Modification of a watermelon seed extracting machine

Shreen. F. A.*, S. F. Swilm

(Agricultural Engineering Research Institute, Agricultural Research Center, Egypt)

Abstract: This study was carried out at a private farm in Kfer Singabe District, Dikhlia governorate Egypt during 2015 summer season. The overall objective of the present investigation was to modify and evaluate the performance of a local manufactured machine for extracting seeds from watermelon seeds. Point three to develop machine: off the machine attached to tractor to propelled machine, used incline circle level instead of screw conveyor to decrease the energy required and increased the volume of feed rate by increasing the crushing drum length from of 850 mm to 1050 mm. the machine by determined the driving stability of machine (longitudinal, lateral and turn stability factor) and study the machine slip percentage. The developed equipment has been tested and evaluated considering different feeding rates of 80, 100, 120 and 140 kg/min with crushing drum speed 0.40, 0.82, 1.2 and 1.6 m/s, The effect of previous considered parameters on the performance of fabricated equipment were evaluated in terms of visible seed damage, the separation capacity, seed losses, cleaning efficiency, energy and cost requirements. The results of the developed machine illustrated that: 1) The angle of longitudinal stability factor should be less than 35 degree, the angle of lateral stability factor should be less than 8 degree and the suitable forward speed for developing machine were 1 to 4 m/s with turning radius 0.5 to 2 m By increasing feed rate from 80 to 140 kg/min, the visible seed damage was decreased by average 0.95% and the seed losses increased by average 2.43%. By increasing drum speed from 0.40 to 1.60 m/s the visible seed damage was increased by average of 0.80 and seed losses increased by average 1.60% and 4%. By using the developed machine the power consumed was decreased by average 52.48% and saved the cost by average 31%.

Keywords: A local, machine, extracted, watermelon seeds, self propelled.

Citation: Shreen. F. A., and S. F. Swilm 2016. Modification of a watermelon seed extracting machine. Agricultural Engineering International: CIGR Journal, 18(3):94-105.

1 Introduction

Seed melon (Colocynthis citrullus), belongs to the Cucurbitaceae family, is a strategic vegetable product in Egypt that can be exported to several Arab countries and cultivated in the arid and semi-arid areas of northern half of the Nile Delta in Egypt, and newly cultivated in reclaimed land**.** Abdel-Mageed et al. (2006) designed and evaluated stable equipment for watermelon seeds. The developed equipment, accomplishes the seed extraction by a combination of impact and rubbing actions. The hopper delivers the fruits across the orifice to the drum by gravitation. As the drum rotates, the knives on the drum crush (strike) the fruits. Since these knives are mounted at some angle to the drum axis, the crushed mass is displaced not only in the plane of the drum rotation, but also in its knife axial direction. The cutting parts are forced to transport through the gap between the concave and the drum to a central location on the drum. Then the fingers of the separating unit repeat impact and rubbing actions on the crushed mass. Consequently, most of the seeds and the liquid flesh

material pass through the concave holes and fall down ward on the inclined plate. The machine was taking the power from electric motor. Abu Shieshaa et al (2006) evaluated the effect of moisture content on some physical and mechanical properties of seed melon seeds and their kernel. The average length, width, thickness, mass and hardness of 100 seeds were 12.42, 7.80, 2.37 mm, 0.097 g and 64.8 N, respectively, at a seed moisture content of 9.53%

(w.b.) corresponding values of kernel were 10.5, 6.50, 1.64 mm, 0.061 g and 14.0 N. The increase of seed moisture content from 9.53% to 24.08% to increase the

Received date: 2016-03-20 **Accepted date:** 2016-04-15

***Corresponding author: Shreen. F. A.,** Agricultural Engineering Research Institute, Agricultural Research Center, Egypt. Email: shreenfouad@gmail.com

