FARM MACHINERY AND POWER

SELECTING THE PROPER CONDITIONS FOR THRESHING LENTIL AND BEAN

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ABSTRACT

Filed experiments were carried out to select the optimum conditions for threshing both lentil and bean in order to minimize energy consumed and criterion cost under Egyptian conditions. All experiments were conducted under three variables for both lentil and bean: four material feed rates of (0.7, 0.75, 0.8 and 0.85) Mg/h and (0.6, 0.65, 0.7 and 0.75) Mg/h, four drum speeds of 450, 480, 510 and 540 rpm and 460, 490, 520 and 550 rpm and four seed moisture contents (wb) of (14.1, 12.3, 10.6 and 9.7 %) and (13.5, 12.4, 10.2 and 9.1 %)for lentil and bean, respectively. Threshing machine performance was evaluated in terms of threshing losses, threshing and cleaning efficiency, energy requirements and criterion cost. The experimental results reveal to the following:

- *The suitable feed rates to thresh lentil and bean were 0.8 and 0.7 Mg/h, respectively.*
- *The proper drum speed for threshing lentil and bean were 510 and 520 rpm, respectively.*
- *The optimum seed moisture content suitable for threshing lentil and bean were 10.6 and 10.2 %, respectively.*

INTRODUCTION

Lentil and bean are considered two of the most important legumes crops all over the world. Agricultural policy depends on the successful technology through mechanizing the agricultural processes of strategicall crops. Many researches are deducing in the scope of mechanical threshing of some crops such as: wheat, rice, soybean, peanut, lupine and chickpea. But threshing of lentil (*lens exculenta*) and bean (*Phaseolus vulgaris L.*) crops are still threshed manually in Egypt. The seeds of lentil contain 23.7 % of protein and 45 % of carbohydrates. The total lentil cultivated area in Egypt are about 75238.1 feddan yearly producing about 45000 Mg with an average yield of 0.598 Mg /fed according to http://www.reefnet.gov.sy/agri/lentils.

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The seeds of bean contain 13 to 33 % of protein, 40 to 55% of carbohydrates and 4 to 10% of oil, **Stallknecht *et al.* (1995)**. The total bean cultivated area in Egypt devoted for dry seeds at 2010 are about 47000 feddans yearly producing about 53000 Mg with an average yield of 1.13 Mg /fed according to **Agricultural Economic Bulletin(2010)**. In addition, both lentil and bean are considered two of the crops which play an important role in the improvement of soil properties especially in new reclaimed lands as they contains vitamins A and B. Lentil is currently used in human feeding dry seeds but bean is currently used in human feeding either green pods or dry seeds. More over lentil and bean residues serve as a filling material for animal feed. **Greven et al. (2001)** reported that the most common reason for poor seed quality in large seeded legumes were occur when seeds are threshed at unsuitable seed moisture content and at high drum speed. **Souza et al. (2002)** reported that the best seed germination, vigor and purity of bean seeds and also lowest seed damage were obtained with 14.1% seed moisture content and a threshing cylinder velocity of 420 rpm. **Greven et al. (2004)** stated that after harvesting but not threshing of bean seeds before maximum seed weight had been reached leaving seeds in the pod had a significant influence on final seed size and viability. The quality of bean seeds depends on many pre and post-harvest factors, such as area of production, cultivation techniques, seed maturity, harvest, threshing, and processing of storage conditions. **Moussa (2006)** studied the performance of threshing machine with three different legume crops (soybean, lentil and chickpea) in term of grain loss, grain damage, energy requirements and threshing cost as a function of change in cylinder speed 10, 12 and 14 m/s, feed rate (600, 800 and 900 kg/h) and grain moisture content (10, 12.12 and 14.1 %) for soybean, (10.12, 12.16 and 13.78 %) for lentil and (9, 10.7 and 11.53 %) for chickpea. He found that the highest values of grain damage were 1.63, 1.42 and 1.25 % at feed rates of 600, 800 and 900 kg/h, respectively at drum speed of 14 m/s and grain moisture content of 10.12 %. Also the highest values of un-threshed grain were 2.03, 2.47 and 3.0 % at feed rates of 600, 800 and 900 kg/h, respectively at drum speed of 10 m/s and grain moisture content of 13.78 % for lentil. The highest values of threshing efficiencies were 98.74, 97.68 and 97.46

