RECIPROCATING FRICTION SURFACE UTILIZATION TO SHELL THE KERNEL FROM THE CORN EAR

Ismail, Z. E.
Engineering Dept, Faculty of Agriculture, Mansoura University, Egypt
Egypt. ebrahimzi@yahoo.com

ABSTRACT

Based on relevant physical properties of the corn ear, the corn prototype was designed to achieve corn shelling with lowest losses (un-shelling) and highest shelling efficiency in proper time. The reciprocating shelling plate is investigated as friction surface that easy shell the kernel from the corn ear. This way able to reduce the corn ear movement in varies the direction consequentially rising the percentage of shelling efficiency. The shelling prototype has two segments: one to remove the kernel from ear; and a second to collect the kernels. The oscillating shelling plate is a separator that is manual-driven and can reciprocate at four levels of reciprocating stroke were changed during caring out the experiment that were regulated by changing the crank radius (4.5; 6.5; 8.5 and 10.5cm). Three levels of shelling teeth number 100; 125 and 150 and three phases of the hand revolution of pedal, namely15; 25 and 35 rpm were investigated. The clearance between the corn ear and shelling plate were 2.5; 3.0 and 3.5mm.The shelling plate speed (m/s) was recorded relative to the angular speed of connecting shelling plate with the end point of crank radius. All experiments were carried out under constant kernel and cob ear moisture content "MC" of 10.8% and 10.32 "wb" respectively. The study gives the indicator to judge and deduce that the best factors which give the highest shelling efficiency (98.0%) were found at shelling plate frequency of 1.18 Hz, 10.2 shelling displacement of point 'P' and crank "ω t" of 3.8 radial and the highest productivity (79. 23 kg/h) was recorded at displacement of crank radius of 10.5 cm, 25mm corn shelling clearance and 0.94Hz frequency factor. Whereas, the lower value of productivity (26.8 kg/h) was found at frequency factor of shelling plate of 1.23 Hz with corresponding lower crank radius and the highest clearance values of 4.5 cm and 2.5 mm respectively.

INTRODUCTION

The government is doing its best to increase the corn production and make a success in the expanded corn program. Therefore, the new technology available should be adopted and the most effective post-production operations be used. In terms of corn shelling, there is a need to identify the optimum shelling with loose losses.

In the small Egyptian farms, the corn is shelled by rubbing the maize cobs against one another by hand or by direct removal of the kernels with one's fingers. This is very tedious, extra time and labor consuming and thus too expensive. Therefore, corn shelling machines are one of the most convenient and labor-saving that the practical farmer has in use. Consequently, the quest for a satisfactory cheap effective means of detaching the kernels from the cobs, so replacing such traditional shelling-techniques, is of importance for small and even medium-size farms in Egypt.

Petkevichus *et al.* (2008) states that the wet maize ears with a height and medium moisture content of 32.5% and 18.5% were fed in parallel and perpendicular to the drum shaft of a conventional threshing drum. They

added that the maize ears fed in parallel with the drum shaft in the concave clearance moved twice as fast (4–5 m s^{-1}), received twice rasp bar impacts, and 10–20% of the threshed grain passed through the concave when compared to thresh with the maize ears fed perpendicular to the drum shaft. While, Nkakini *et al.* (2007) used a manually-operated handle to rotate two shafts, one of which translates rotational motion to become linear motion of a slider crank. The slider pushes the maize cobs into the sheller continually one after another. Though manually operated, the sheller can provide a continuous flow; the kernels being collected via a chute. At a speed of 60 rpm, a shelling effectiveness of 67% was achieved, with a low kernel-breakage factor of 0.090 and a throughput of 6.82 kg/h.

The manual shelling of maize is a time-consuming and tedious operation was studded by Nkakin *et al.* (2007). The power requirement of such shellers is high and hence. The prime mover is very expensive. To evaluation, the performance of a locally fabricated maize sheller the cob breakup, shelling efficiency, kernel damage and separation loss were measured for three varieties of maize over three harvest dates. Harvest date was found to have significant effects on most of the variables studied because of the variations in moisture contents. The kernel damage and cob breakup decreased significantly with later harvest date. The shelling efficiency was not significantly affected by changes in the harvest date. Therefore; the maize sheller can comfortably be used to shell local maize varieties.

Rudakov (2002); Ismail *et al.* (2009); Sudajan *et al.* (2002); Akubuo (2002) and Vindizhev and blaev (2003) indicated the effect of some operating factors such as clearance, shelling speed and number of beaters, direction of corn feeding, feeding rate, drum speed and drum types on damage and machine efficiency. The results showed that the malleability as the number of beaters increased a clearance decreased. They indicated that the grain damage increased with an increase each of drum speed and feed rates. This increase was due to higher impact levels transmit to the crop during threshing at higher drum speeds.

