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DEVELOPMENT OF THE STATIONARY BALER TO IMPROVE ITS PERFORMANCE FOR BALING RESIDUES OF SOME FIELD CROPS

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ABSTRACT: The main experiments were carried out to develop the stationary baler to improve its performance for baling residues of some field crops and compare its performance with the same baler before development.

Evaluation of the stationary balers before and after development was done taking into consideration baler feed rate, bale density, size requirements for storing bales, number of broken bales, fuel, power, energy and baling cost.

The experimental results revealed the following:

The use of the stationary baler after development for baling residues of some field crops is recommended under the following conditions:

- **Baler feed rates of between 2.3 to 3.1 ton/h, 2 to 2.6 ton/h, and 4.5 to 6.1 ton/h during baling rice straw, wheat straw, and berseem hay respectively.**
- **Moisture contents of between 13 to 16%, 10 to 12% and 22 to 27% during baling rice straw, wheat straw, and berseem hay respectively.**
- **Plunger speed of about 41 m/min.**

Key words: Development, baler, performance, baling, crop, residues.

INTRODUCTION

In Egypt, there are about 25 million ton yearly of the field raw materials, the most important of which are rice straw (4 million tons), maize stalks (3.5 million tons) and cotton stalks (2.0 million tons) (Awady *et al.*, 2001).

Continuous increase in the cost of removal and collection of straw, hay, and agricultural field residues is considered from the policy of agricultural field intensification in Egypt.

Severe dangers are caused by agricultural field residues, such as pollution of enviroment, public health hazard, possibility of fire eruption of these residues.

So, removing straw, hay, and crop residues is considered an important question to be answered, added to that, quick removal of these residues from the land helps to avoid delay of cultivation of new crops which may add a significant increase to the intensification ratio of the Egyptian agriculture.

The density of hay pressed into bales varies from 100 to 300 kg/m^3. Three densities are recommended for pressing hay into bales: low (up to 100 kg/m^3), medium (from 100 to 200 kg/m^3), and high (up to 300 kg/m^3) (Klenin and Popov, 1970).

Ram balers including both local stationary balers and imported plunger-type field balers (pick-up balers) are used to press the hay and straw into rectangular bales with high and medium density. Imported round balers are used to press the plant mass into large cylindrical bales with low density.

The high cost of imported baling machines and the small size of holdings are great hindrance to mechanical baling. From this point of view, many small workshops and manufactures produce local baling machines without any scientific guidance. For this reason, such care had to be taken to construct, develop and operate local baling machines taking into consideration machine efficiency, baling losses, durability, energy and cost requirements.

Kepner *et al.* (1978) indicated many types and sizes of field balers are available for use. The performance of those machine were different according to:

a- The size of the bales.

b- The number of plunger strokes per minute.

c- Capacity limitations of the pick up and feed mechanisms.

d- The amount of power available.

e- The durability and reliability of the machine.

They added that the following important operating factors affect the balers performance :

a- Size and uniformity of windrows.

b- The condition of the field surface, in so far as it limits the forward speed.

c- The condition of the hay.

d- The density of the bales.

e- The skill of the operator.

El-Berry and Ahmed (1989) undertaken a field study to evaluate harvesting and baling operation of wheat in desert lands. The baling operation of wheat straw using a pick-up baler was a function of baling rate (132.5 bales per hour with 0.118 m3/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/t.

Hanel and Marx (1990) tested the economics of handling straw as large rectangular bales, with particular regard to transport and storage. Savings to be made include 30% of process costs, 20% on labour, 20% on fuel, 20% on baler twine and 60% on storage.

Frerichs and Clostermeyer (1994) stated that the need for easier dissolution of bales, for cut and baled straw, for higher density and better quality silage led to the development of chopping units on big balers. In addition, a smaller number of higher density bales reduces handling and transport costs. A rotor with a helix arrangement of star-shaped tines and independently sprung static knives feeds the crop directly into the bale chamber (round bales) or to a second feeder and then into the chamber (square bales). A chop length of 70 mm for round bales and 45 mm for square bales is standard. An increased chop length can be achieved with fewer knives.

Morad (1996) experimentally investigated the performance of the plunger-type field baler in terms of baler productivity efficiency, bale density and baling power as a function of change in baler feed rate and material moisture content during baling alfalfa, wheat straw, and rice straw. The experimental results reveal that the bale density and the baling power were in the optimum region under the following conditions:

- Forward speeds of between 3-4.5 Km/h.
- Baler feed rates of between 1.6-2.3, 2.6-3.8, 4.2-6.0 ton/h for alfalfa, wheat straw, and rice straw respectively.
- Material moisture contents of between 20-25 %, 12-16% and 15-20% for alfalfa, wheat straw, and rice straw respectively.

El-Danasory and Imbabi (1998) studied the mechanical pickup and packing of wheat straw after harvesting with combine. This included capacity (kg/fed), straw losses, period after harvesting (day), some characteristics of straw, and cost (L.E./fed).

The results indicated that the actual capacity of baler was affected by the weight of straw yield and forward speed. The baler losses decreased by decreasing the forward speed and decreasing the period after harvesting.

El-Shal (2001) compared the performance of the plunger-type field baler with both round and stationary balers taking into consideration bale density, size for storing bales, fuel, power, energy and cost during baling rice straw, wheat straw, and berseem hay.

The experimental results reveal that the bale density, baling power, size for storing bales, and criterion costs were in the optimum region, under the following conditions:

- Forward speeds for the plunger-type field baler (pick-up baler) between 2 to 3 km/h.
- Baler feed rates between 2.1 to 3.0 ton/h, 1.7 to 2.4 ton/h, and 4.1 to 5.7 ton/h during baling rice straw, wheat straw, and berseem hay respectively.
- Moisture contents between 12 to 15%, 9 to 12%, and 20 to 25% during baling rice straw, wheat straw, and berseem hay respectively.
- Plunger speed of 97 m/min (64 rpm).
- The stationary baler required the minimum value of criterion cost followed by the plunger-type field baler while the round baler requires the maximum criterion cost.

The main objectives of the study are:

1- Developing the stationary baler to improve its performance during baling forage crops as well as some field crop residues.

2- Optimizing some operating parameters (feed rate, material moisture content, plunger speed) affecting the baler performance.

3- Comparing the stationary baler before and after development from the economic point of view.

MATERIALS AND METHODS

The main experiments were carried out during two agricultural seasons of 2003-2004 and 2004-2005 at Bordien farm, Sharkia Governorate to develop the stationary baler to improve its performance for baling residues of some field crops and compare its performance with the same baler before development.

1. Materials

1.1 Crops

Rice straw (Sakha 101), wheat straw (Sakha 69), Berseem hay (Fahl (Giza 3)).

1.2. Machinery and equipment

The following machines were used in carrying out the baling-operations:

1.2.1. Tractor

A4-wheel tractor of the standard type was used, with the following specifications:

Type : Universal 650-M

Made in: Romania

Engine type: Four stroke diesel with direct injection.