% at feed rates of 600, 800 and 900 kg/h, respectively at drum speed of 14 m/s and grain moisture content of 10.12 % for lentil. The highest and lowest criterion costs of lentil were 190.15 and 126.1 L.E. /fed at drum speed of (550 and 500) rpm and grain moisture content of (13.78 and 10.12 %), respectively. **Morad, *et. al*. (2007)** studied the threshing operation of cowpea crop at different drum speeds, and different seed moisture contents. They found that drum speed of 19.10 m/s (500 r.p.m) and seed moisture content of 9.52 % are considered the proper values for threshing cowpea crop as they recorded maximum efficiency, minimum energy and minimum cost**. Zaalouk (2009)** evaluated local machine performance for threshing dry bean. Threshing drum speeds tested were 11.72, 13.18 and 15.38 m/sec., feed rates of 10, 15 and 20 kg /min and seed was used at moisture contents of 13.56, 11.53 and 9.20 %. The obtained results show that, the local threshing machine can be successfully used for threshing bean under the following conditions: seed moisture content of 9.20 % drum speed of 15.38 m/sec and feed rate of 20 kg /min, resulting in seed damage of 2.17 % and un-threshed seed of 1.48 %, threshing efficiency of 98.52 %, consumed power of 14.70 kW and criterion cost of 143.20 L.E /ton including operation and losses. **Abd El-Atty, *et. al*.(2012)** investigated the threshing operation of bean under three different drum speeds of 400, 500 and 600 rpm and three moisture contents (db) of 8.61, 11.33 and 17.82 % at a constant feed rate of 185 kg/h. He found that the optimum conditions for threshing bean were drum speed of 500 rpm and moisture content (db) of 11.33 %. **Suleiman *et. al*. (2012)** stated that bean seeds were removed by hand or by mechanical threshing at different seed moisture contents from 20% down to 11%. The lowest percentage of normal seedlings and significantly higher abnormal seedlings, as well as a higher incidence of cracked seed coats were found for machine threshed seeds at below 14% SMC. The field emergence at two sites showed evidence of reduced emergence in seeds that had been machine threshed at 11% SMC. These findings showed that bean seeds should not be harvested and threshed by machine at below 14% SMC if seed quality is to be maintained. This work has turned toward concept of mechanical threshing of lentil and bean. The objectives of this study are to select the optimum conditions for the

threshing operation of lentil and bean (feed rate, drum speed and seed moisture content) to minimize energy consumed and criterion cost under Egyptian conditions.

MATERIALS AND METHOD

The main field experiments were carried out for threshing lentil (Giza 51 variety) and bean (Giza 6 variety) crops in a private farm in Sharkia governorate during the agricultural seasons of 2011 and 2012 to select the optimum conditions for threshing lentil and bean. All experiments were conducted using a threshing Turkish type machine. The elevation and plan of Turkish thresher machine are shown in Fig. (1).

MATERIALS:

Threshing machine:

Made	Turkish		
Type of drum	Beater fingers	Concave holes (No./100 cm^2)	18
Drum diameter (cm)	73	Concave hole diameter (cm)	1.8
Drum length (cm)	120	Screen holes (No./100 cm^2)	40
Concave clearance (cm)	3	Screen holes diameter (cm)	1.4

The threshing machine was powered with Naser M34/T tractor with a four cylinder diesel engine – 60 hp (44.10 kW).

METHOD:

All experiments were conducted under three variables for lentil and bean: four material feed rates of (0.7, 0.75, 0.8 and 0.85) Mg/h and (0.6, 0.65, 0.7 and 0.75) Mg/h, four drum speeds of 450 (9.42), 480 (10.05), 510 (10.67) and 540 (11.3) rpm (m/s) and 460 (9.63), 490 (10.62), 520 (10.89) and 550 (11.51) rpm (m/s), respectively and four seed moisture contents (wb) of (14.1, 12.3, 10.6 and 9.7 %) and (13.5, 12.4, 10.2 and 9.1 %) for lentil and bean, respectively. The seed moisture content was determined on wet basis using the oven method at 105°C for 24 hours in the laboratory of Faculty of Agriculture, Zagazig University.

