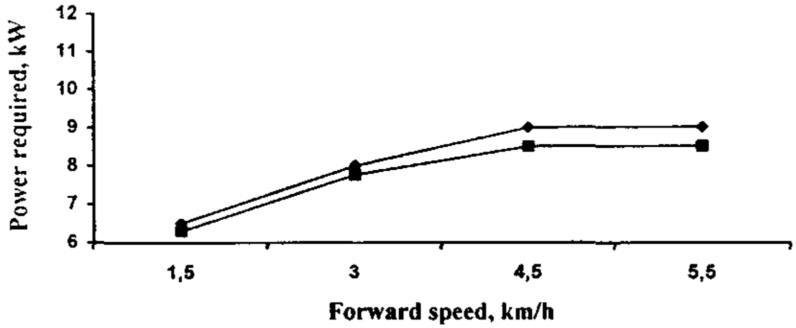



**Fig.7: Effect of forward speed on power required.**

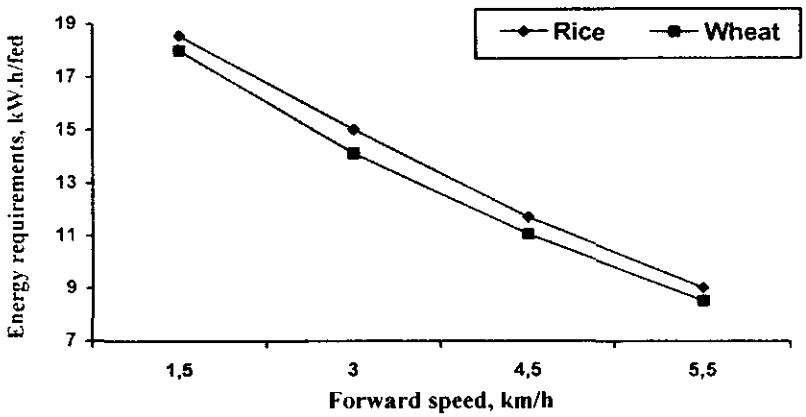



**Fig.8: Effect of forward speed on energy requirement.**

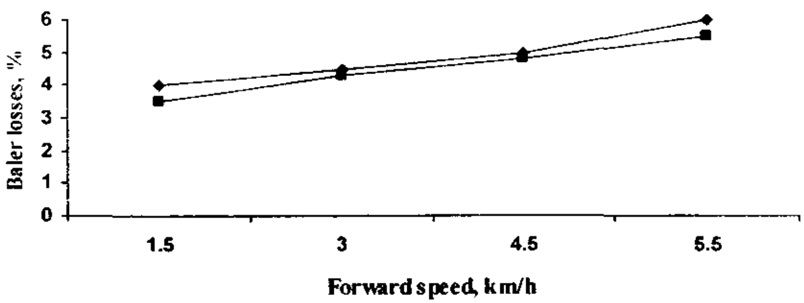



**Fig.9: Effect of forward speed on baler losses.**

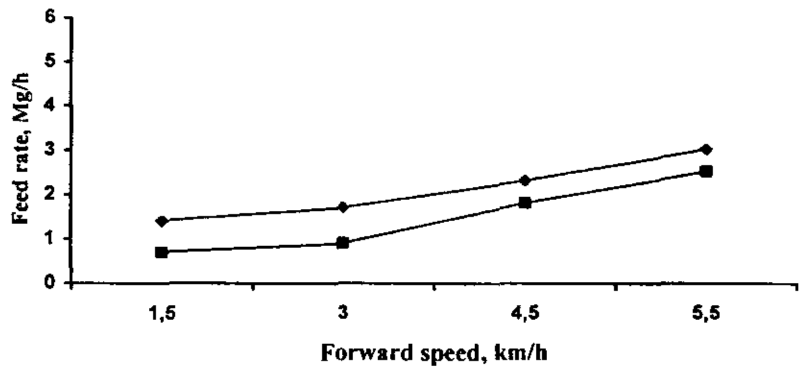



**Fig.10: Effect of forward speed on feed rate.**

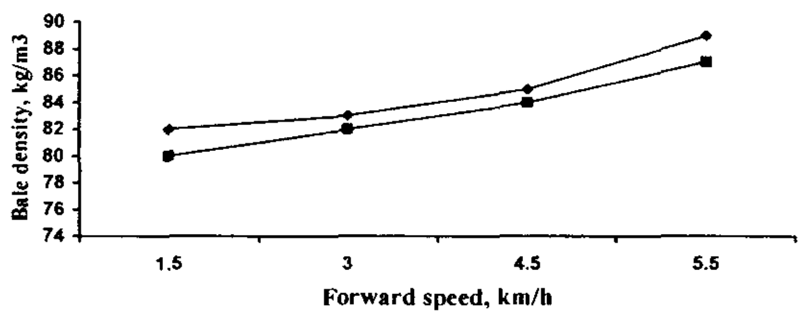



**Fig.11: Effect of forward speed on bale density.**

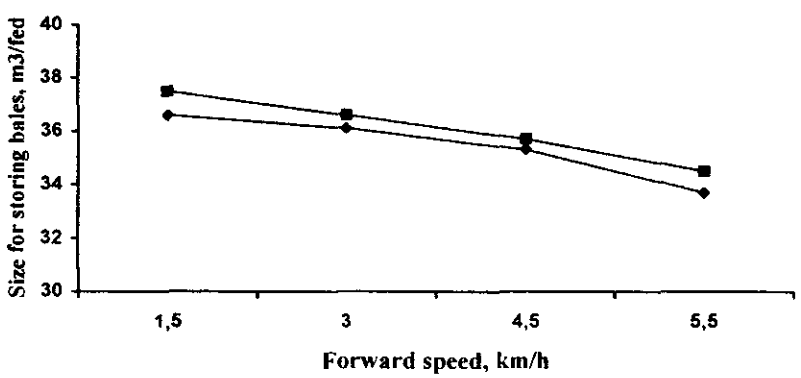



**Fig.12: Effect of forward speed on size for storing bales.**

The decrease in the size required for storing bales by increasing material feed rate is due to the increase of bale density. Size required for storing bales is minimum comparing with the size required for storing free straw.

**1-7:Baling cost:**

Increasing baler forward speed from 1.5, 3.0, 4.5, and 5.5 km/h tends to decrease operating cost from 171.43, 107.40, 77.92, and 50.18 L.E/fed. The higher value of operating cost at lower forward speed were attributed to lower field capacity.