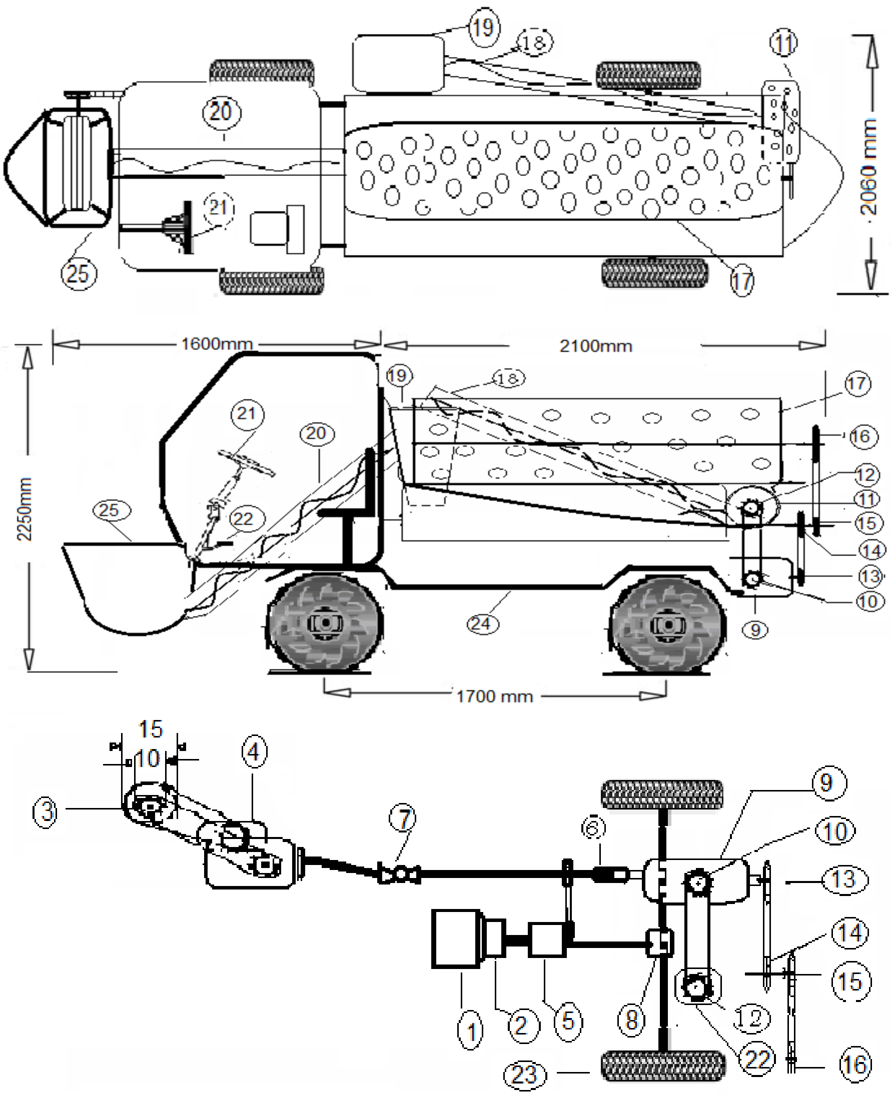
bulk density of seed and kernel from 490 to 600 and 510 to 640 kg/m^3, respectively. However, the true density of seed was decreased from 1160 to 1000 kg/m^3. The highest values of terminal velocity were 6.4, 4.67 and 3.94 for seed, kernel and hull, respectively, at seed moisture content of 24.08%. Same increase in seed moisture content increased the static coefficient of friction of seed from 0, 24 to 0.65, 0.23 to 0.80 and 0.34 to 0.90 for galvanize metal, stainless steel and plywood, respectively. Eliwa and Elfatih (2012) a local extraction watermelon seeds machine by cutting and smashing the fruits manually into two halves by using a knife then, the labor put two halves on two rotary conical units to separate the flesh and seeds from its peel. The crushing drum with plastic brush and welding with volute screw bolts which support the brush for separating seeds only from flesh. The machine was taking the power from electric motor. Abdrabo (2013) prototype to separate the seeds of watermelon pulp. The threshing drum of watermelon pulp consists of a cylinder of 155.0 cm in length with 30.0 cm diameter. The drum shaft passes through the center of the cylinder drum where a circular steel sheet is welded to close each of the drum ends. The threshing section width is 45 cm and consists of bars spike-tooth fixed on the drum surface. The other part of the drum is separating section width of 105.0 cm where one agitator bars and 10.0 cm height are fixed to the above mentioned bases spirally on the drum. The kernels separated here fall also into the front and rear conveying auger through. The machine was taking the motion from tractors. Shreen (2014) developed and evaluated the watermelon extracting machine; the machine was taking the motion from tractor. The results indicated that the maximum value of cleaning efficiency was 93.8% with concave clearance of 3 cm, drum speed of 0.46 m/s, knives number of 14 and feed rate of 60 kg/min the minimum value of 79.0% was obtained under concave clearance of 1 cm, drum speed of 1.4m/s, knives number of 6 and feed rate of 120 kg/min. The cost value of 1052 LE/t was achieved at feeding rate of 60 kg/min and drum speed of 1.4m/s. While, the least cost was estimated at 120 kg/min feed rate for all different ranges of drum speed. The developed unit saved about 61.4% and the cost per ton was 1052LE compared to the manual extraction.

The objectives of the present study were to treat some negative effects from using a local industrial machine by turning off the machine motion from tractor to self-propelled machine therefore, the movement of machine is facility and can any place in the field so, it decreased the time requirement and employees number.

2 Material and methods

The field experiments were carried out at Kfer Singabe District, Dikhlia governorate Egypt during agricultural summer season of 2015. In this experiment, watermelon Sakha 101 variety was used. The overall objective of present investigation was to develop, construct, and quantify the performance of a watermelon extracting machine. The developed machine had three sections: the front part was the crushing portion, consists of crushing drum and cut knives in the external peripheral of drum. Thus, the crushing drum crushes the materials and pushes them to screw conveyor. The center part was the separating portion ,has rotary hollow cylindrical tubular steel with big holes to allow the seeds pass but, the skin releasing were thrown out from the cylindrical end. Whereas the seeds fill down to incline circle level which deliver the seeds with small part and juice to second separate stage by using rotary hollow cylindrical tubular steel with small holes which throw away the small part and juice. This part delivers the seeds to screw conveyor which fill down the seeds to seed collection pan. This machine took the power from engine (79hp). Figure 1 shows a photograph view of fabricated equipment, while Figure 2 a schematic diagram of that equipment.