1-Threshing losses:

The threshing losses percentage (*TL*) including both un-threshed seed (U_nS) and mechanical seed damage (*M S D*) was calculated using the following equation, **(Mishram and Desta 1990)**:-

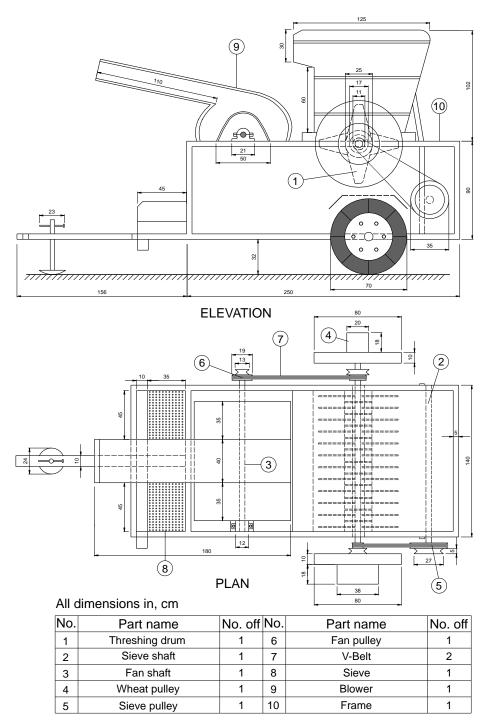$$TL,(\%) = \frac{UnS + MSD}{T_S} \times 100 ....(1)$$

ELEVATION

PLAN

All dimensions in, cm

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

Fig. (1): Elevation and plan of a Turkish threshing machine.

Where:

UnS = mass of un-threshed seeds per unit time, kg.

MSD = mass of damaged seeds collected at all outlets per unit time, kg.

T_S = mass of total seeds input per unit time, kg.

Un-threshed seed percentage was calculated as follows:-

$$UnS, (\%) = \frac{UnS}{T_S} \times 100 ....(2)$$

Mechanical seed damaged percentage was calculated as follows:-

$$MSD, (\%) = \frac{MSD}{T_S} \times 100 ....(3)$$

2-Threshing and cleaning efficiencies:

Both threshing and cleaning efficiencies were calculated according to the following equation:-

$$Threshing\ efficiency\ , (\%) = \frac{T_S - UnS}{T_S} \times 100 .....(4)$$

$$Cleaning\ efficiency\ , (\%) = \frac{W}{W_O} \times 100 ....(5)$$

Where:-

W = mass of seeds from the main output opening after cleaning, kg.

W_O = mass of seeds and small chaff from the main output opening, kg.

3-Energy requirements:

To estimate the engine power during threshing process, the decrease in fuel level is accurately measured immediately after each treatment. The following formula was used to estimate the corresponding used engine power (*EP*) according to **Hunt (1983)**.

$$EP = \left[f.c.(1/3600) PE \times L.C.V. \times 427 \times \eta_{thb} \times \eta_m \times 1/75 \times 1/1.36 \right], kW ....(6)$$

Solving equation (6), the engine power can be calculated as following:

$$Engine\ power(Diesel) = 3.16\ f.c., kW.. ....(7)$$

Where:-

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

PE = The density of fuel, (kg/*l*), (for Gas oil = 0.85).

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

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

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

η_m = Mechanical efficiency of the engine (٨٣ % for Diesel).

Hence, the energy requirements can be calculated as follows:-

$$Energy\ requirements = \frac{EP,(kW)}{Feed\ rate,(Mg/h)},\ kW.h/Mg................(7)$$

4- Threshing cost:

The total cost of threshing operation was estimated using the following equation, (**Awady** *et al.* **1982**):-

$Threshing\ cost,\ (L.E/\ Mg\ ) = Operating\ cost + Grain\ losses\ cost....$(8)

Operating cost was determined using the following equation:-

$$Operating\ \cos t = \frac{Machine\ \cos t\ (L.E/h)}{Feed\ rate\ (Mg/h)},(L.E/Mg)..................(9)$$

Machine cost could be determined using the following equation (**Awady 1978**):-

$$C = \frac{P}{h}\left(\frac{1}{a}+\frac{i}{2}+t+r\right)+(1.2W.S.F)+\frac{m}{144}.....................................(10)$$

Where:-

C = Hourly cost, L.E/h. P = Price of machine, L.E.

h = Yearly working hours, h/year. a = Life expectancy of the machine, h.

i = Interest rate/year. F = Fuel price, L.E/l.

t = Taxes, over heads ratio. r = Repairs and maintenance ratio.

m = Monthly average wage, L.E 0.9 = Factor accounting for lubrications.