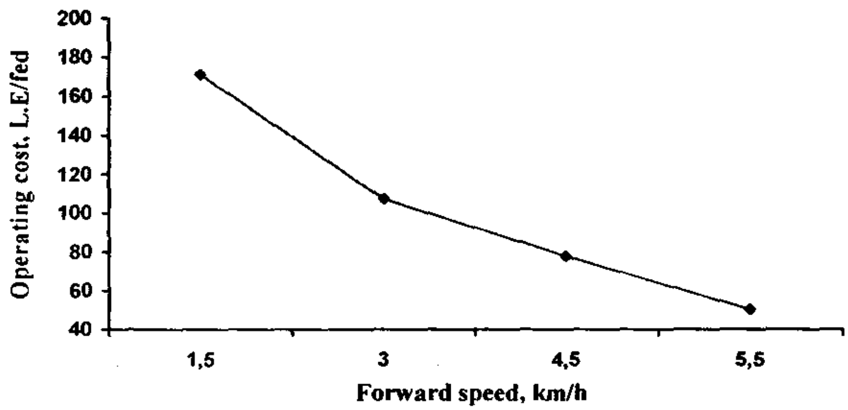



**Fig.13: Effect of forward speed on Operating cost.**

**2- Comparative study between pick- up baler and stationary baler**

Some of the machine characteristics that effect the performance of the baler are the size of bales,

**2-1: Effect of baler type on bale density and size for storing bales:**

Results show that stationary baler formed bales with maximum densities (130.0 kg/m$^3$ for rice straw, and 125.0 kg/m$^3$ for wheat straw) comparing with the pick -up baler (100.0 kg/m$^3$ for rice straw,and 97.0 kg/m$^3$ for wheat straw).

The same results show that the stationary baler required the minimum size for storing bales (23.0 m$^3$/fed for rice straw, and 24.0 m$^3$/fed for wheat straw) comparing with the pick -up baler (30.0 m$^3$/fed for rice straw, and 31.0 m$^3$/fed for wheat straw) Table 3.