Figure 1 Photograph of the modified watermelon seed extracting machine



No	Part name	No	Part name	No	Part name
1	Engine	9	Gear box	17	Rotary hollow cylindrical tubular steel with big holes
2	Clutch	10	Gear,15cm diameter	18	Screw conveyor
3	Gear	11	Rotary hollow cylindrical tubular steel with small holes	19	Seed collection pan.
4	Karona arrive motion to screw conveyor (20)	12	Gear,10cm diameter	20	Screw conveyor
5	Gear box	13	Gear,5cm diameter	21	Drive wheel
6	Power shaft	14	Gear, 5cm diameter	22	Corona arrive motion to screw conveyor (18)
7	Bearing	15	Gear,20 cm diameter	23 24	Wheel Chassis
8	Power distribution device	16	Gear, 5cm diameter	25	Crush pan

Figure 2 and rather than a table: Schematic diagram of the modified watermelon seed extracting machine

Drop type hopper: drop type hopper was delivered the watermelon fruits depending on the horizontal feed rate. It used to feed watermelon fruits to the crushing drum. This hopper has been manufactured from galvanized steel sheet by thickness of 25 mm, length of 900 mm and width of 650 mm and depth of 550 mm.

The crushing drum: crushing drum has been manufactured from galvanized steel with diameter of 450 mm, length of 1050 mm, mass of 50 kg and the knives numbers on its external peripheral (18 knives) of crushing drum by thickness of 7 mm.

Screw conveyor (20): screw conveyor used to transfer mixing crushing to separate unit. The screw conveyor has been manufactured from sheet steel with main dimensions: length of 1500 mm, diameter of 300 mm, distance between two steps of 400 mm and inclined on horizontal axle by angle of 170.

First unit: first separate unit consists of cylindrical shell hollow. The cylinder was perforated with round holes with diameter of 15 mm to allow seeds and things which equal seeds size to cross but the large size hurtle outward under the effect of rotating movement, it constructed from a galvanized steel with thickness of 3 mm, diameter of 600 mm length of 1200 mm and speed of 1.36 m/s.

Inclined a circle half level: part was put under the first separate unit. The cylindrical chamber has been manufactured from a steel sheet with main dimensions: length of 1350 mm, diameter of 500 mm, height of 500 mm and thickness of 3 mm and the inclined ratio was decreased by 1° to 100mm. this part used to transport seeds and things which mixed with it to second separate stage.

Second separate unit consists of cylindrical shell hollow; the cylinder is perforated with round holes by diameter of 5mm to allow small things and juice to hurtle outward but the seeds moved by rotational movement to the unit end. It constructed from galvanized steel by thickness of 1.5 mm with the main dimensions diameter of 300 mm length of 600 mm and speed of 0.93 m/s..

Screw conveyor (18): conveyor was mounted in the end of second separate part. It was used to raise the seeds to seed collection pan and constructed from a steel sheet by thickness of 1.5 mm, diameter of 200 mm and length of 1200 mm.

Seed collection pan the pan form was parallelogram, plenty in top and narrow in the bottom. This pan has been manufactured from galvanized steel by thickness of 15 mm, length of 1200 mm, width of 500 mm and depth of 1250 mm. There was in the pan bottom mobilizing gate, can be opened and closed.

Steel frame steel frame was fabricated from square channel iron 75×75×7 mm, and mounted on four rubber wheels. These elements were mounted on a tubular steel frame having a wall thickness of 3.3 mm.

2.1Methods

Determination of the driving stability

The developed machine about 23.54 kN (machine mass =2400 kg),machine wheel base (X1) of 1700 mm. Under normal operating conditions, the machine weight distributed by about 60% on rear traction wheels versus 40% on the front transport steering wheels. Under such conditions, the lever arm will be shortened as driving on grades and tend to make the machine unstable. The rear traction wheels are arranged at lateral distances (L) of 1800 mm. Traction surface may be investigated as furrow, or tilled or paved field surface conditions. This data are showing in Figure 3.

See Figure 3 please

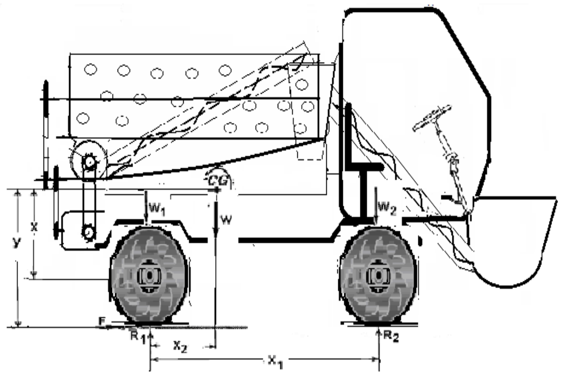


Figure 3a Diagram showing forces acting on the machine under simplest and normal operating conditions

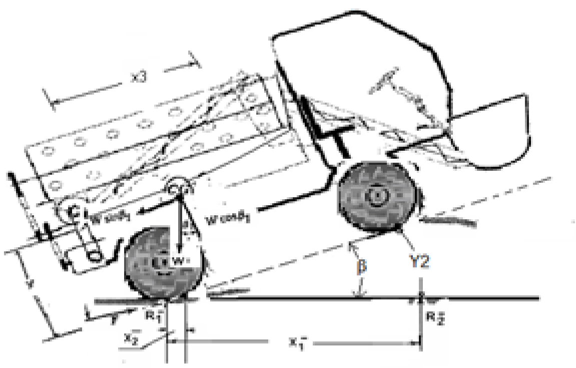


Figure 3b Forces influencing longitudinal stability of the machine during operating on grade at any angle to the horizontal