W = Engine power, hp. S = Specific fuel consumption, l/hp.h.

144 = Reasonable estimation of monthly working hours.

RESULTS AND DISCUSSION

Discussion will cover the results obtained under the following headings

1- Un-threshed, mechanical seed damaged, threshing losses, threshing efficiency and cleaning efficiency:

The un-threshed seeds as well as mechanical seed damaged are affected by many parameters such as material feed rate, threshing drum speed, grain moisture content, ..…etc.

1-1- Effect of material feed rate on un-threshed, mechanical seed damage, threshing losses, threshing efficiency and cleaning efficiency:

Results in Fig. (2) show the effect of lentil feed rate on the percentage of un-threshed seeds. Increasing lentil feed rate increased the percentage of

un-threshed seeds and decreased the percentage of mechanical seeds damage under all experimental conditions. Increasing feed rate from 0.7 to 0.85 Mg/h, increased the un-threshed seeds from 2.41 to 4.09 %, from 1.42 to 2.72 %, from 1.05 to 2.17 % and from 0.69 to 1.93 %, under constant drum speed of 510 rpm and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. While, increasing feed rate from 0.7 to 0.85 Mg/h, decreased mechanical seeds damage from 4.28 to 1.77 %, from 4.89 to 2.51 %, from 5.02 to 2.91 % and from 6.22 to 4.1 %, under the same previous conditions. Relating to the effect of lentil feed rate on the percentage of threshing losses, Fig. (2) shows that increasing feed rate, decreased threshing losses up to 0.8 Mg/h. Any further feed rate increase, up to 0.85 Mg/h, increased threshing losses. Increasing feed rate from 0.7 to 0.85 Mg/h, decreased threshing losses from 6.69 to 5.86 %, from 6.31 to 5.23 %, from 6.07 to 5.08 %, and from 6.91 to 6.03 %, under constant drum speed of 510 rpm and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively.

Results in Fig. (2) show the effect of lentil feed rate on the percentage of threshing efficiency and cleaning efficiency. Increasing lentil feed rate decreased both the percentage of threshing and cleaning efficiencies under all experimental conditions. Increasing feed rate from 0.7 to 0.85 Mg/h, decreased threshing efficiency from 97.59 to 95.91 %, from 98.58 to 97.28 %, from 98.95 to 97.83 % and from 99.31 to 98.07 %%, under constant drum speed of 510 rpm and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. Also, increasing feed rate from 0.7 to 0.85 Mg/h, decreased cleaning efficiency from 96.08 to 92.54 %, from 97.04 to 94.42 %, from 97.84 to 95.22 % and from 98.44 to 96.03 %%, under the same previous conditions.

Results in Fig. (2) show the effect of bean feed rate on the percentage of un-threshed seeds. Increasing bean feed rate increased the percentage of un-threshed seeds and decreased the percentage of mechanical seeds damage under all experimental conditions. Increasing feed rate from 0.6 to 0.75 Mg/h, increased the un-threshed seeds from 2.67 to 4.15 %, from 1.51 to 2.91 %, from 1.12 to 2.44 % and from 0.74 to 1.95 %, under constant drum speed of 520 rpm and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively. While, increasing feed rate from
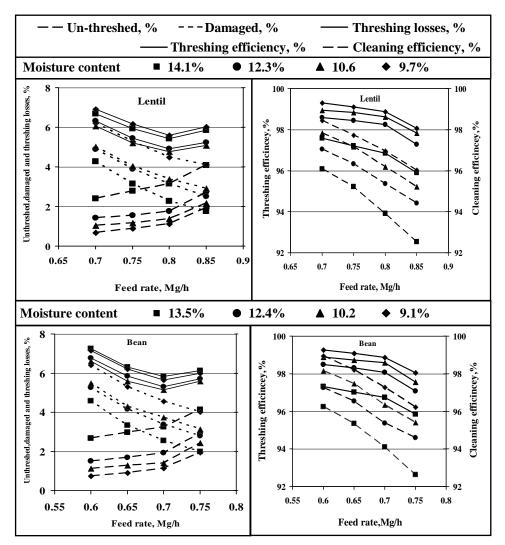
Fig (2): Effect of lentil and bean feed rate on un-threshed, damaged, threshing losses, threshing efficiency and cleaning efficiency under different seed moisture contents (D.S. = 510 rpm for lentil and 520 rpm for bean).