It can be concluded that the pick-up baler makes compact, rectangular bales of size small enough to be lifted by hand when necessary, comparing with the stationary baler which make heavy bales.

On the other hand, the stationary baler make high pressure bales which occupies less space in storage than do the pick-up baler.

**Table (2): Effect of baler forward speeds and material moisture contents on the performance of pick-up baler.**

| Material moisture content, (%) | Forward speed, (km/h) | Straw material type | Feed rate, (Mg/h) | Baler losses, (%) | Bale density, (kg/m$^3$) | Size for storing bales, (m$^3$/fed) | Power required, (kW) | Energy requirements, (kW.h/fed) | Actual field capacity (fed/h) | Field efficiency (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| 11 and 7 | 1.5 | Rice | 1.4 | 4.0 | 82.0 | 36.6 | 6.5 | 18.57 | 0.35 | 90 |
| | | Wheat | 0.7 | 4.0 | 80.0 | 37.5 | 6.3 | 18.00 | | |
| | 3.0 | Rice | 1.7 | 4.5 | 83.0 | 36.1 | 8.0 | 15.00 | 0.56 | 84 |
| | | Wheat | 0.9 | 4.3 | 82.0 | 36.6 | 7.76 | 14.11 | | |
| | 4.5 | Rice | 2.3 | 5.0 | 85.0 | 35.3 | 9.0 | 11.68 | 0.77 | 76 |
| | | Wheat | 1.8 | 4.8 | 84.0 | 35.7 | 8.5 | 11.04 | | |
| | 5.5 | Rice | 3.0 | 6.0 | 89.0 | 33.7 | 11.0 | 9.02 | 1.22 | 70 |
| | | Wheat | 2.5 | 5.5 | 87.0 | 34.5 | 10.4 | 8.52 | | |
| 15 and 10 | 1.5 | Rice | 1.8 | 4.6 | 85.0 | 35.3 | 5.8 | 16.57 | 0.35 | 90 |
| | | Wheat | 1.3 | 4.1 | 82.0 | 36.6 | 5.6 | 16.00 | | |
| | 3.0 | Rice | 2.5 | 6.0 | 87.0 | 34.5 | 7.8 | 13.93 | 0.56 | 84 |
| | | Wheat | 1.6 | 6.5 | 86.0 | 34.9 | 7.7 | 13.75 | | |
| | 4.5 | Rice | 3.0 | 8.0 | 90.0 | 33.3 | 8.5 | 11.04 | 0.77 | 76 |
| | | Wheat | 2.2 | 8.7 | 92.0 | 32.6 | 8.0 | 10.39 | | |
| | 5.5 | Rice | 3.5 | 8.5 | 95.0 | 31.6 | 10.0 | 8.20 | 1.22 | 70 |
| | | Wheat | 3.0 | 9.0 | 93.0 | 32.3 | 9.3 | 7.62 | | |
| 19 and 13 | 1.5 | Rice | 2.3 | 6.0 | 91.0 | 33.0 | 5.3 | 15.14 | 0.35 | 90 |
| | | Wheat | 2.0 | 7.0 | 89.0 | 33.7 | 5.1 | 14.57 | | |
| | 3.0 | Rice | 2.8 | 7.0 | 100.0 | 30.0 | 7.0 | 12.50 | 0.56 | 84 |
| | | Wheat | 2.4 | 7.6 | 94.0 | 31.9 | 6.6 | 11.79 | | |
| | 4.5 | Rice | 3.4 | 8.6 | 105.0 | 28.6 | 8.0 | 10.38 | 0.77 | 76 |
| | | Wheat | 2.8 | 9.0 | 100.0 | 30.0 | 7.3 | 9.48 | | |
| | 5.5 | Rice | 3.7 | 9.0 | 109.0 | 27.5 | 9.0 | 7.38 | 1.22 | 70 |
| | | Wheat | 3.2 | 9.5 | 105.0 | 28.6 | 8.5 | 6.97 | | |
| 24 and 16 | 1.5 | Rice | 2.5 | 7.0 | 100.0 | 30.0 | 5.0 | 14.29 | 0.35 | 90 |
| | | Wheat | 2.2 | 7.6 | 95.0 | 31.6 | 4.6 | 13.14 | | |
| | 3.0 | Rice | 3.0 | 8.0 | 110.0 | 27.3 | 6.5 | 11.61 | 0.56 | 84 |
| | | Wheat | 2.5 | 8.5 | 99.0 | 30.3 | 6.0 | 10.71 | | |
| | 4.5 | Rice | 3.6 | 9.0 | 115.0 | 26.1 | 7.4 | 9.61 | 0.77 | 76 |
| | | Wheat | 3.0 | 9.4 | 110.0 | 27.3 | 7.0 | 9.10 | | |
| | 5.5 | Rice | 3.8 | 10.0 | 120.0 | 25.0 | 8.5 | 6.97 | 1.22 | 70 |
| | | Wheat | 3.4 | 10.5 | 115.0 | 26.1 | 8.0 | 6.56 | | |

