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DEVELOPING THE DRUM OF THE TURKISH THRESHING MACHINE.

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ABSTRACT

A double cone shape drum device was developed, and inserted in the construction of the Turkish threshing machine in order to increase the machine threshing efficiency and capacity, and to improve the threshed grain quality. The wheat threshing by the investigated machine before and after development was tested, compared, and evaluated versus different drum speeds and grain moisture content levels.

The comparison, and evaluation based on the threshing efficiency related to the percent of un-threshed grain; the grain quality related to the percent of damaged grain; and the machine threshing capacity related to the drum speeds.

The results showed that the wheat threshing efficiency was ranged from 96.8 to 99.3%), % for the developed thresher, while it was nearly from 92.6 to 97.25% for the Turkish thresher before development. The results also indicated a marked improvement in the final grain quality for the thresher equipped with the developed drum (95.88%) compared to the thresher before development (93.13%).

In general replacing the developed drum device instead of the traditional one in the construction of the Turkish threshing machine led to increase the machine capacity by about 12.6 % ,and was very competitive.

INTRODUCTION

Wheat crop is an important strategic crop in world, because it is considered the most economical crop in the international income. Therefore increasing the wheat grain yield and quality by decreasing grain losses and damage during harvesting and threshing operations are viable subjects to be investigated. In fact, there are many factors affecting the performance of threshing machines such as the drum design assembly, cylinder speed, feeding rate and grain moisture content But the drum design assembly, plays the key role in determining the performance of threshers.

Klenin *et al* (1985) Unfortunately in Egypt there are many small workshops and manufactures that are producing the components of the threshing machines without regarding any scientific guidance.

Helmy (1988) compared two threshing machines, American (A) and Egyptian made (E) for threshing wheat. In the comparison, he tested three cylinder speeds (20,36,and 65 m/s), five feed rates (0.06;0.13;0.19;I0.25 and 0.31 kg/s) over ranges of 13.6 to 08.8% and 9.7 to 13.5% (d.b) grain and straw moisture contents respectively. The comparison, based on the threshing efficiency, unit energy, total grain damage, un-threshed grain and cut straw length which recorded better for the thresher (A),and were 99.1%, 1 I.0 Kw.h/t, 6.5%, 0.8690 and 22.5% respectively.

He strongly recommended developing the local threshing machines for good performance, and showed that 20.52 m/s cylinder speed and 0.25 kg/s feed rate at18.8% and 13.5 grain and straw moisture contents were optimum conditions of the local thresher (B).

Morad (1997) investigated threshing machine performance in terms of grain losses, energy requirement and threshing cost as a function of wheat threshing. From the obtained data, the results indicated that threshing losses as will as threshing cost can be minimized when the feed rate of 1.0 ton/h drum speed of 25 m/s and moisture content of 20% are considered for the used machine. increasing feeding rate decrease machine threshing efficiency.

Abd El-Ghany and El-Sahar (1999) investigated the performance of a flail threshing machine at drum speeds of 11.20 and 36.7 m/s and feeding rates of 0.013, 0125 or 0.050 kg/s., for threshing bread wheat. Whereas, three selected wheat cultivars namely:- cv. (Giza-163 and Sids - 10), and durum wheat cv. (Sohag - 1) were dried to a moisture contents of about 9.8 and 7% and threshed in that thresher

They found that the broken grain percentage was higher in Sohag-1 than the other cultivars, at 8 and 9% moisture content than 7%, and it increases with increasing drum speed, but it was decrease with increased machine feeding rate.

Gill *et al.* (2002) studied the effects of various operational factors like feed rate and cylinder speed on wheat grain loss, cleaning efficiency, threshing efficiency of a spike tooth cylinder type plot thresher having dimensions of (925 x 700 x 925 mm) were studied. The feeding rates taken were 150.252 and 348 kg/h at each feed rate, the observations were taken at cylinder speed of 775,900 r.p.m and 1050 rpm. The optimum combination of feed rate and cylinder speed was found 252 kg/h and 900 rpm, respectively. At this combination the threshing efficiency, cleaning efficiency and total grain losses were 99.14, 99.97 and 1.3% respectively.

The present study is aimed to:-

1-Develop and replace a double cone shape drum device instead of the traditional drum in the construction of the Turkish thresher.

2-Asses, and evaluate the performance of the Turkish thresher, before and after drum development

3-Deduce and recommend the best operational parameters for the developed thresher after equipping the developed double cone shape drum device.