0.6 to 0.75 Mg/h, decreased mechanical seeds damage from 4.59 to 1.98 %, from 5.26 to 2.8 %, from 5.49 to 3.14 % and from 6.41 to 4.03 %, under the same previous conditions. Relating to the effect of bean feed rate on the percentage of threshing losses, Fig. (2) show that increasing feed rate, decreased threshing losses up to 0.7 Mg/h. Any further feed rate increase, up to 0.75 Mg/h, increased threshing losses. Increasing feed rate

from 0.6 to 0.75 Mg/h, decreased threshing losses from 7.26 to 6.13 %, from 6.77 to 5.71 %, from 6.61 to 5.58 %, and from 7.15 to 5.98 %, under constant drum speed of 520 rpm and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively.

Results in Fig. (2) show the effect of bean feed rate on the percentage of threshing efficiency and cleaning efficiency. Concerning increasing bean feed rate decreased both the percentage of threshing and cleaning efficiency under all experimental conditions. Increasing feed rate from 0.6 to 0.75 Mg/h, decreased threshing efficiency from 97.٣٣ to 95.85 %, from 98.49 to 97.09 %, from 98.88 to 97.56 % and from 99.26 to 98.05 %, under constant drum speed of 520 rpm and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively. Also, increasing feed rate from 0.6 to 0.75 Mg/h, decreased cleaning efficiency from 96.24 to 92.64 %, from 97.26 to 94.61 %, from 98.15 to 95.41 % and from 98.94 to 96.23 %, under the same previous conditions.

1-2- *Effect of drum speed on un-threshed, mechanical seed damage, threshing losses, threshing efficiency and cleaning efficiency:*

Results in Fig. (3) show the effect of drum speed on the percentage of un-threshed seeds. Increasing drum speed, decreased the percentage of un-threshed seeds and increased the percentage of mechanical seeds damage under all experimental conditions. Increasing drum speed from 450 to 540 rpm, decreased the un-threshed seeds from 5.73 to 2.11 rpm, from 4.67 to 1.46 rpm, from 4.11 to 1.03 rpm and from 3.45 to 0.78 rpm, under constant lentil feed rate of 0.8 Mg/h, and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. While, increasing drum speed from 450 to 540 rpm increased mechanical seeds damage from 0.76 to 3.86 rpm, from 1.62 to 4.13 rpm, from 1.87 to 4.38 rpm and from 3.22 to 5.36 rpm, under the same previous conditions. Relating to the effect of drum speed on the percentage of threshing losses. Fig. (3) shows that increasing drum speed, decreased threshing losses up to 510 rpm. Any further drum speed increase, up to 540 rpm, increased threshing losses. Increasing drum speed from 450 to 540 rpm decreased threshing losses from 6.49 to 5.97 %, from 6.29 to 5.59 %, from 5.98 to 5.41 %, and from
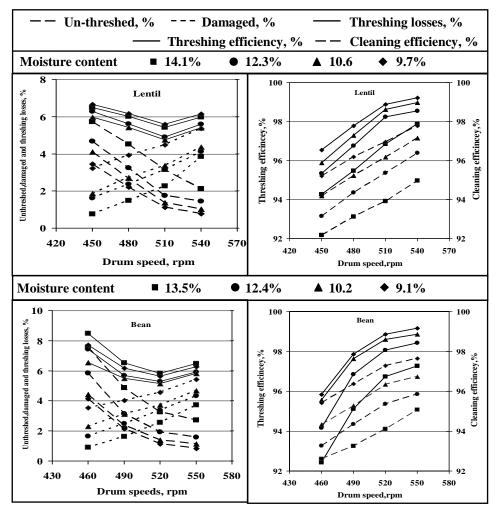
Fig (3): Effect of drum speed on un-threshed, damaged, threshing losses, threshing efficiency and cleaning efficiency under different seed moisture contents (F.R. =0.8 Mg/h for lentil and 0.7 Mg/h for bean).