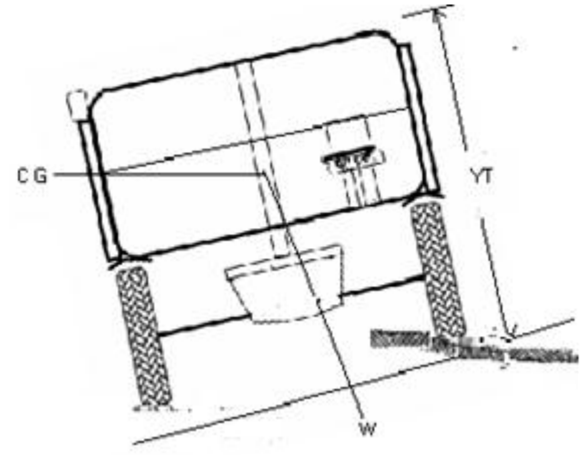


Figure 3c Forces resulting when one of the rear wheels is dropped-suddenly into furrow and creates lateral instability

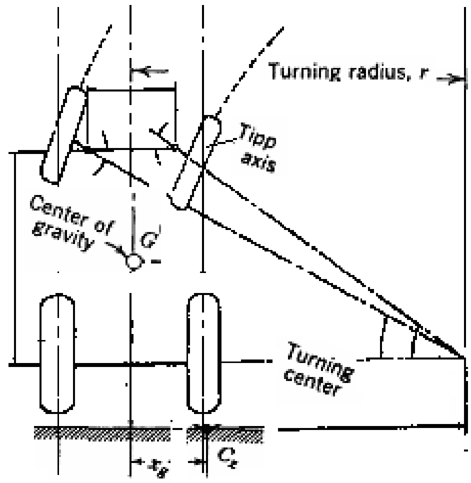


Figure 3d Forces resulting when the machine is making a short turn at high speed on level ground, and centrifugal force creates lateral instability

Figure 3 Show the diagrams forces acting on the machine and influencing the driving stability under four different operating conditions

The machine may be operated on grades, which may be inclined at any angle (β1) in the range from 5 to 400 with respect to the horizontal.

The machine may be operated on lateral, which may be inclined at any angle (β1) in the range from 2 to 10 degree with respect to the horizontal.

Driving speed may be in the range of 1- 5 m/s.

Turning radius (R) was depended the arrangement of the ridges in the field, the value of (R) may be considered in the range of 0.5 to 2 m.

Determination the longitudinal stability factor.

The longitudinal stability factor can be determined by using follows formula ASAE (1984) by using equation 1:-

That point (CG) is located at a distance ahead of the rear wheel axle (x_2) of 700 mm, at height above the ground surface (y) > 8500 mm, and at height with respect to the rear axle (y_3) of 38 mm wheel base (X_1) of 2100 mm,

$$\text{Stability factor on grade} = \frac{W \cos\beta_1 * X_2 + W_1 \cos\beta_1 * X_3}{W \sin\beta_1 * Y_1 + W_1 \sin\beta_1 * Y_3} \quad \text{..................1}$$

Bearing in mind that ASAE (1984) stated that minimum value of longitudinal stability factor must not be less than 1.25,can be recognized that a certain minimum value of stabilizing couples is required to give the front wheels sufficient grip on the soil.

Determination the lateral stability factor**.**

The lateral stability factor can be determined by Equation 2:

$$\text{Stability factor on hillside} = \frac{\cos\beta\,(L+D)}{2Y} - \sin\beta \quad \text{...........................2}$$

Determination the turn stability factor.

The turning stability factor was determined by Equation 3:

$$\text{Stability factor in making turn at high speed} = \frac{R * g*(L+D)}{2Y*V^2} \quad \text{................ 3}$$

Where L= lateral distances between rear traction wheels 1800 mm

D= wheel width 150 mm Consequently, the stability moment, is equal to W (L+D)/2, .

The slip percentage.

The slip percentage could be obtained when substituting the distance (M) between the starting and the end lines, and also the actual travel time (T1) was measured to get the actual operating (V0) speed by Equation 4:

V0 = M/T1 4

The theoretical travel speed (Vt) could be estimated knowing the machine rear wheel circumference(C) by Equation 5: -

Vt= N*C / T 5

Then slip percent (SL %) was calculated for each deduced treatments with respect to the ASAE (1984) standard formula by Equation 6:

SL% = (Vt – V0) / Vt x 100 6

Experimental plan

The develop equipment has been tested and evaluated considering different feeding rates of

80, 100, 120 and 140 kg/min with crushing drum speed 0.40, 0.82, 1.2 and 1.6 m/s. The effect of previous considered parameters on the performance of fabricated equipment was evaluated in terms of visible seed damage seed losses, cleaning efficiency, energy and cost requirements.

Visible seed damage

The visible seed damage was calculated according to Desta and Mishra (1990) as Equation 7:

$$\text{Visible seed damage,\%} = \frac{\text{Broken seeds mass in sample,g.}}{\text{Total seeds mass in sample,g.}} \times 100 \quad \text{...........7}$$

Seed losses

The seeds which found mixed with peels were separated and collected manually and weighed. Then the percentages of seed losses were determined by using the following Equation 8:

$$\text{Seed losses, \%} = \frac{M_1}{M_1 + M_2} \times 100 \qquad 8$$

Where:

M_1=Seed mass mixed with the expelled peels, g; M_2 = Seeds mass clean from output opening, g.