**2.2: Effect of baler type on equivalent fuel power and energy requirements:**

Results show that the pick -up baler requires minimum values of power and energy (8.5kW and 12.2 kW.h/fed for rice straw, 8.0 kW and 11.5 kW.h/fed for wheat straw). While maximum values were noticed with the use of stationary baler (19.0kW and 26.03 kW.h/fed for rice straw, and 21.2 kW and 29.04 kW.h/fed for wheat straw). Table 3.

**2.3: Effect of baler type on baling cost:**

The most critical factor in selecting the baling machine is the cost requirements for the baling operation.

Results in Table 3 show that the stationary balers requires the minimum value of criterion cost (90.5 L.E/fed for rice straw, and 100.2 L.E./fed for wheat straw) comparing to the pick- up baler (100.0 L.E/fed for rice straw, and 110.0 L.E./fed for wheat straw).

This may be attributed to the low price of the stationary baler (10000 L.E) comparing with the pick -up baler (50000 L.E) in addition the minimum value of baling losses with the use of stationary baler comparing with pick- up baler.

**Table (3):Average performance of both pick-up baler and stationary baler.**

| Parameters | Pick-up baler | | Stationary baler | |
|---|---|---|---|---|
| | Rice straw | Wheat straw | Rice straw | Wheat straw |
| Bale density, (kg/m$^3$) | 100.00 | 97.00 | 130.00 | 125.00 |
| Size for storing bales, (m$^3$/fed) | 30.00 | 31.00 | 23.00 | 24.00 |
| Power required, (kW) | 8.50 | 8.00 | 19.00 | 21.20 |
| Energy requirements, (kW.h/fed) | 12.20 | 11.50 | 26.03 | 29.04 |
| Criterion cost, (L.E/fed) | 100.00 | 110.00 | 90.50 | 100.20 |

## SUMMARY

The following conclusion can be derived from the above study:

1- Increasing the baler forward speed from 1.5 to 5.5 km / h at moisture content of 11.0 and 7.0 % for rice and wheat straw increased field capacity from 0.35 to 1.22 fed / h. While, the field efficiency

decreased from 90 to 70 % under the same previous conditions. Also, decreased operating cost from 171.43 to 50.18 L.E / fed.

2- Increasing the baler forward speed from 1.5 to 5.5 km / h tends to increasing power required from 6.5 to 11.0 kW, and 6.3 to 10.4 kW during baling rice and wheat straw at the moisture content of 11.0 and 7.0 %. Resulting in decreased of energy requirements from 18.57 to 9.02 kW.h / fed and 18.00 to 8.52 kW.h / fed under the same previous conditions.

3- By increasing the forward speed from 1.5 to 5.5 km / h tends to increase baler losses from 4.0 to 6.0 % and 4.0 to 5.5 % during baling rice and wheat straw at moisture content of 11.0 and 7.0 %. Also, increasing the material moisture content from 11.0 to 24.0 % and 7.0 to 16.0 % increased baler losses from 4.0 to 7.0 % and 4.0 to 7.6 % during baling rice and wheat straw at 1.5 km / h baler forward speed.

4- Results show that the pick-up baler requires minimum values of power and energy 8.5 kW and 12.2 kW.h / fed for rice straw while was 8.0 kw and 11.5 kW.h /fed for wheat straw. Also, maximum values were noticed with the use of stationary baler 19.0 kW and 26.03 kW.h / fed for rice straw while was 21.2 kW and 29.04 kW.h / fed for wheat straw.