The corn shelling processes depending on moisture content in the grain, flow of the ear through the sheller and tension of spring bolt on the output opening of sheller, are obtainable by each of Choe *et al.* (1985); Tec, A.B. Jr (1987); Penelitian_Pertanian (1991); Kovacvic *et al.* (1997) and Bermundo *et al.* (2002). They added that the highest shelling performance was obtained at the drum speed 600rpm, 15.5-16.0% of corn moisture content. Under these conditions, the prototype has a capacity of 2.591kg/h in corn shelling and 2.5% of kernel damage. Comparative evaluation with existing shellers revealed that the improved machine obtained the highest efficiency of 97.11%, lowest mean unshelled loss and impurities of 0.14% and 0.79%, respectively, when shelling maize with moisture content of 22%-35%.

From the previous reviews, the corn shelling machines by traditional methods (drum-concave or drum rasp-bars) recorded maximum grain damage with increasing lode on the cleaning system. As a result, this paper aims to use the friction's theories to shell the kernel from ear by investigating

reciprocating shelling plate and to construct and evaluate the shelling teeth number, frequency factor of shelling plate and shelling plate clearances on shelling, un-shelling efficiencies and prototype productivity in proper time.

MATERIALS AND METHODS

The general descriptions of prototype

1- The reciprocating plate to shell corn was constructed in the workshop of Faculty of Ag, Mansoura University (Fig-1). It was created as a simple mechanism, eases for operation, repairs and maintains and may be operating by anyone without instruction. The prototype consists of the main frame, holding devices and shelling metering. It designs to easy set in stool and having stable balancing during rotated by hand. The main elements of it namely: frame and holding device, shelling and transmission units.

2- The main frame made of mild steel angle 50 × 50 mm and 5mm thickness. The holding device frame was fixed on it using four bolts that moving in the perpendicular direction to adjustment the clearance between shelling plate and holding device.

3- The holding device consists of three similar in the cub units, located on the prototype frame. Every unit contains a stationary concave compartment's segment of a tube with its concavity shape that facing the shelling plate. The cub was constructed from steel of 2mm thickness, cut to accommodate the maximum length and diameter of the corn ear to facilitate their firmly contact against shelling plate. The diameter at the concave end less than that at the front to avoid throwing cobs after shelling into the chute with kernels and to facilitate remove it's from holding units.

4- The reciprocating plate with 5mm thickness of sheet plate is provided with a number of bolts (Fig-2). There were distributed on the surface of shelling plate with rows spacing of 10-15mm and 10 mm inter-rows spacing.

5- The motion was a supply to prototype by rotating the hand of pedals that turning the crank which pushes the connecting rood of the slider block. The motions metamorphose to slider flat bars by the connecting rod, then the reciprocating motion of the slider pushing the shelling plat. To improve the handle motion, it covered with a freely rotating pipe, is provided for energizing the machine.

The description of prototype work

The transmission motion from hand pushing to shelling plate was regulated by changing the crank radius. The ears rotate about vertical cob's axes in proportional motion with reciprocating shelling plate, which reciprocating (recycling) with greater rapidity than the rotating ears. Therefore, it is bringing all parts of the ear under the action of the shelling teeth.
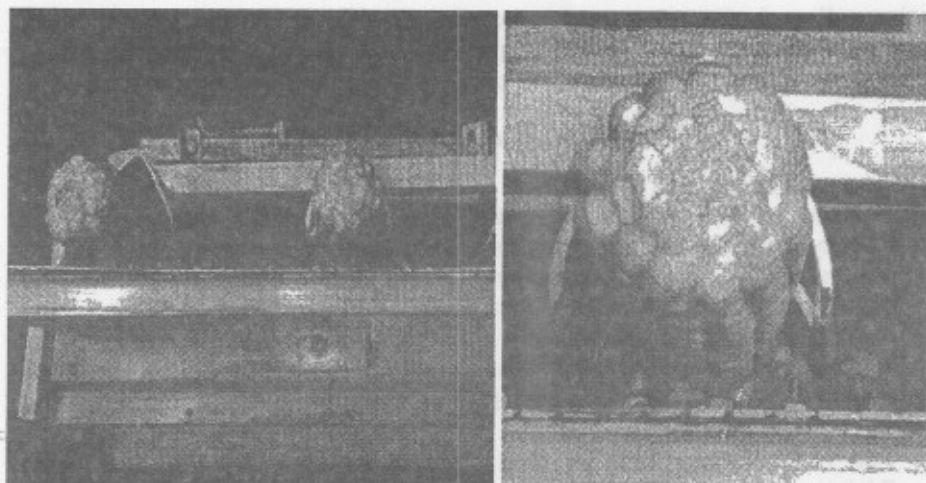
Fig. (1): The shelling corn prototype

The theoretical predication of the shelling operation

The hand pedal revolves the rank at 'ω radians/sec" and the pin forces the arm to move right and left. The pin slides in the slot and point "P" on the shelling plate oscillates right and lift (Figure 2) as it is constrained to move only in the side direction by the hole through which it slides. The motion of point "P" is simple harmonic motion. Point "P" moves slide right and left so at any moment it has a displacement "x", velocity "v" and acceleration "a".