Separation capacity and efficiency of modify machine

The separation capacity of the fabricated equipment was calculated by Equation 9:

$$\text{Separation capacity,kg/h} = \frac{\text{seeds mass,kg} \times 60}{\text{Pass time, min.}}$$ 9

And the efficiency of modify machine can be determined by taking four random samples (each number 25 fruit) were taken from the entire field then; determined the mass of its. After that extracted manual the seeds from fruits and determined the mass of the seeds. Then, it can be determined the actual seeds production, kg/h by

$$\text{The machine efficiency} = \frac{\text{the machine productivity of seeds,kg/h.}}{\text{actual seed production,kg/h}} \times 100$$

using Equation 10:

10

Cleaning efficiency

After each treatment, a sample of 1 kg from output material was taken into laboratory and separated to clean seeds (Mc) which collected from seeds opening, the seeds expelled with the peels and foreign matters were picked (ML) and weighed. So, the cleaning efficiency was calculated according to the following Equation 11:

$$\text{The cleaning efficiency,\%} = \frac{M_c}{M_c + M_L} \times 100$$ … 11

Specific traction energy requirements

The following items are determined as cited by Srivastava et al. (2006). The draught force (*D*) is measured as the horizontal component of the force between the tractor and the machine by using a spring dynamometer. The average dynamometer readings (*D*) are determined when the machine are moving in sequence on the experimental soil surface. The traction force (TF) required for the machine is estimated as the difference between the dynamometer reading and the rolling resistance (*RR*). Then, the power required for operating is calculated by Equation 12:

Po = *TF x S*, kW 12

Where:

Po is power requirements, kW; *TF* is traction force, and *S* is actual tractor forward speed, m/s.

specific laborer energy requirements, see Equation 13

Laborer energy requirements = *0.075 x* AFC^h *x Nl*, kW……………………………....13

Where:

0.075 is power of agricultural laborer, kW/fed; *Nl* is number of laborers and AFC^h is manual field capacity, t/h. The output energy requirements were calculated by using Equation 14:

$$\text{output energy requirements} = \frac{\text{total energy requirements}}{\text{machine productivity}}$$

, kW/t ……………………………..…14

Extracting costs:

As cited by Begum et al.(2012), threshing costs (LE/h) are calculated by employing the conventional method of estimating both fixed and variable costs. And calculated by using Equation 15.

$$\text{Extracting costs ,LE/ton.} = \frac{\text{Operation costs,LE/h.}}{\text{Machine productivity,ton/h}} + \text{Lossed grains price, LE}$$

………………… 15

Statistical

SPSS (Version 20.0) computer software package is used to employ the analysis of variance test and the L.S.D. tests for extracting productivity data

3 Results and discussion

Evaluation the stability of the developed machine

The stability of the developed machine was identified under the most critical operating situations by estimating the values of three different stability factor indicators. The investigated stability factors were indicated as the developed machine is operating on inclined grade at any angle to the horizontal and hillside case, as the rear wheels dropped suddenly into furrow and as the developed machine is making a short turn at high speed on level ground.

Estimation the longitudinal stability factor.

When the machine worked in ridge field the front wheel is raised ridge with an inclination angle (β1) to the horizontal. Bearing in mind that ASAE (1984) stated that minimum value of longitudinal stability factor must not be less than 1.25, Figure 4 shows the accepted limits of the stability factor (K) for the developed machine as it will be operated under the different operation conditions. It was noticed that increasing Grad inclination angle (β1) from 5 to 40 degree the (K) values decreased by (2.67 to 1.05). Moreover, it is indicated from Fig 4 that operating on the other investigated conditions exhibited some K values less than the recommended minimum K value. Thus the viable operation angle (β1) should be less than 35 degree.

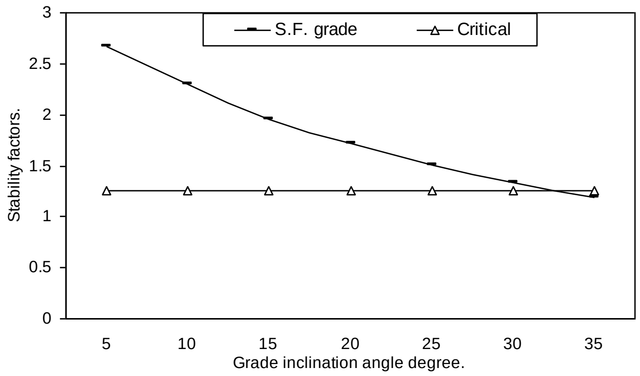


Fig 4 Estimation the longitudinal stability factor

Estimation the lateral stability factor.

The lateral stability factor values were estimated under critical practical operation conditions namely, operating on a hillside. Figure 5 shows the accepted limits of the stability factor (K) for the developed machine as it will be operated under the different operation conditions. It is easily noticed that increasing each angle (β) by (2 to 10) the (K) values decreased by (1.35 to 1.19). Moreover it is indicated from this figure that operating on the other investigated conditions exhibited some K values less than the recommended minimum K value. Thus the viable operation angle (β) should be less than 8 degree.