Engine power: 75 hp (55.93 kW)

PTO speed: 540 rpm

Mass: 3820 kg

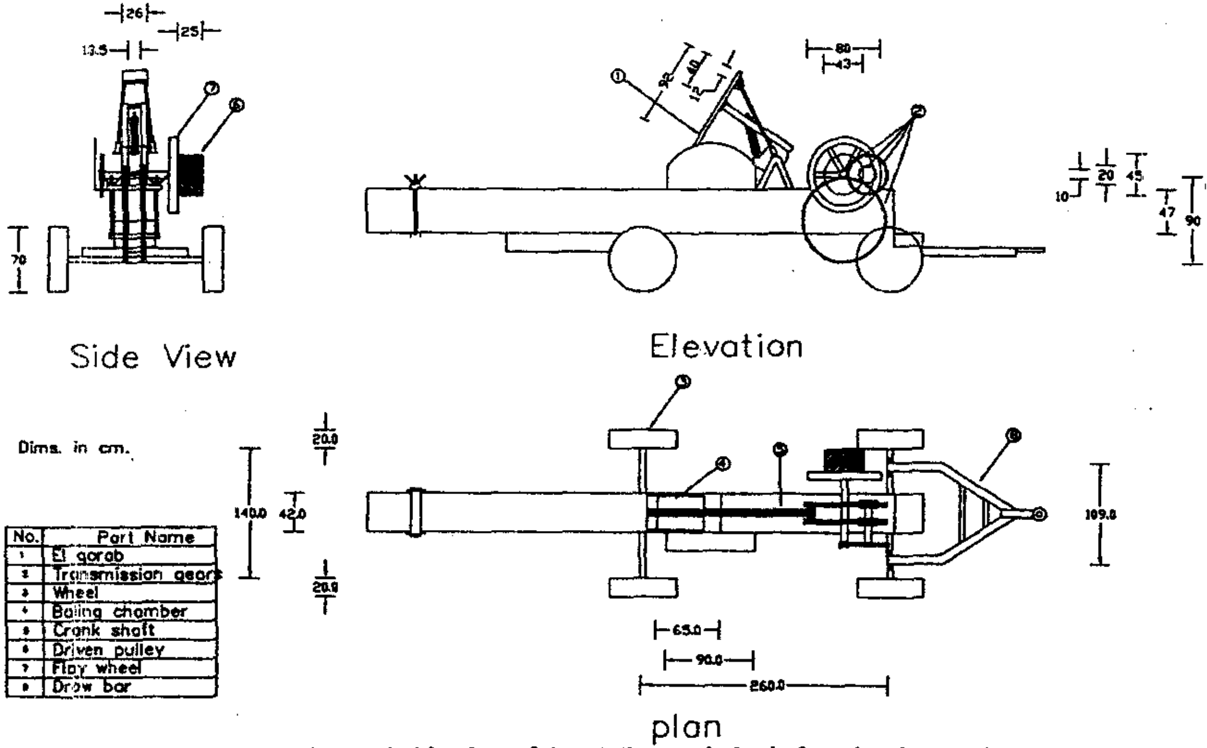
1.2.2. Stationary baler before development

The stationary baler before development local made shown in Fig. 1 has weight of 2000 kg and overall length of 580 cm, width of 180 cm and height of 175 cm driven by means of belt and pulley produced bale size 45 x 55 x 140 cm. Manual feeding through the upper opening and the feeder head (El-Gorab). The plunger stroke was 64 cm run with 20 cycles per min.

1.2.3. Stationary baler after development

The stationary baler was developed as follows:

- Exchanging the manual feeding of the stationary baler by a mechanical feeding device (self feeding).
- Developing the power transmission system by using gear box with flexible joint instead of the driven pulley and belt system.



No.	Part Name
1	El gorab
2	Transmission gears
3	Wheel
4	Baling chamber
5	Crank shaft
6	Driven pulley
7	Flay wheel
8	Draw bar

Fig. 1: Elevation, plan and side view of the stationary baler before development.

- Adding two knives, the first is fixed on the plunger edge, while the other is fixed opposite to the baler chamber opening to cut the straw while the feeding operation is taking place.
- A groove is made to put the wooden block which separates the formed bale from the next one.
- Adding baling chute in the back of the baler for delivering the bales safely.

The stationary baler after development local made shown in Fig. 2 has weight of 2100 kg and overall length of 480 cm, width of 265 cm and height of 152 cm driven by flexible joint produced bale size 45 x 55 x 140 cm. The added pickup; width 145 cm, number of teeth 64 on four tooth bars, number of 2 forks. The plunger stroke was 64 cm.

2. Methods

The experimental area was about 12 feddans divided into three equal plots (4 feddans each) one of the three plots was planted with rice, the second with wheat, and the third with berseem hay.

A comparison study was conducted to compare the performance of the stationary baler before and after development during baling rice straw, wheat straw, and berseem hay.

The baler performance was studied as a function of change of the following parameters:

2.1. Feeding rate

- For stationary baler before development:

Average feeding rates of 2.2, 1.9 and 2.6 ton/h for rice straw, wheat straw and berseem hay respectively were tested.

- For stationary baler after development:

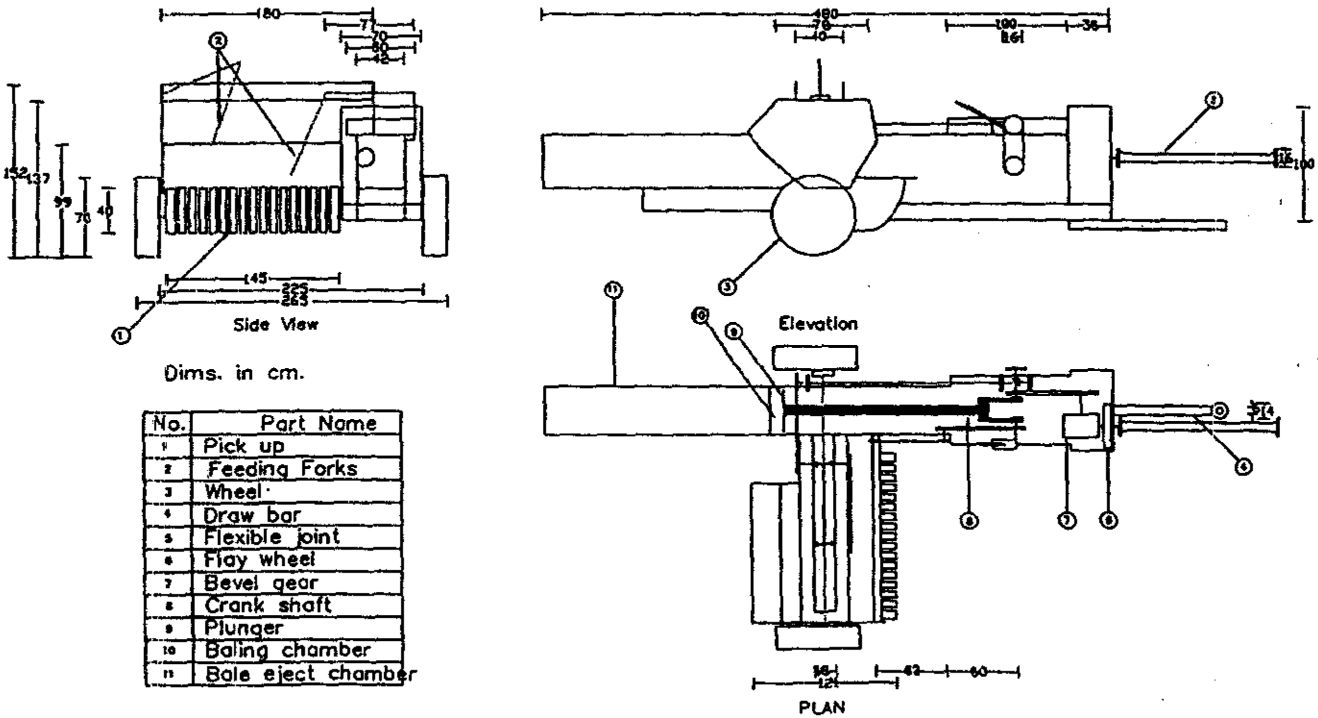
Four average feeding rates for each crop were carried out as follows: 1.3, 2.3, 3.1 and 3.7 ton/h for rice straw, 1.1, 2, 2.6 and 3.1 ton/h for wheat straw and 2.5, 4.5, 6.1 and 7.4 ton/h for berseem hay. The different baler feeding rates for each crop were obtained by changing baler forward speed.

2.2. Material moisture content

Four average plant moisture contents for each crop were considered as follows: 8, 13, 16 and 21% for rice straw, 7, 10, 12 and 16% for wheat straw and 16, 22, 27 and 32% for berseem hay.

2.3. Plunger speed

- For the baler before development:



No.	Part Name
1	Pick up
2	Feeding Forks
3	Wheel
4	Draw bar
5	Flexible joint
6	Flay wheel
7	Bevel gear
8	Crank shaft
9	Plunger
10	Baling chamber
11	Bale eject chamber

Fig. 2:Elevation, plan and side view of the stationary baler after development

Four average plunger speeds of 12.8, 19.2, 25.6 and 32 m/min were carried our for the three crops.

- For the baler after development:

Four average plunger speeds of 28.2, 34.6, 41 and 47.4 m/min were carried out for the three crops.

2.4. Measurements

The stationary baler performance before and after development was measured taking into consideration the following indicators:

2.4.1. Bale density

The obtained bales were weighted. The density was calculated by dividing bale weight by its volume.

2.4.2. Size requirements for storing bales

Size requirements for storing bales was calculated using the following equation:

$$S.R.S.B. = \frac{S.Y.}{B.D.}$$

Where:

S.R.S.B. – Size requirements for storing bales, m^3/fed;

S.Y.– Straw yield, kg/fed;

B.D. – Bale density, kg/m^3

2.4.3. Number of broken bales per feddan

Number of broken bales were counted per feddan during the baling operation using both stationary baler before and after development.

2.4.4. Power required for baling

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

The required power (P) was calculated by using the following formula (Barger *et al.*, 1963).

$$P = Wf \times C.V \times \zeta_{thb} \times 427 \times \frac{1}{75} \times \frac{1}{1.36}\ kW$$

Where:

Wf – Rate of fuel consumption, kg/s;

C.V.– Calorific value of fuel, k cal/kg (C.V. of solar fuel is about 10000 k cal/kg).

427 – Thermo-mechanical equivalent, kg. m/k cal;

ζ_{thb} – Thermal efficiency of the engine, % (considered to be 30% for diesel engine)

2.4.5. Energy requirements for baling

Energy requirements was calculated using the following equation:

Energy requirements (kW.h/ton) =

$$\frac{\text{Baling power, kW}}{\text{Feeding rate, ton/h}}$$

2.4.6. Baling cost

The baling cost was determined using the following equation (Awady, 1978).

$$C = \frac{p}{h}\left(\frac{1}{a} + \frac{i}{2} + t + r\right) + (0.9\ W.F.S) + \frac{m}{144}$$

Where:

C – Hourly cost ;

P – Price of the machine ;

h – Yearly working hours ;

a –Life expectancy of the machine;

i – Interest rate / year ;

t – Taxes over heads ratio;

r – Repairs and maintenance ratio;

W – Power ;

F – Specific fuel consumption;

S – Fuel price ;

m – Operator monthly salary ;

0.9– Factor a counting for ratio of rated power and lubrications;

144- The monthly average working hours.

The operating cost was determined using the following equation:

Operating cost, (LE//ton) =

$$\frac{\text{Machine cost, (LE/ton)}}{\text{Feeding rate, ton/h}}$$

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

Criterion cost (LE/ton)= operating cost, (LE/ton)+product losses cost, (LE/ton)

Residues crop moisture content was determined on dry basis with the oven method at 105°C for 4 hours.

RESULTS AND DISCUSSION

The experimental results can be summarized as follows:

1. Effect of Material Feed Rate on Bale Density, Size for Storing Bales and Number of Broken Bales

Results show that bale density is the principal parameter governing the quality of the compressed material, the size required for storing bales and number of broken bales, Fig. 3.

Concerning the use of stationary baler before development under feed rates of 2.2, 1.9 and 2.6 ton/h, bale density values were 129.7, 115.3 and 158.5 kg/m^3, size requirements for storing bales were 32.4, 30.4 and 53 m^3/fed, and number of broken bales 4, 2 and 9 bale/fed for rice straw, wheat straw, and berseem hay at a moisture contents of 13, 10 and 22% respectively.

While with the use of stationary baler after development results show that there is an appreciable increase in bale density and number of broken bales accompanied with decrease in size for storing bales as the feed rate increased. Increasing baler feed rate from 1.3 to 3.7 ton/h (for rice straw), from 1.1 to 3.1 ton/h (for wheat straw), and from 2.5 to 7.4 ton/h (for berseem hay), at a moisture contents of 13, 10 and 22%, increased bale density by 16, 18 and 13%, number of broken bales by 75, 80 and 63% resulting in decrease of size for storing bales by 16, 18 and 13% during baling rice straw, wheat straw, and berseem hay respectively.

The increase in bale density by increasing material feed rate is attributed to the excessive weight of material in the bale chamber.

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. This means that bales can be left to dry in minimum storage size without damage or losses.

2. Effect of Material Feed Rate on Fuel, Power, and Energy Requirements

Results obtained show that fuel consumption as well as power and energy requirements are too related to the material feed rate. Both fuel and energy requirements decreased as the feed rate increased and the vice versa is noticed with the baling power, Fig. 4.