MATERIALS AND METHODS

The commonly grown wheat variety (Gimmeza, 10) was selected for carrying out the experiment. The machinery experimental tests were performed for the Turkish thresher before and after development during the agricultural summer season 2007 in a private farm at Alexandria Governorate.

The main specifications of the two threshing drums that utilized in the present study are given in table (1),and their respective sketched photograph views are shown in figs (1,and 2) respectively. Also, the elevation and plan views of whole Turkish thresher before and after development are shown in figs (3, and 4) respectively.

Table (1) the main specifications of the utilized drums

The drum specifications	**The Traditional drum**	**The developed drum**
Total drum length, mm	1200	1200
Main diameters, mm	700	700/420
No. of knives, dimensionless.	44 unwilled	104

Country made	Turkish	Egypt

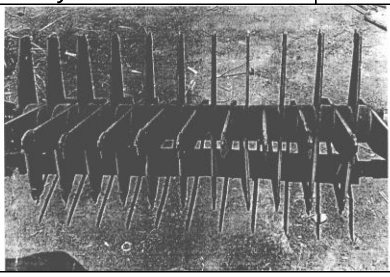
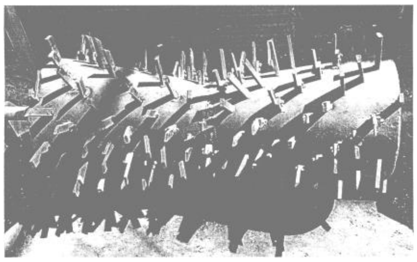

		

Fig. (l):Drum before development		**Fig. (2):Drum after development**

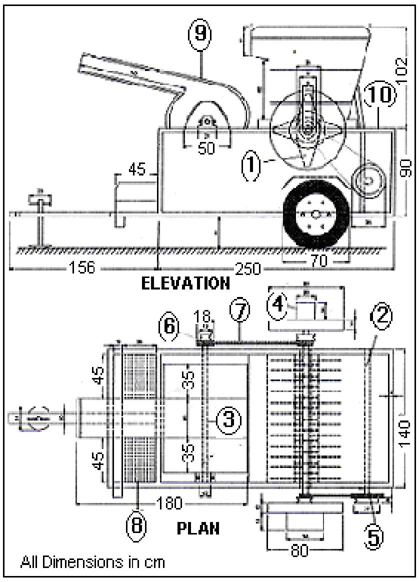
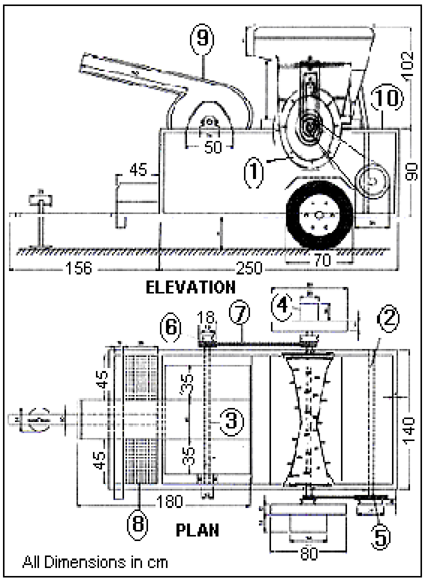

		

Fig. (3) elevation and plan views of the Turkish thresher before development.		**Fig. (4) elevation and plan views of the Turkish thresher after development**

No.	Part name	No.	Part name
1	Threshing drum	6	Fan pulley
2	Sieve shaft	7	V-Belt
3	Fan shaft	8	Sieve
4	Wheat pulley	9	Blower
5	Sieve pulley	10	Frame

As shown in figs. (3, and 4) the investigated machine consists of two main components threshing and winnowing units. The threshing unit consists of a drum and concave with holes. The winnowing unit consists of a fan, vibrating screen, and air pressure elevator for separating and cleaning of grains.

It should be denoted that some of the thresher adjustments were kept constants throughout the testing procedures such as: - The concave clearance is fixed at 35/25 mm as for inlet and outlet respectively, input and output orifice dimensions, the blower speed,

While, the following parameters were varied during carried out the performance tests:-

-**Threshing drum type**s, whereas, two threshing drum types were deduced namely: - the traditional (cylindrical drum shape), and the developed (double cone shape drum)

-**Threshing drum speed**, whereas, four different rotational speed levels were tested with each drum namely: - 800 r.p.m.(**S_1**), 1000 r.p.m.(**S_2**), 1200 r.p.m.(**S_3**), and 1400 r.p.m.(**S_4**).