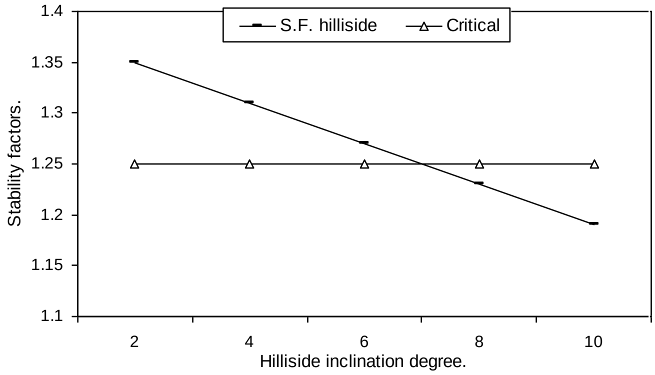


Fig 5 Estimation the lateral stability factor

Estimation the turn stability factor

Figure 6 show the rate of forward speed for machine with making different level of turning radius. The machine will become unstable as the turn radius increased by 0.5 to 2.5 m, by increasing forward speed from 1 to 6 m/s, the stability factors will decrease by 14.33 to 0.67, so, when the turn radius increased by 0.5 m the stability factors will decrease by about 48%. Too, from this figure it can be seen that the suitable forward speed for machine were (1 to 4 m/s) with turning radius (0.5 to 2 m).

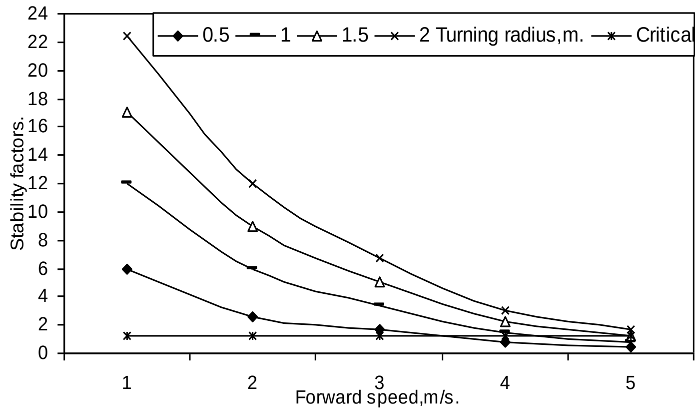


Figure 6 Estimation the turn stability factor

Evaluation the percentage of slip

Figure 7 shows the influences of three forward speed levels 0.78, 1.3 and 1.8 m/s. The machine was operated and un-operated and track surface conditions on the percent of slip for driving the developed machine. It could be noticed that the slip on a furrow field surface is much more than on paved field surface, at any forward speed level (gear setting or fuel throttle opening), and operated machine. The maximum value of slip was 11.4% during driving at un-operate machine on furrow field surface and used three speed but, the minimum value of slip was 3.7% during driving at operate machine on paved field surface and used first speed. In general, first and second speeds were suitable working for machine in all study surfaces.

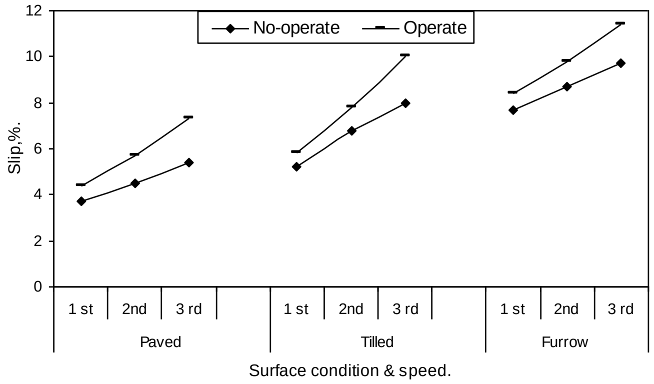
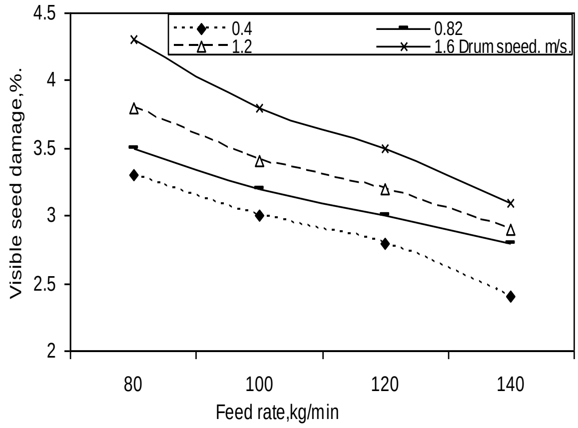


Figure 7 The effect of surface condition and machine forward speed on slip,%

Visible

It can be seen in Figure 8 that by increasing feed rate from 80 to 140 kg/min, the visible seed damage was decreased by average 0.95%. On the other hand, by increasing drum speed from 0.40 to 1.60 m/s; the visible seed damage was increased by average of 0.80. The minimum seed damage percentage was associated with feed rate 140 kg/min gave 2.4% and speed drum 0.4 m/s. The maximum value of seed losses was 4.3% noticed under used speed drum 1.6 m/s and feed rate 80 kg/min. That was may be due to the decrease of impact forces between watermelon seeds and knives too, the low of seeds which were exposed to impact with separate drum rotation.