Concerning the use of stationary baler before development results show that at feed rates values of 2.2 ton/h (for rice straw), 1.9 ton/h (for wheat straw) and 2.6 ton/h (for berseem hay) and at moisture contents of 13, 10 and 22%, fuel consumption values were 3.2, 3.4 and 3.1 L/ton, power required values were 20.9,

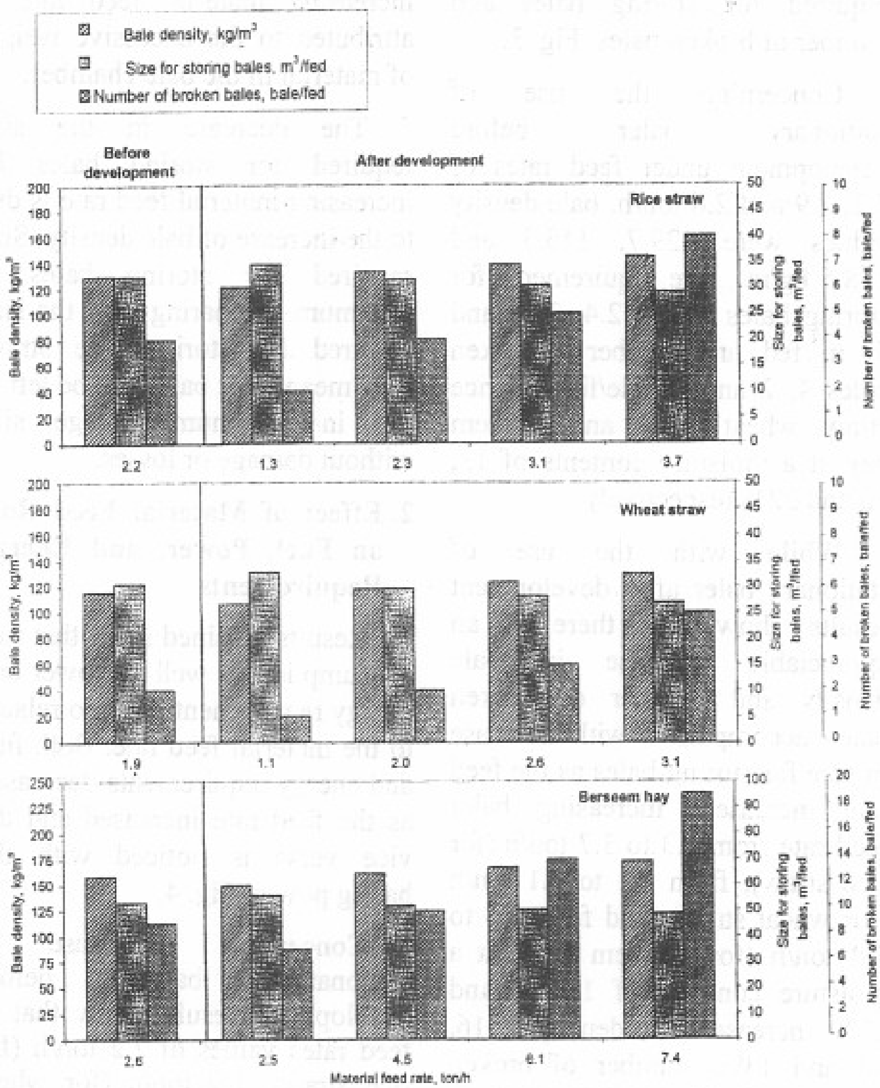


Fig. 3: Effect of material feed rate on bale density, size for storing bales and number of broken bales during baling rice straw, wheat straw and berseem using stationary baler before and after development.

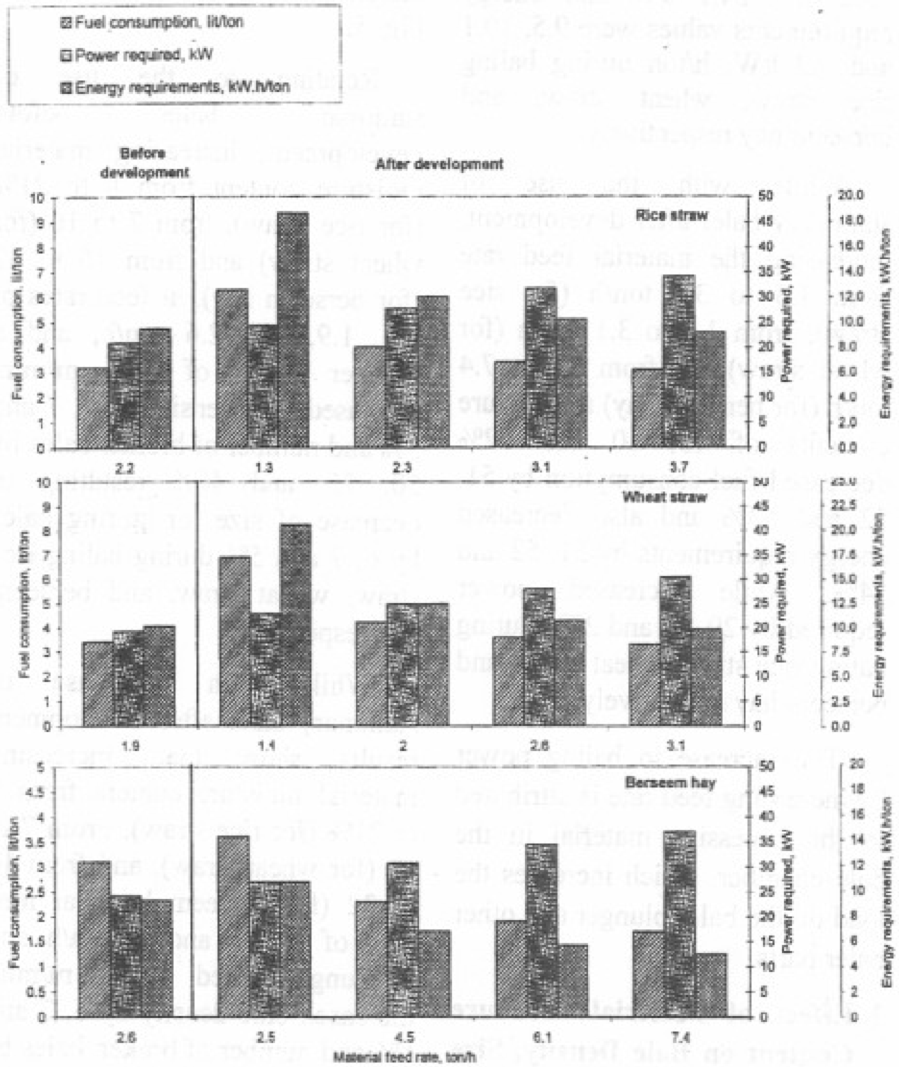


Fig. 4: Effect of material feed rate on fuel, power, and energy requirements for baling rice straw, wheat straw and berseem using stationary baler before and after development.