6.67 to 6.14 % under constant lentil feed rate of 0.8 Mg/h, and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. Results in Fig. (3) show the effect of drum speed on the percentage of threshing efficiency and cleaning efficiency. Increasing drum speed, increased both the percentage of threshing and cleaning efficiency under all experimental conditions. Increasing drum speed from 450 to 540 rpm increased threshing efficiency from 94.27 to 97.89 %, from 95.33 to 98.54 %, from

95.89 to 98.97 % and from 96.55 to 99.22 %, under constant lentil feed rate of 0.8 Mg/h, and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. Also, increasing drum speed from 450 to 540 rpm, increased cleaning efficiency from 92.17 to 94.97 %, from 93.14 to 96.39 %, from 94.18 to 97.15 % and from 95.21 to 97.78 %, under the same previous conditions.

Results in Fig. (3) show the effect of drum speed on the percentage of un-threshed seeds. Increasing drum speed, decreased the percentage of un-threshed seeds and increased the percentage of mechanical seeds damage under all experimental conditions. Increasing drum speed from 460 to 550 rpm decreased the un-threshed seeds from 7.57 to 2.73 rpm, from 5.84 to 1.58 rpm, from 4.43 to 1.14 rpm and from 4.16 to 0.84 rpm, under constant bean feed rate of 0.7 Mg/h, and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively. While, increasing drum speed from 460 to 550 rpm increased mechanical seeds damage from 0.91 to 3.74 rpm, from 1.65 to 4.34 rpm, from 2.31 to 4.69 rpm and from 3.55 to 5.42 rpm, under the same previous conditions. Relating to the effect of drum speed on the percentage of threshing losses. Fig.(3) show that increasing drum speed, decreased threshing losses up to 520 rpm. Any further drum speed increase, up to 550 rpm, increased threshing losses. Increasing drum speed from 460 to 550 rpm decreased threshing losses from 8.48 to 6.47 %, from 7.44 to 5.92 %, from 6.54 to 5.83 %, and from 7.71 to 6.26 % under constant bean feed rate of 0.7 Mg/h, and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively. Results in Fig. (3) show the effect of drum speed on the percentage of threshing efficiency and cleaning efficiency. Increasing drum speed, increased both the percentage of threshing and cleaning efficiency under all experimental conditions. Increasing drum speed from 460 to 550 rpm increased threshing efficiency from 92.43 to 97.27 %, from 94.16 to 98.42 %, from 95.57 to 98.86 % and from 95.84 to 99.16 %, under constant bean feed rate of 0.7 Mg/h, and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively. Also, Increasing drum speed from 460 to 550 rpm, increased cleaning efficiency from 92.61 to 95.08 %, from 93.27 to 95.86 %, from 94.34 to 96.74 % and from 95.42 to 97.64 %, under the same previous conditions.

2- Energy requirements:

The energy requirements are a measure for all parameters affecting the threshing operation. It increased as increasing the material feed rate, threshing drum speed and seed moisture content.

2-1- Effect of material feed rate on energy requirements:

Results obtained in Fig. (4) show that increasing lentil feed rate increased the value of energy requirements under all experimental conditions. Increasing feed rate from 0.7 to 0.85 Mg/h, increased the percentage of energy requirements by 7.69 %, 5.02, 3.4 and 5.42 %, under constant drum speed of 510 rpm and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. Results obtained in Fig. (4) show that increasing bean feed rate increased the value of energy requirements under all experimental conditions. Increasing feed rate from 0.6 to 0.75 Mg/h, increased the percentage of energy requirements by 6.32 %, 4.21, 7.1 and 5.68 %, under constant drum speed of 520 rpm and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively. The increase in the percentage of energy requirements by increasing material feed rate is attributed to the excessive lentil and bean materials in the threshing chamber, that increase the load on the threshing drum caused more fuel consumed.

2-2- Effect of drum speed on energy requirements:

Results obtained in Fig. (4) show that increasing drum speed increased the value of energy requirements under all experimental conditions. Increasing feed rate from 450 to 540 rpm, increased the percentage of energy requirements by 9.97 %, 8.14, 7.81 and 7.18 %, under constant lentil feed rate 0.8 Mg/h, and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. Results obtained in Fig. (4) show that increasing drum speed increased the value of energy requirements under all experimental conditions. Increasing drum speed from 460 to 550 rpm, increased the percentage of energy requirements by 9.2 %, 13.43, 13.7 and 12.27 %, under constant bean feed rate 0.7 Mg/h, and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively.