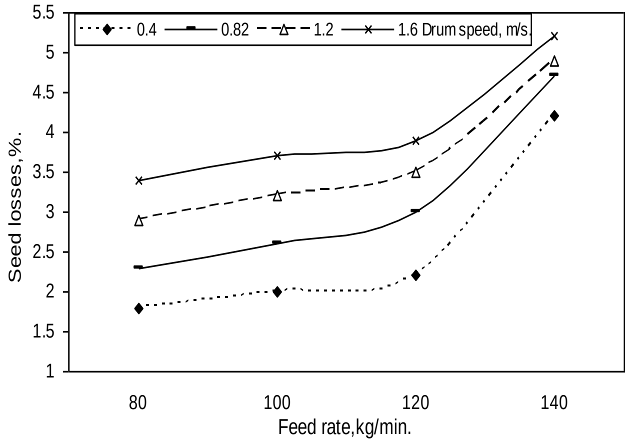


Figure 8 Effect of feed rate and drum speed on visible seed damage and seed losses

Seed

The data in Figure 8 and Table 1 show that the increase of feed rate from 80 to 140 kg/min tends to increase seed losses; from these data it can be observed that the increase in feed rate tends to increase the seed losses at all variable levels. When, the feed rate increased from 80 to 140 kg/min the seed losses increased by average 2.4%. It can be stated that the drum speed had considerable effect on the seed losses. On the whole, by increasing drum speed from 0.40 to 1.60 m/s the seed losses increased by average 1.60%. This trend may be due to the increase of the impact force between knives and seeds which gave the seeds more kinetic energy. This was due to increase in the push rate of the seeds with skin. The minimum seed losses percentage was associated with feed rate 80 kg/min gave 1.8% and speed drum 0.4 m/s.

But the maximum value of seed losses was 5.2% noticed under used speed drum 1.6 m/s and feed rate 140 kg/min.

Table 1 effect of feeding rate and drum speed on machine efficiency

Feeding rate, kg/min	Drum speed, m/s	Machine capacity, kg/h	Machine seeds productivity, kg/h	Actual seeds production, kg/h	Machine efficiency, %
80	0.4	4800	194.8	197.9	97.4
	0.82	4800	194.1	197.9	97.1
	1.2	4800	191.2	197.9	96.6
	1.6	4800	190.2	197.9	96.1
100	0.4	6000	238.2	245.3	97.1
	0.82	6000	239.4	245.3	97.6
	1.2	6000	239	245.3	97.4
	1.6	6000	237.6	245.3	96.9
120	0.4	7200	284.5	296.0	96.3
	0.82	7200	289.5	296.0	97.8
	1.2	7200	290.1	296.0	98
	1.6	7200	288	296.0	97.3
140	0.4	8400	332.9	347.5	95.8
	0.82	8400	333.6	347.5	96
	1.2	8400	342.3	347.5	98.5
	1.6	8400	342.6	347.5	98.6

Cleaning

The effect of feeding rate and drum speed on cleaning efficiency of watermelon seeds after extracting operation indicated in Fig9 cleaning efficiency was decreased by average of 2.8% when the drum speed was increased from 0.40 to 1.6 m/s. Whereas the maximum value of cleaning efficiency was 96.5% with drum speed of 0.40 m/s and feed rate of 80 kg/min. The minimum value of 92% was obtained under used drum speed of 1.6 m/s and feed rate of 140 kg/min. The decrease of cleaning efficiency may be due to the insufficient time to clean the extracting seeds with increasing feed rate and drum speed.

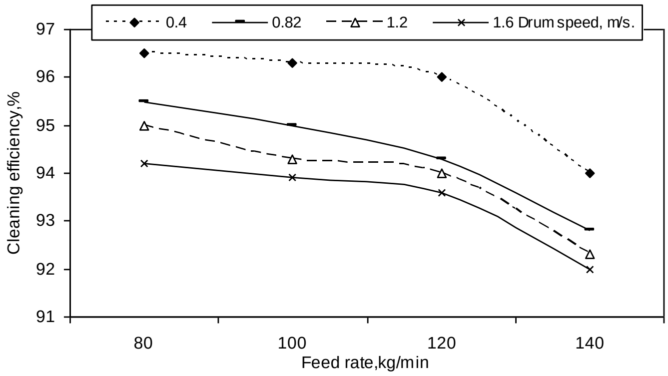


Figure 9 Effect of drum speed and feed rate on cleaning efficiency

Energy requirements

The average values of consumed power as affected by feed rates and drum speeds is plotted in Table2 By decreasing feed rate from 140 to 80 kg/min, the power consumed decreased by average 14.50%. As the feed rate was increased the power consumed for extracting machine was increased at same levels of variables. Too, by decreasing the drum speeds from 1.60 to 0.40 m/s., the power consumed was decreased by average 31.11%. But after developed, by decreasing feed rate from 120 to 60 kg/min, the power consumed decreased by average 24.01%. As the feed rate was increased the power consumed for extracting machine was increased at same levels of variables. By decreasing the drum speeds from 1.40 to 0.47 m/s, the power consumed was decreased by average 38.24%. That result trend may be due to increase the power required for more quantity of material. Moreover, the used modify machine saves the energy by average 52.48%.

Table 2The effect of feed rate and drum speed on consumed power.

Feed rate, kg/min	Consumed power, kW after modify.				Energy requirements, kWh/t							
					After modify				Before modify			
	Drum speed, m/s.				Drum speed, m/s.				Drum speed, m/s.			
	0.4	0.82	1.2	1.6	0.4	0.82	1.2	1.6	0.4	0.82	1.2	1.6
80	5.1	6.75	7.4	9.1	26.2	34.1	47.6	68.1	41.3	58.6	86.0	118.2
100	5.7	7.11	8.0	9.9	29.1	28.6	42.2	55.8	32.5	45.6	68.4	88.5
120	6.4	7.85	8.3	10.2	21.5	26.4	38.1	50.1	28.6	39.1	58.6	74.2
140	7.0	8.22	9.5	11.1	20.1	23.6	32.5	45.1	27.2	35.8	55.8	71.3
Mean	6.0	7.48	8.3	10.1	24.2	28.2	40.3	55.3	32.4	44.8	59.4	88.0

Cost analysis

Figure10 shows that the net profit of develop extracting machine was affected by feeding rate and drum speed. The value of net profit (720 LE/t) was achieved at feeding rate of 80 kg/min and drum speed of 1.6m/s. While, the least net profit was estimated at 140 kg/min feed rate for all different ranges of drum speed. The data also indicted that by increasing drum speed from 0.40 to 1.60 m/s leads to decrease net profits by about 8.6% under all different values of feed rates.