19.2 and 24.1 kW and energy requirements values were 9.5, 10.1 and 9.3 kW. h/ton during baling rice straw, wheat straw, and berseem hay respectively.

While with the use of stationary baler after development, increasing the material feed rate from 1.3 to 3.7 ton/h (for rice straw), from 1.1 to 3.1 ton/h (for wheat straw) and from 2.5 to 7.4 ton/h (for berșeem hay) at moisture contents of 13, 10 and 22% decreased fuel consumption by 51, 52 and 53% and also decreased energy requirements by 51, 52 and 54%, while increased power required by 29, 25 and 27% during baling rice straw, wheat straw, and berseem hay respectively.

The increase in baling power by increasing feed rate is attributed to the excessive material in the bale chamber, which increases the load on the baler plunger and other baler parts.

3. Effect of Material Moisture Content on Bale Density, Size for Storing Bales, and Number of Broken Bales

Results show that bale density, size required for storing bales, and number of broken bales are primarily functions of the type of material and its moisture content, Fig. 5.

Relating to the use of stationary baler before development, increasing material moisture content from 8 to 21% (for rice straw), from 7 to 16 (for wheat straw) and from 16 to 32 (for berseem hay), at feed rates of 2.2, 1.9, and 2.6 ton/h, and a plunger speed of 25.6 m/min, increased bale density by 6, 7 and 5% and number of broken bales by 50, 75, and 46% resulting in decrease of size for storing bales by 6, 7 and 5% during baling rice straw, wheat straw, and berseem hay respectively.

While with the use of stationary baler after development results show that, increasing material moisture content from 8 to 21% (for rice straw), From 7 to 16 (for wheat straw), and from 16 to 32 (for berseem hay), at feed rates of 3.1, 2.6 and 6.1 ton/h, and a plunger speed of 41 m/min, increased bale density by 6, 7 and 5% and number of broken bales by 43, 60 and 33% resulting in decrease for size of storing bales by 6, 7 and 5%, during baling rice straw, wheat straw, and berseem hay respectively.

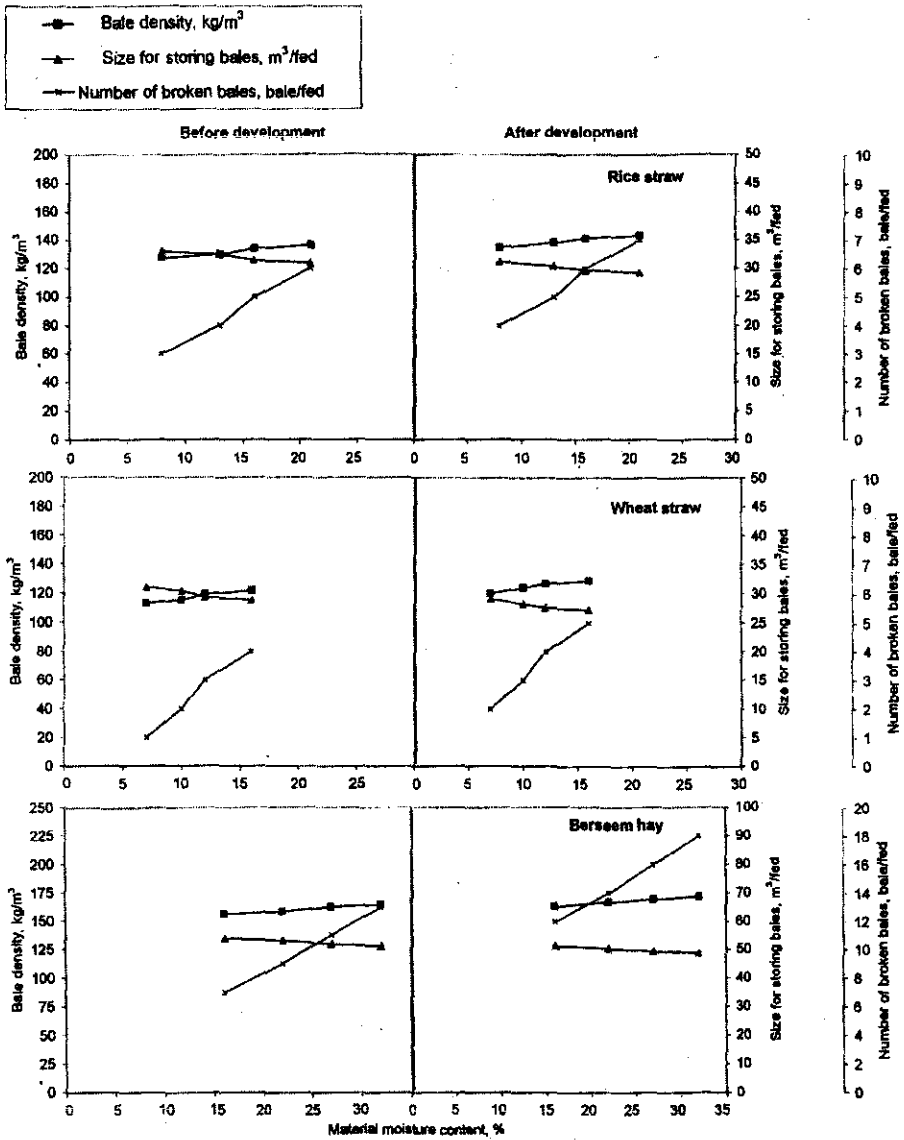


Fig. 5: Effect of material moisture content on bale density, size for storing bales and number of broken bales during baling rice straw, wheat straw and berseem using stationary baler before and after development.

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.

4. Effect of Material Moisture Content on Fuel, Power and Energy Requirements

Results obtained show that there is a remarkable reduction in fuel, power, and energy requirements as the material moisture contents increased up to 13, 10 and 22% for rice straw, wheat straw, and berseem hay respectively, Fig. 6. Any further moisture increase up to 21, 16 and 32%, fuel, power, and energy will increase.

Relating to the stationary baler before development, increasing material moisture contents from 8 to 13% (for rice straw), 7 to 10% (for wheat straw), from 16 to22% (for berseem hay), at a feed rates of 2.2, 1.9 and 2.6 ton/h and a plunger speed of 25.6 m/min, decreased fuel consumed by 3, 6 and 6% power required by 3, 5 and 4% and energy requirements by 3, 5 and 4% during baling rice straw., wheat straw, and berseem hay respectively.

While with the use of stationary baler after development, there is a remarkable reduction in fuel, power, and energy requirements as the material moisture contents increased up to 13, 10 and 22% for rice straw, wheat straw, and berseem hay respectively. Any further moisture contents increase up to 21, 16 and 32%, fuel, power, and energy will increase.