3- Criterion cost:

3-1- Effect of material feed rate on Criterion cost:

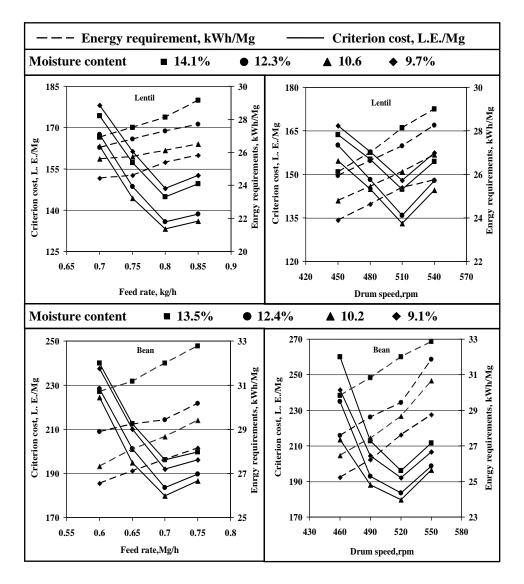Relating to the effect of lentil feed rate on criterion cost. Fig. (4) show

Fig (4): Effect of feed rate and drum speed on energy requirement and Criterion cost under different seed moisture contents.

that increasing feed rate, decreased criterion cost up to 0.8 Mg/h. Any further feed rate increase, up to 0.85 Mg/h, increased criterion cost. Increasing feed rate from 0.7 to 0.85 Mg/h, decreased criterion cost from 174.2 to 149.6 L.E./Mg, from 167.5 to 138.5 L.E./Mg, from 163.3 to 136 L.E./Mg, and from 178.04 to 152.6 L.E./Mg, under constant drum speed of 510 rpm and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. Relating to the effect of bean feed rate on criterion cost.

Fig. (4) show that increasing feed rate, decreased criterion cost up to 0.7 Mg/h. Any further feed rate increase, up to 0.75 Mg/h, increased criterion cost. Increasing feed rate from 0.6 to 0.75 Mg/h, decreased criterion cost from 240.01 to 199.8 L.E./Mg, from 228.33 to 189.73 L.E./Mg, from 224.5 to 186.6 L.E./Mg, and from 237.5 to 196.2 L.E./Mg, under constant drum speed of 520 rpm and different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively.

3-2- Effect of drum speed on Criterion cost:

Relating to the effect of drum speed on criterion cost. Fig. (4) shows that increasing drum speed, decreased criterion cost up to 510 rpm. Any further drum speed increase, up to 540 rpm, increased criterion cost. Increasing drum speed from 450 to 540 rpm decreased criterion cost from 163.6 to 154.45 %, from 160.1 to 147.8 %, from 154.63 to 144.6 %, and from 166.76 to 157.4 % under constant lentil feed rate of 0.8 Mg/h, and different seed moisture contents of 14.1, 12.3, 10.6 and 9.7 %, respectively. Relating to the effect of drum speed on criterion cost. Fig. (4) shows that increasing drum speed, decreased criterion cost up to 520 rpm. Any further drum speed increase, up to 550 rpm, increased criterion cost. Increasing drum speed from 460 to 550 rpm decreased criterion cost from 260 to 211.71 %, from 235 to 198.6 %, from 213.6 to 196.43 %, and from 241.5 to 206.71 % under constant bean feed rate of 0.7 Mg/h, different seed moisture contents of 13.5, 12.4, 10.2 and 9.1 %, respectively.

CONCLUSION

The field experiments aim to select the optimum conditions for the threshing operation of lentil and bean to minimize energy consumed and criterion cost under Egyptian conditions. The field experiments were carried out for threshing lentil and bean crops in a private farm in Sharkia governorate during the agricultural seasons of 2011 and 2012 to investigate some different systems using a threshing Turkish type machine. Results showed that the threshing efficiency were maximum while both threshing losses and criterion cost were minimum for lentil and bean, respectively under the following conditions:

- The proper feed rates are 0.8 and 0.7 Mg/h.
- The proper drum speeds are 510 and 520 rpm.
- The optimum seed moisture contents are 10.6 and 10.2 %.