5- Results show that the stationary baler requires the minimum value of criterion cost 120.0 L.E /fed for rice straw and 128.0 L.E / fed for wheat straw, followed by the pick-up baler 125.0 L.E /fed for rice straw and 135.0 L.E / fed for wheat straw.

6- Results show that the stationary baler formed bales with maximum densities 130.0 kg / $m^3$ for rice straw and 125.0 kg / $m^3$ for wheat straw, comparing with the pick-up baler 100 kg / $m^3$ for rice straw and 97.0 kg / $m^3$ for wheat straw.

7- Results show that the stationary baler required the minimum size for storing bales 23.0 $m^3$ / fed for rice straw and 24.0 $m^3$ / fed for wheat straw, comparing with the pick-up baler 30.0 $m^3$ / fed for rice straw and 31.0 $m^3$ / fed for wheat straw.

## RECOMMENDATIONS

Results that baling operation is considered great importance for residues and straw of most crops because it makes compact, rectangular bales of size small enough to be lifted by hand when necessary and required size minimum for storing comparing with the size required for storing free residues of straw.

The pick- up baler has been found useful for baling some crops, especially after harvesting by combine as it leaves straws in windrows, which facilitate the work of the baler and requires minimum power and energy comparing with stationary baler. While the stationary baler is recommended to be used for baling residues and straws of most crops because it make high pressure bales which required less size of storage than do the pick-up baler and minimum criterion costs.

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## الملخص العربي

## دراسة مقارنة أداء المكبس الثابت والمتحرك لتبييل قش الأرز وتبن القمح

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تستخدم محاصيل الأعلاف في تغذية الحيوان ولكن المساحة المنزرعة بهذه المحاصيل عادة لا تكفى ولذا اتجهت الأنظار نحو استغلال بقايا المحاصيل مثل قش الأرز وقش القمح لموجهة نقص محاصيل الأعلاف وذلك لتغذية الحيوان. وتعتبر عملية كبس محاصيل الأعلاف وكذلك بقايا المحاصيل في بالات من أفضل الطرق لتهيئة هذه المحاصيل واستخدامها وقت الحاجة وذلك لان البالات تشغل حيزا صغيرا أثناء التخزين وكذلك لسهولة النقل والتداول وكذا الإسراع في عملية إخلاء الأرض للمحاصيل الأخرى.

اتجه هذا البحث لدراسة أداء المكابس المتحركة والثابتة أثناء تشغيلها مع محاصيل قش الأرز وقش القمح بهدف الوصول إلي أفضل سرعة للمكبس وأفضل محتوى رطوبى للمحصول.

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وقد تم تقييم أداء المكابس مع الأخذ في الاعتبار السعة الحقلية والكفاءة الحقلية ومعدل التلقيم وفوا قد الكبس وكثافة البالة والاحتياجات الحجمية لتخزين البالات وكذلك القدرة والطاقة وأيضا تكاليف عملية التبييل.

**وقد وجد من تحليل النتائج ما يلي:**

١- تشير النتائج أن زيادة السرعة الأمامية لآلة كبس البالات المتحركة من ١,٥ إلى ٥,٥ كم / ساعة أدت إلى زيادة السعة الحقلية من ٠,٣٥ إلى ١,٢٢ فدان / ساعة ونقص الكفاءة الحقلية من ٩٠ إلى ٧٠ % عند المحتوى الرطوبى ١١ ، ٧ % لقش الأرز والقمح على التوالي. وأيضا نقص تكاليف التشغيل من ١٧١,٤٣ إلى ٥٠,١٨ جنية / فدان.

٢- أدت زيادة السرعة الأمامية لآلة كبس البالات المتحركة من ١,٥ إلى ٥,٥ كم / ساعة إلى زيادة متطلبات القدرة من ٦,٥ إلى ١١ كيلو وات ، ٦,٣ إلى ١٠,٤ كيلووات خلال تبييل قش الأرز والقمح. وأيضا نقص احتياجات الطاقة من ١٨,٥٧ إلى ٩,٠٢ كيلووات.ساعة / فدان ، ١٨,٠٠ إلى ٨,٥٢ كيلووات.ساعة / فدان خلال تبييل قش الأرز والقمح عند المحتوى الرطوبى ١١ ، ٧ % لقش الأرز والقمح على التوالي.