-Grain moisture content, whereas, three different moisture content levels (d.b.) were tested with each drum namely :- 14.3(M_1); 11.2 (M_2; and (M_3= 9.1 %).

Each experimental test was repeated three times, thus a total of **72 tests**, were performed. Depending on the threshing drum speed, and the corresponding fed rate each test had its own time duration. For each threshing performance test, the data for determining the machine threshing efficiency (Thr.eff. %), the threshed grain quality (GQ %), and the Turkish thresher outlet capacity, (**Mca**).

The threshing efficiency (Thr.eff. %), was defined to be the threshed grain (Thr G) received at all outlets with respect to the total grain input (TG). It was expressed as percent by weight, and it could be calculated as follows:-

$$Thr.eff.\% = \frac{Thr.G}{TG} \times 100 \ldots\ldots\ldots\ldots(1)$$

The threshed grain quality (GQ %),. was defined to be the mass of undamaged grain (UDG) without partially or wholly broken grain that collected per unit time with respect to the total grain inlet weight (TG). The threshed grain quality (GQ %),. It could be calculated as follows:-

$$GQ\% = \frac{UNG}{TG} \times 100 \ldots\ldots\ldots\ldots(2)$$

The thresher output capacity (**Mca**), was defined to be the mass (Wt) of the total material per unit time at the main thresher outlets against different drum speeds, and grain moisture contents. It could be calculated as follows:-

$$Mca = \frac{W_t}{Tcons} \quad Kg/sec \ \ldots\ldots\ldots\ldots(3)$$

Where:-

Thr G = mass of threshed grains, kg.
UThr G = mass of un-threshed grains kg.
DG = mass of damaged grains, kg.
UDG = mass of un-damaged grains, kg.
Wt = the total material weight per unit time at the main thresher outlets
TG = mass of total grains input, kg.

Threshing losses (Thr. Loss) is including damaged and un-threshed grains. It can be calculated using the following equation:

Thr. Loss= DG+ UThr G…….(4)

RESULTS AND DISCUSSION

The performance data of Turkish thresher before and after drum development was compared and evaluated in terms of the machine threshing efficiency (Thr.eff. %), the threshed grain quality (GQ %), and the Turkish thresher output capacity, (**Mca**).

Machine Threshing Efficiency (Thr.eff.%),

Based on equation (1), the threshing efficiency (Thr.eff. %), of the Turkish thresher against different drum speed, and grain moisture content levels were calculated for the machine before and after drum development. The data obtained from the field for threshed and threshed grain weights were analyzed using Microsoft Excel Program.

Figs (5 and 6) in sequence summarize the average values of Thr.eff. %, associated with the Turkish thresher before and after drum development, and as affected by drums speed, and grain moisture content respectively,

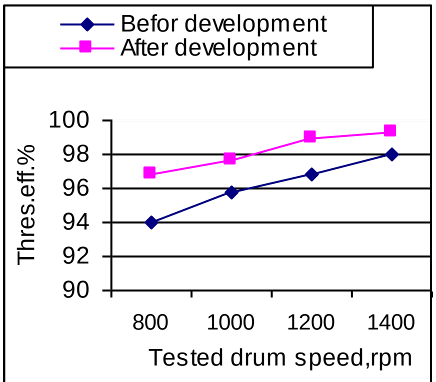


Fig (5) Threshing efficiency due to the drum development and as affected by drum speed

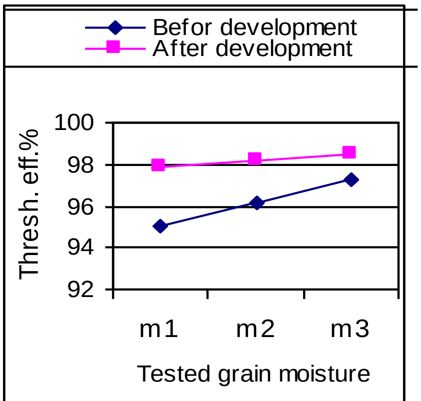


Fig (6) Threshing efficiency due to development and as affected by grain moisture

Comparing the threshing efficiency of the Turkish thresher before and after drum development at a particular set of operation conditions, it can be found that the developed drum often exhibited the highest threshing efficiency values. Figs (5, and 6) also indicate, that Thr.eff.%, is increased by increasing drum speed ,and by decreasing grain moisture content . But this trend was not clear in the case of developed drum type, in comparison with traditional drum type.