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الملخص العربـــي

اختيــــار الظروف المناسبة لدراس العدس والفاصوليا

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يعد محصولى العدس والفاصوليا من أهم المحاصيل البقولية المستخدمة فى تغذية الإنسان والحيوان فى مصر ، حيث يحتوى العدس على(٢٣.٧%) بروتين، وعلى(٤٥%) كربوهيدرات وفي الطب يستعمل العدس كملين وهو يعادل اللحم في قيمته الغذائية فيما لو أضيف إليه الخبز، وهذا بالإضافة لاحتوائه على بعض العناصر المعدنية كالحديد والنحاس وعلى بعض العناصر اللامعدنية كالفوسفور والكالسيوم وعلى فيتامين (ب١). وتحتوى الفاصوليا على(١٣-٣٣%) بروتين، وعلى(٤٠-٥٥%) كربوهيدرات، و(٤-١٠%) زيوت، كما تستعمل عروشهما الخضراء علفاً للحيوانات، و في تسميد الأراضى الفقيرة بالأزوت وبالمواد العضوية وذلك بقلبهما في التربة عندما يكونان في طور الإزهار، ويستعمل تبن العدس لتغذية الأغنام والماعز. هذا وتعتبر عملية الدراس من أكثر العمليات الزراعية صعوبة على الفلاح المصري لأنها ما زالت تعتمد على الطريقة اليدوية خاصة للعدس والفاصوليا، والتي ينتج عنها فواقد كبيرة بالإضافة إلى تعريض الحبوب للتلف فكان لزاما على الباحث محاولة الوصول للظروف المثلى لدراس العدس والفاصوليا بآلة متوفرة فى مصر لرفع كفاءة عملية الدراس وتقليل فواقد الدراس، والطاقة المستهلكة والتكاليف الحدية. أجريت العديد من التجارب الحقلية لدراس العدس والفاصوليا خلال موسمى ٢٠١١، و٢٠١٢ في إحدى المزارع الخاصة بمحافظة الشرقية.

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وكان الهدف من الدراسة هو: اختيار الظروف المثلى لدراس العدس والفاصوليا (معدل التلقيم، سرعة درفيل الدراس، ونسبة رطوبة الحبوب).

واشتملت الدراسة علي المتغيرات التالية:

- أربعـــة معـــدلات تلقـــيم (٠.٧، ٠.٧٥، ٠.٨، و٠.٨٥)،و(٠.٦، ٠.٦٥، ٠.٧، ٠.٧٥، و٠.٨٥) ميجا جرام/ساعة لكل من العدس والفاصوليا على الترتيب.

- أربعـة سرعات لـدرفيل الـدراس (٤٥٠، ٤٨٠، ٥١٠، و ٥٤٠ لفة/دقيقـة)، و(٤٦٠، ٤٩٠، ٥٢٠، و ٥٥٠ لفة/دقيقة) لكل من العدس والفاصوليا على الترتيب.

- أربعة نسب لرطوبة الحبوب حسبت على أساس رطب (١٤.١، ١٢.٣، ١٠.٦، و٩.٧%)، و(١٣.٥، ١٢.٤، ١٠.٢، ٩.١ %) لكل من العدس والفاصوليا على الترتيب.

وقد تم تقييم المعاملات من حيث:

- نسبة الحبوب الغير مدروسة والمكسورة وفواقد الدراس.
- كفاءة الدراس والتنظيف.
- القدرة، والطاقة المستهلكة، والتكاليف الحدية لعملية الدراس.

وقد أظهرت النتائج ما يلى:

- أقل نسبة للحبوب الغير مدروسة كانت ١.٣٨، ١.٤% ، وأقل نسبة للحبوب المكسورة كانت ٣.٣٨، ٣.٧٤ % ، وأقل نسبة لفواقد الـدراس كانت ٤.٧٦، ٥.١٤ % ،أقل تكلفة حدية كانت (١٣٣.٢ ، و ١٧٩.٨) جنيه/ ميجا جرام وذلك عند معدل تلقيم (٠.٨ ، ٠.٧) ميجا جرام/س، وسرعة درفيل الدراس(٥١٠، و ٥٢٠) لفة/دقيقة، ونسبة رطوبة (١٠.٦، ١٠.٢ %) لكل من العدس والفاصوليا على الترتيب.

ومن خلال النتائج تم التوصل إلى التوصيات الآتية لدراس العدس والفاصوليا على الترتيب:

- معدل التلقيم (٠.٨ ، ٠.٧) ميجا جرام/ساعة.
- سرعة درفيل الدراس(٥١٠، و ٥٢٠) لفة/دقيقة.
- نسبة رطوبة الحبوب (١٠.٦، ١٠.٢ %).