Increasing material moisture contents from 8 to 13% (for rice straw), 7 to 10 (for wheat straw), and from 16 to 22 (for berseem hay), at a feed rates of 3.1, 2.6 and 6.1 ton/h and a plunger speed of 41 m/min, decreased fuel consumed by 3, 3 and 5%, power required by 3, 2 and 3% and energy requirements by 4, 3 and 2% during baling rice straw, wheat straw, and berseem hay respectively.

The reduction in baling power by increasing material moisture content to a certain limit is mainly because 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.

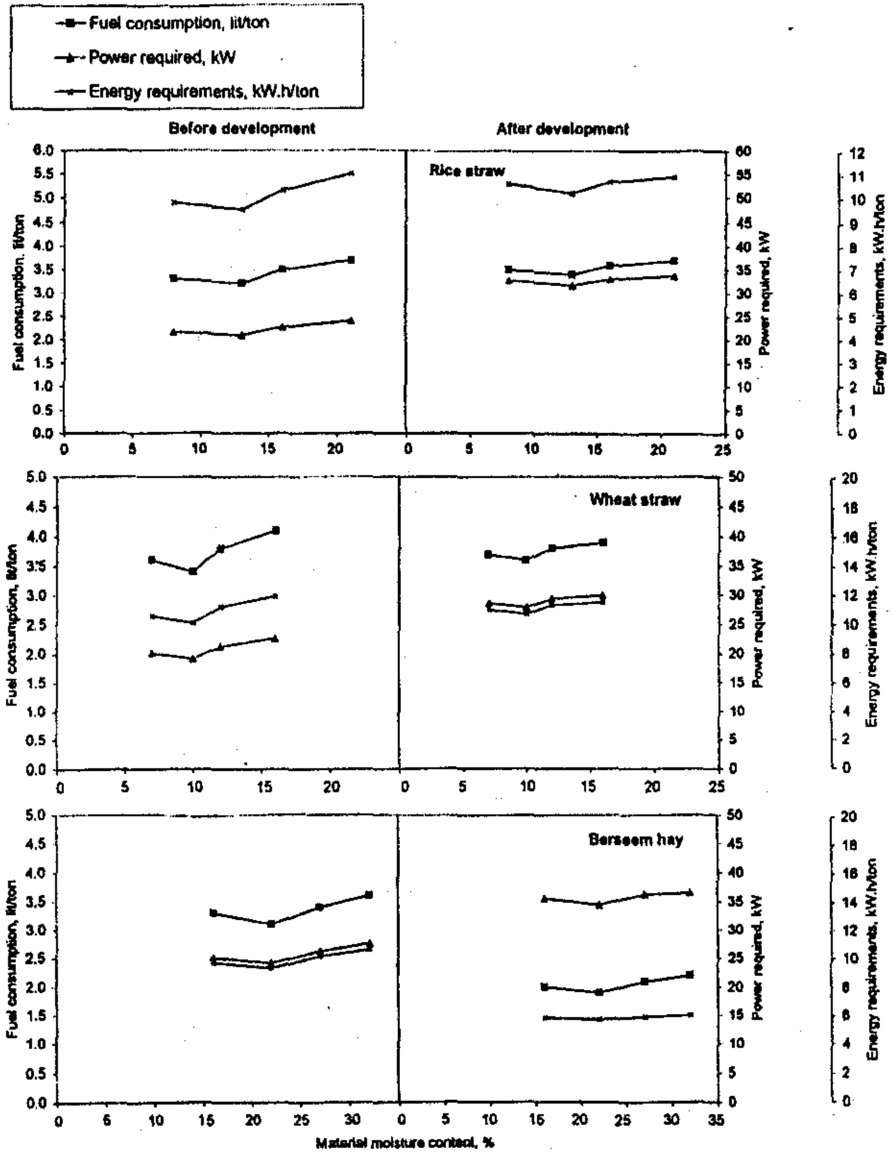


Fig. 6: Effect of material moisture content on fuel, power, and energy requirements for baling rice straw, wheat straw and berseem using stationary baler before and after development.

5. Effect of Plunger Speed on Bale Density, Size for Storing Bales and Number of Broken Bales

Results obtained show that increasing plunger speed, increased bale density and number of broken bales while size for storing bales decreased, Fig. 7.

Considering the use of stationary baler before development, increasing plunger speed from 12.8 to 32 m/min, at moisture content of 13, 10 and 22%, increased bale density by 4, 4 and 3% and number of broken bales by 40, 67 and 27%, resulting in decrease of size for storing bales by 4, 4 and 3%, during baling rice straw, wheat straw, and berseem hay respectively.

While with the use of stationary baler after development, results show that increasing plunger speed from 28.2 to 47.4 m/min, at moisture contents of 13, 10 and 22%, increased bale density by 3, 4 and 3% and number of broken bales by 33, 50 and 19%, resulting in decrease of size for storing bales by 4, 4 and 3%, during baling rice straw, wheat straw, and berseem hay respectively.

6. Effect of Plunger Speed on Fuel, Power and Energy Requirements

Results show that the use of stationary baler before development, increasing plunger speed from 12.8 to 32 m/min at feed rates of 2.2, 1.9 and 2.6 ton/h and moisture contents of 13, 10 and 22%, increased fuel consumption by 23, 26 and 24%, power required by 23, 24 and 23% and energy requirements by 23, 24 and 24%, during baling rice straw, wheat straw, and berseem hay respectively.

While with the use of stationary baler after development results show that increasing plunger speed from 28.2 to 47.4 m/min at feed rates of 3.1, 2.6 and 6.1% ton/h, and moisture contents of 13, 10 and 22%, increased fuel consumption by 19, 15 and 15%, power required by 18, 16 and 15% and energy requirements by 18, 16 and 15%, during baling rice straw, wheat straw, and berseem hay respectively, Fig. 8.

The increase of baling power by increasing plunger speed is attributed to greater number of plunger revolutions per minute, resulting in high force, requiring more fuel, and consequently more power and energy.