٣- النتائج تشير إلى زيادة فواقد الكبس من ٤ إلى ٦ % ، ٤ إلى ٥.٥ % أثناء تبييل قش الأرز والقمح مع زيادة السرعة الأمامية لآلة كبس البالات المتحركة من ١,٥ إلى ٥,٥ كم / ساعة عند المحتوى الرطوبى ١١ ، ٧ % لقش الأرز والقمح وأيضا زيادة المحتوى الرطوبى من ١١ إلى ٢٤ % ، ٧ إلى ١٦ % أدى إلى زيادة فواقد الكبس من ٤ إلى ٧ % ، ٤ إلى ٧,٥ % خلال تبييل قش الأرز والقمح عند سرعة أمامية ١,٥ كم / ساعة.

٤- أوضحت النتائج أن آلة كبس البالات المتحركة تحتاج إلى أقل قيمة للقدرة واحتياجات الطاقة ٨,٥ كيلووات ، ١٢,٢ كيلووات.ساعة / فدان خلال تبييل قش الأرز بينما كانت ٨,. كيلووات ، ١١,٥ كيلووات.ساعة / فدان خلال تبييل تبن القمح. أيضا آلة الكبس الثابتة تحتاج إلى أعلى قيمة للقدرة واحتياجات الطاقة ١٩ كيلووات ، ٢٦,٠٣ كيلووات.ساعة / فدان خلال تبييل قش الأرز ٢١,٢ كيلووات ، ٢٩,٠٤ كيلووات.ساعة / فدان خلال تبييل تبن القمح.

٥- تتطلب آلة الكبس الثابتة أقل قيمة لتكاليف التشغيل ٩٠,٥ جنية / فدان لقش الأرز ، ١٠٠,٢ جنية / فدان لتبن القمح يليها آلة كبس البالات المتحركة ١٠٠ جنية / فدان لقش الأرز ، ١١٠ جنية / فدان لتبن القمح.

٦- تشكل آلة كبس البالات الثابتة بالات ذات كثافة عالية ١٣٠ كجم / م$^3$ لقش الأرز ، ١٢٥ كجم / م$^3$ لتبن القمح بالمقارنة بآلة كبس البالات المتحركة ١٠٠ كجم / م$^3$ لقش الأرز ، ٩٧ كجم / م$^3$ لتبن القمح.

٧- النتائج توضح أن آلة كبس البالات الثابتة تحتاج إلى حيز صغير عند التخزين ٢٣ م^٣ / فدان لقش الأرز ، ٢٤ م^٣ / فدان لتبن القمح بالمقارنة بآلة كبس البالات المتحركة ٣٠ م^٣ / فدان لقش الأرز ، ٣١ م^٣ / فدان لتبن القمح.

**التوصيات**

استخدام آلات الكبس اللاقطة لعمل بالات ذات حجم صغير مما يسهل حملها باليد لمعظم محاصيل الأعلاف وكذلك بقايا معظم المحاصيل الحقلية يوفر الحجم اللازم لتخزين هذة المحاصيل عما لو كانت في حالتها العادية مع الإسراع بعملية إخلاء الحقل من المحصول السابق ونقلة وتداولة والاستفادة من المخلفات بالمقارنة بالحجم اللازم لتخزين هذة المخلفات في حالة لو تركت حرة بعد الحصاد حيث تشغل حيز كبير جدا في مساحة التخزين.

وبالتالي يوصى باستخدام آلة كبس البالات المتحركة مع بعض المحاصيل التي يتم حصادها بآلة الحصاد الجامعة التي تترك بقايا المحاصيل في صفوف مما يسهل عمل الآلة وهى تحتاج إلى أقل قدر من القدرة والطاقة بالمقارنة بالمكابس الثابتة. بينما يوصى باستخدام آلة الكبس الثابتة أثناء عمل بالات لمعظم بقايا المحاصيل حيث أنها تنتج بالات أعلى كثافة بالمقارنة بالمكابس اللاقطة وذلك يوفر الحجم اللازم لتخزين هذة المحاصيل عما لو كانت في حالتها العادية كما إنها تتطلب أقل تكاليف للتشغيل.