The maximum Thr.eff% value (99.3%), was recorded with the developed drum at rotational speed of 1400 rpm, and grain moisture content of 9.1 %. The minimum Thr.eff% value 94.2 % was associated with the traditional Turkish drum at rotational speed 800 rpm, and grain moisture content of 9.1 %.

The threshed grain quality (GQ %),

The effects of drum design assembly, drum rotational speed, and grain moisture content on the threshed grain quality (GQ %),.are shown in Figs (8, and 9).From these results, it can be found that the double cone shape drum was better grain quality (GQ %),.than the traditional cylindrical shape drum.

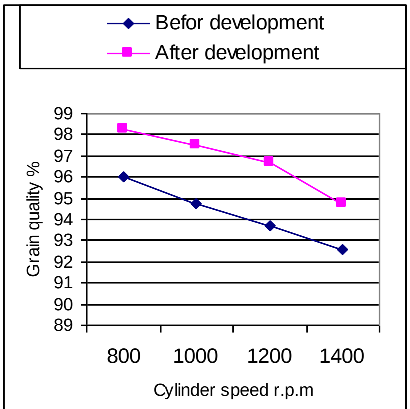
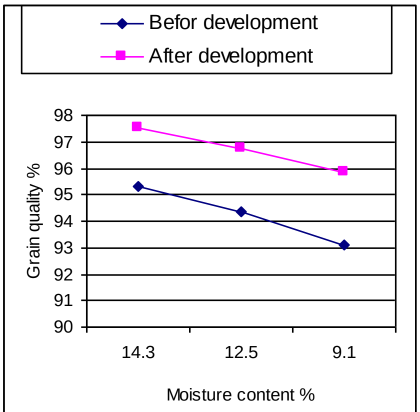


Fig (7) Grain quality due to the drum development and as affected by drum speed



Fig(8) Grain quality due to drum development and as affected by grain moisture content

Calculating the Threshing losses (Thr Loss) using equation (4) It can found that the maximum, and minimum (Thr Loss %) were 10.05 % and 9.70 % for the thresher before development. The corresponding (Thr Loss %) values for the thresher after development were, 6.80, and 4.6 %. That data revealed that the development of the drum led to decreasing Threshing losses (Thr Loss by about 5.5 %.

Thresher outlet capacity, (Mca).

The Turkish thresher outlet capacity (Mca), before and after drum development was evaluated. The obtained data of (Mca) is tabulated against different drum speed,grain moisture content and feed rates levels in table (2).

From Table (2), it can be seen in general that the outlet capacities of the local threshing machine before development are small in comparison with the outlet capacities that accompanied the thresher after development by about 12.6 %. That result trend may be attributed to the conical shape developed drum which applied the shearing method instead of the hammering method of the traditional cylindrical shape drum.

In addition, fig (9) illustrates the outlet capacity increments% due to the development, under different drum speeds, and feed rate levels. The shown data in fig (9) indicate that the maximum outlet capacity increments% was accomplished the developed drum speed of 1000 rpm at feed rate of 1 kg/sec ,while the minimum was accomplished the developed drum speed of 1400 rpm at feed rate of 0.5 kg/sec. That figure recommends to operate the developed drum at drum speed at speed from 1000 to 1200 rpm. Its also can be seen that increasing the feeding rate resulted in sensible outlet capacity increments%. But that trend was obviously clear at the slowest speed than the higher one.

Table (2) Turkish thresher outlet capacity (kg/sec) before, and after development, under different studied variables levels

Drum speed(r.p.m)	Feed rate (kg / s)	outlet capacity before development, under different moisture levels			outlet capacity after development, under different moisture levels		
		M1	M2	M3	M1	M2	M3
S1 (800)	0.50	0.44	0.46	0.47	0.46	0.48	0.50
	1.00	0.87	0.88	0.96	0.92	0.95	0.97
	1.50	1.31	1.34	1.35	1.39	1.41	1.45
AV(Mca)		0.87	0.89	0.93	0.92	0.95	0.97
S2 (1000)	0.50	0.46	0.47	0.48	0.47	0.49	0.49
	1.00	0.88	0.90	0.93	0.93	0.96	0.98
	1.50	1.33	1.36	1.40	1.41	1.43	1.46
AV(Mca)		0.89	0.91	0.94	0.94	0.96	0.98
S3 (1200)	0.50	0.47	0.48	0.49	0.48	0.49	0.50
	1.00	0.89	0.94	0.95	0.96	0.98	0.99
	1.50	1.35	1.38	1.40	1.43	1.46	1.48
AV(Mca)		0.90	0.93	0.95	0.96	0.98	0.99
S4 (1400)	0.50	0.47	0.48	0.49	0.49	0.50	0.50
	1.00	0.93	0.94	0.96	0.98	0.99	0.99
	1.50	1.38	1.41	1.43	1.46	1.47	1.49
AV(Mca)		0.93	0.94	0.96	0.95	0.95	0.95
Total Av.		0.90	0.92	0.94	0.94	0.96	0.97