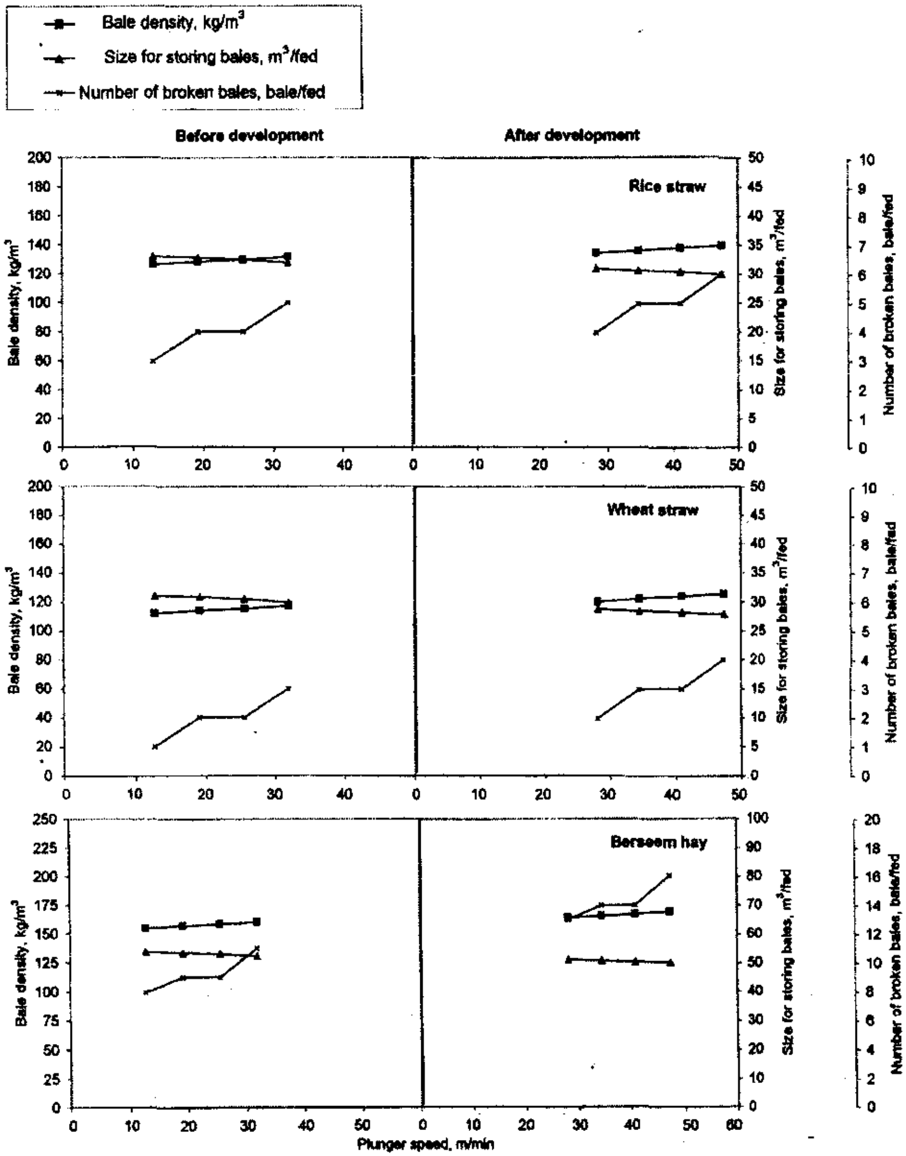


Fig. 7: Effect of plunger speed on bale density, size for storing bales and number of broken bales during baling rice straw, wheat straw and berseem using stationary baler before and after development.

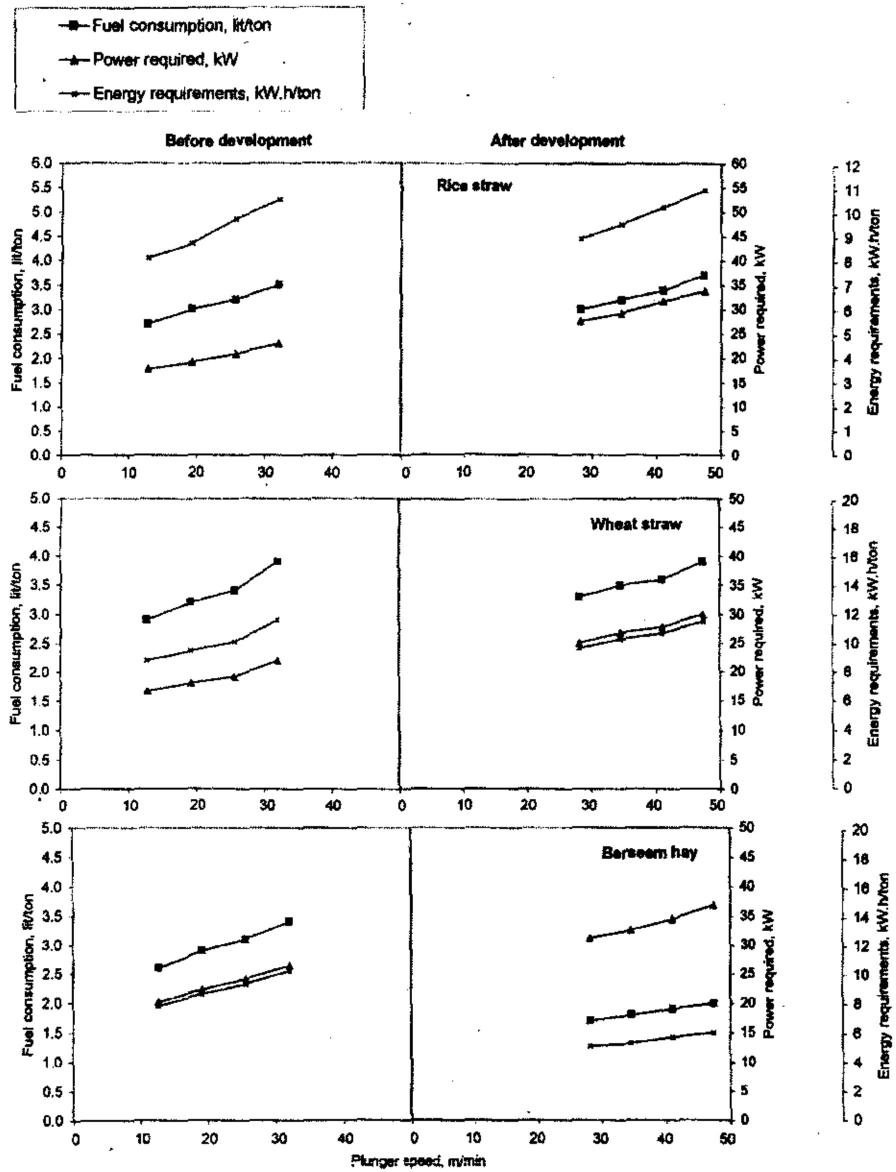


Fig. 8: Effect of plunger speed on fuel, power, and energy requirements for baling rice straw, wheat straw and berseem using stationary baler before and after development.