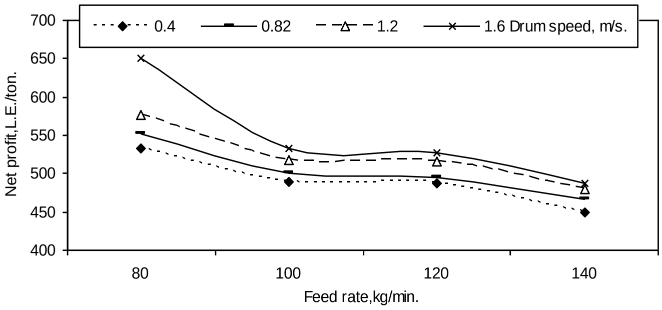


Figure 10 Effect of drum speed, and feed rate on net profit.

Comparison between the machine after and before developed

By comparing data of mechanical and manual watermelon seed extraction cost, the mechanical method save the costs by about 61.4% (shreen, 2014).The cost extract ton of seed by using machine before developed was cost 1052 to 550 LE/ton by average 801 LE/t. But, by using the developed machine gave 650 to 448 ton by average 549 LE/t. So, the developed machine saved the cost by average of 31%.

Statistical analysis:

Table 3 shows the statistical analysis had a high significant and significant by using feed rate 140 kg/min and drum speed 1.2 and 1.6 m/s worth mention drum speed 1.2 and 1.4 m/s were suitable with high feed of 120 and 140 kg/min but; drum speed0.04 and 0.82 m/s were suitable with low feed of 80 and 100 kg/min.

Table 3 The results of LSD test

Feed rate,	Drum speed, m/s.			
kg/min	0.04	0.82	1.2	1.6
80	*	*	ns	ns
100	*	**	*	ns
120	ns	*	**	*
140	ns	ns	*	**

** = highly significant at a level of 1 * = significant at a level of 1 %; ns, non-significant.

4 Conclusion

The test of a locally fabricated extraction machine was done by the stability factor of develop machine on lateral, longitudinal and turning. The developed equipment has been tested and evaluated considering feeding rates of 80, 100, 120 and 140 kg/min and different drum speeds of 0.40, 0.82, 1.2 and 1.8 m/s. The results of the developed machine illustrated that the angle of longitudinal stability factor should be less than 35 degree, the angle of lateral stability factor should be less than 8degree and the suitable forward speed for developed machine were 1 to 4m/s with turning radius 0.5 to 2m.The results illustrated that; by increasing feed rate from 80 to 140 kg/min, the visible seed damage was decreased by average 0.95% and the seed losses increased by average 2.4%. In the same time by increasing drum speed from 0.40 to 1.60 m/s; the visible seed damage was increased by average of 0.80 and seed losses increased by average 1.60%.The cleaning efficiency was decreased by average of 2.8% when the drum speed was increased from 0.40 to 1.6 m/s. By decreasing the drum speeds from 1.40 to 0.47 m/s. high value of machine efficiency was noticed under used drum speed 1.2 and 1.6 m/s, and feed rate 140 kg/min. The used modify machine saves the energy by average 52.48%. The operation cost of develop machine was 549 LE/ton. So, the developed machine saved the cost by 31%.

References

Abdel-Mageed H, A., E.Abou-Elmagd and I. F. Sayed. 2006. Construction and performance of a machine for separating watermelon seeds. *Misr. J. Ag. Eng*. 19(2): 491-507.

Abu Shieshaa,R., R. Kholief, A. A. El Meseery. 2006. A study of some physical and mechanical properties of seed melon seed. *Misr. J. Ag. Eng.*, 24(3): 575-592.

Abdrabo, A. F. A. 2013. Manufactured prototype to separate the seeds of watermelon pulp. *Egyptian Journal of Agricultural Research,* 92 (1):237-255.

ASAE yearbook standard. 1984. Pub. by the American society of Ag., Eng.,St. Joseph, Michigan, USA.

Begum, E.A., M. I. Hossain, and E. Papanagiotou. 2012. Economic analysis of post-harvest losses in food grains for strengthening food security in northern regions of Bangladesh. *IJAR-BAE*, 1(3): 56-65.

Desta, K.D., and T. W. Mishra. 1990. Development and performance evaluation of Sorghum thresher. AMA, 21(3): 33-37.

Eliwa, A. A., and A. Elfatih. 2012. Developing a local extraction watermelon seeds machine.

Journal of Applied Sciences Research, 8(1): 474-482.

Shreen, F. A. M. 2014. Development and evaluation of a local industrial machine for watermelon on seeds extraction. *J Soil Sci and Agric Eng*, Mansoura Univ 5(10): 1405-1426.

Srivastava, A. K.,C.E. Goering, and R. P. Rohrbach. 2006.Engineering principles of agricultural machines. 2nd Ed. ASABE Pub. USA.