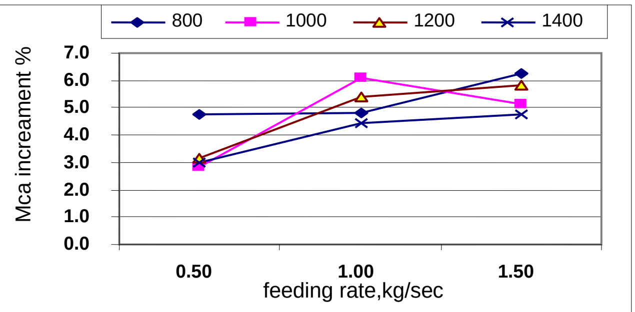


Fig (9) Mca increament % due to the development as affected by drum speed and feed rate

That result trend may also attribute to apply the shearing method instead of the hammering method of the traditional cylindrical shape drum.

SUMMAR AND CONCLUSIONS

It was necessary to develop the local threshing machine to increase its efficiency, capacity quality. This modification includes the development of both the drum and concave shapes of the Turkish threshing machine.

The comparison and evaluation between the thresher before and after developments revealed the following important results:-

The developed drum had the highest threshing efficiency (98.50%), and the least breakage of grain (1.0%) in comparison with the traditional cylindrical shape drum.

The highest threshing efficiency (98.50%) for the developed drum was observed at 1400 rpm and moisture content of 9.1 %. While the lowest was achieved at 800 rpm and moisture content of 14.3 %

The threshed grain quality (GQ %),for the developed drum was better at 1200 rpm and grain moisture content of 9.1 %, whereas, the least grain broken percentage of 1.0 % was achieved.

The double cone shape drum with a rotational speed ranging from 1000to1200 rpm is recommended to be used for developing the Turkish threshing machine for increasing the traditional Turkish thresher outlet capacity (Mca) by about 12%.

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تطوير درفيل آلة الدراس التركية

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تم تصميم درفيل دراس عبارة عن مخروطين يمثل القطر الأكبر لهما الأطراف الخارجية للدرفيل بقطر (70سم خارجا) بينما يتجمع القطران الأصغران في منتصف الدرفيل بقطر داخلي 42سم والدرفيل المطور يمتد بنفس طول درفيل ماكينة الدراس التركية وبطول 120سم

حيث تم تركيبه على آلة الدراس التركية ومقارنة أداء الماكينة في دراس محصول القمح قبل التطوير وبعد التطوير تحت ظروف تشغيل واحدة تضمنت اختبار ثلاثة مستويات نسبة رطوبة 14.3% ، 12.5% ، 9.1% وأربع سرعات لدرفيل الدراس 800 r.p.m و 1000 r.p.m و 1200 r.p.m و1400 r.p.m ومعدلات تلقيم تراوحت ما بين 0.5 إلى 1.5 كجم/ثانية مع اعتبار إن خلوص الدرفيل (20 /30) داخلي / خارجي ثا بت وكذلك معدل التلقيم .

وقد أجريت هذه تجارب اختبارات آلة الدراس فبل وبعد تطوير درفيل الدراس فى مزرعة خاصة بأحد الباحثين بمحافظة الإسكندرية وتابعة لمنطقه العامرية قرية البصرة. وقد أظهرت النتائج المتحصل عليها ما يلي:

1- أدى إحلال الدرفيل المطور ضمن تركيب آلة الدراس التركية مكان الدرفيل التقليدي الاسطواني تأثير واضح على زيادة كفاءة الدراس بمقدار 6% وتحسين جودة الحبوب بنسبة 9% وزيادة سعة إخراج الآلة بمقدار12 %

2-. أنسب سرعة لتشغيل الدرفيل المطور هى 1200 لفة/دقيقة بينما انسب رطوبة حبوب هي 9.1 %

3- يوصى باستخدام تصميمات درافيل الدراس ذات الشكل المخروطي واختبارها لدراس مع محاصيل أخرى غير القمح.