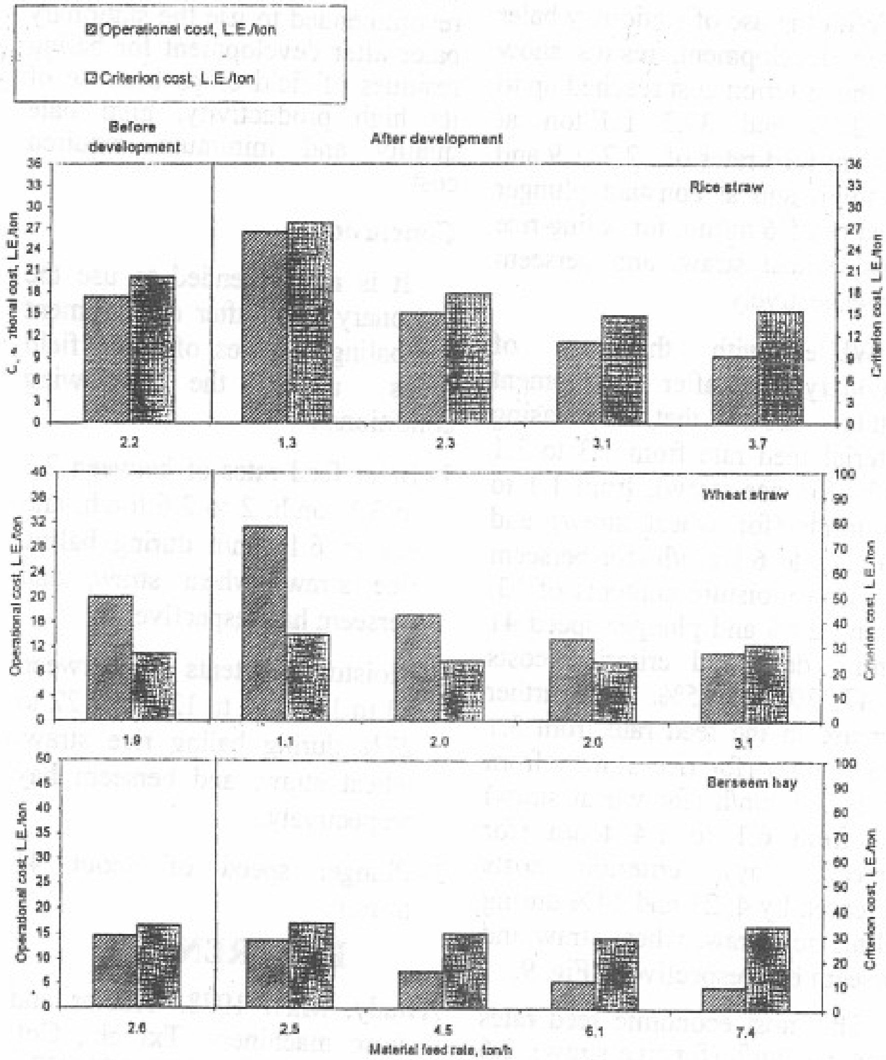


Fig. 9: Effect of material feed rate on opreration and criterion cost during baling rice straw, wheat straw and berseem using stationary baler before and after development.

7. Baling Criterion Cost

With the use of stationary baler before development, results show that the criterion cost reached up to 20, 27.3 and 33.2 L.E/ton at constant feed rates of 2.2, 1.9 and 2.6 ton/h and at constant plunger speed of 25.6 m/min for baling rice straw, wheat straw, and berseem hay respectively.

While with the use of stationary baler after development results show that increasing material feed rate from 1.3 to 3.1 ton/h (for rice straw), from 1.1 to 2.6 ton/h (for wheat straw) and from 2.5 to 6.1 ton/h (for berseem hay) at a moisture contents of 13, 10 and 22% and plunger speed 41 m/min. decreased criterion costs by 47, 30 and 15%. Any further increase in the feed rate from 3.1 to 3.7 ton/h (for rice straw), from 2.6 to 3.1 ton/h (for wheat straw) and from 6.1 to 7.4 ton/h (for berseem hay), criterion costs increased by 4, 21 and 14% during baling rice straw, wheat straw and berseem hay respectively, Fig. 9.

The most economic feed rates were 3.1 ton/h (for rice straw), 2.6 ton/h (for wheat straw), and 6.1 ton/h (for berseem hay) respectively with the use of stationary baler after development. Results also show that the baler before development requires the maximum criterion cost comparing with the same baler after development. So, it can be recommended to use the stationary baler after development for baling residues of field crops because of its high productivity, high bale quality and minimum required cost.

Conclusions

It is recommended to use the stationary baler after development for baling residues of some field crops under the following conditions :

1- Baler feed rates of between 2.3 to 3.1 ton/h, 2 to 2.6 ton/h, and 4.5 to 6.1 ton/h during baling rice straw, wheat straw, and berseem hay respectively.

2- Moisture contents of between 13 to 16%, 10 to 12% and 22 to 27% during baling rice straw, wheat straw, and berseem hay respectively.

3- Plunger speed of about 41 m/min.

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تطوير المكبس الثابت لتحسين أدائه لعمل بالات من بعض بقايا المحاصيل الحقلية

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تم إجراء التجربة في حقل بردين بمحافظة الشرقية لتطوير المكبس الثابت لتحسين أدائه لكبس مخلفات حقلية لبعض المحاصيل الحقلية ومقارنة معدل أدائه مع نفس المكبس قبل التطوير.

أهداف هذا العمل:

١- تطوير المكبس الثابت لتحسين أدائه أثناء كبس محاصيل الأعلاف والمخلفات الحقلية.

٢- الحصول على القيم المثلي لمعدل التلقيم ونسبة رطوبة المحصول ومتوسط سرعة المكبس المؤثرة على أدائه.

٣- دراسة مقارنة لاقتصاديات المكبس الثابت قبل وبعد التطوير.

المكبس الثابت تم تطويره كما يلي:

- تغيير التغذية اليدوية للمكبس الثابت بتغذية ذاتية (آلية).
- تطوير جهاز نقل القدرة باستخدام صندوق تروس مع وصلة مرنة بدلا من الطارة والسير.
- إضافة سكينتين الأولي مثبتة علي جانب المكبس متحركة معه والثانية ثابتة في الجهة المقابلة المفتوحة من غرفة الكبس لقص القش مع عملية التغذية المستمرة.
- قطع من الخشب تم تصنيعها لوضعها لفصل البالات عن بعض.
- إضافة زحافة للبالة حتي تنزل البالة إلى الأرض بأمان.

تم تقييم المكبس الثابت قبل وبعد التطوير مع الأخذ في الاعتبار كثافة البالة، الاحتياجات الحجمية اللازمة لتخزين البالات، عدد البالات المكسورة، الوقود اللازم والقدرة، الطاقة المستهلكة، وتكاليف عملية الكبس.

من النتائج نوصي بإستخدام المكبس الثابت بعد التطوير لعمل بالات من بقايا بعض المحاصيل الحقلية تحت الظروف الآتية:

١- معدلات تلقيم ٢,٣ إلى ٣,١ طن / ساعة، ٢-٢,٦ طن/ ساعة، ٤,٥- ٦,١ طن/ ساعة خلال عمل بالات قش الأرز وتبن القمح ودريس البرسيم على الترتيب.

٢- نسبة رطوبة بين ١٣- ١٦%، ١٠ – ١٢%، ٢٢- ٢٧% خلال عمل بالات قش الأرز وتبن القمح ودريس البرسيم علي الترتيب.

٣- سرعة متوسطة للمكبس ٤١م/ الدقيقة.