The pin is located at radius "R" from the centre of the wheel. The horizontal displacement of the pin from the vertical centre line at any time is "x". This is also the displacement of point "P". The yoke reaches a maximum displacement equal to "R" when the pin is at the left end and "–R" when the pin is at the horizontal position. This is the amplitude of the oscillation. If the wheel rotates at "ω" radian/sec then after time "t" seconds the angle rotated is" $\theta = \omega t$" radians. From Figure 3, we find

$$x = R \cos (\omega t)$$

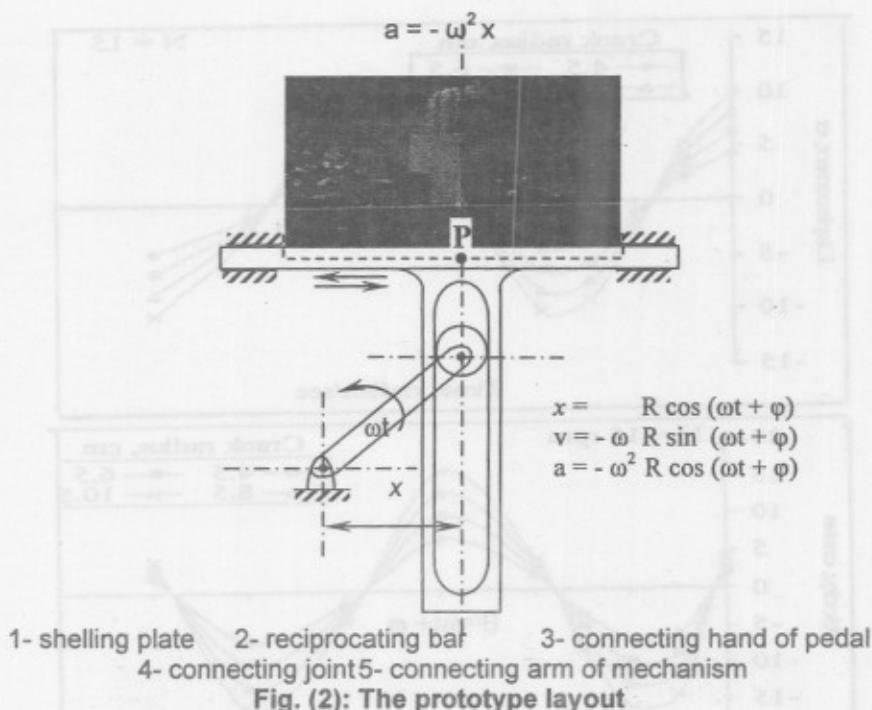Velocity is the rate of distance change with time and in calculus form of "$v = dx/dt$". If we differentiate "x" we get "$v = dx/dt = - \omega R \sin (\omega t)$".

The plot is also shown on figure 3. The maximum velocity or amplitude is "ωR" and this occurs as the pin passes through the vertical position and is plus on the way slide right and minus on the way slide left. This makes sense since the tangential velocity of a point moving in a circle is "$v = \omega R$" and at the vertical point they are the same thing.

Acceleration is the rate of change of velocity with time and in calculus form "$a = dv/dt$". Differentiating "v" we get

$$a = dv/dt = - \omega^2 R \cos (\omega t).$$

The plot is also shown on figure 3. The amplitude is "$\omega^2 R$" and this is positive at the left slide and minus at the right (when the yoke is about to change direction). Since, $R \cos (\omega t) = x$ then substituting x we find

$$a = -\omega^2 x$$

$$x = R \cos (\omega t + \varphi)$$
$$v = -\omega R \sin (\omega t + \varphi)$$
$$a = -\omega^2 R \cos (\omega t + \varphi)$$

1- shelling plate   2- reciprocating bar   3- connecting hand of pedal
4- connecting joint 5- connecting arm of mechanism

Fig. (2): The prototype layout

This is the usual definition of simple harmonic motion (S.H.M). The equation tells us that anybody that performs sinusoidal motion must have an acceleration that is directly proportional to the displacement and is always directed to the point of zero displacement. The constant of proportionality is "ω^2". Any vibrating body that has a motion that can be described in this way must vibrate with S.H.M. and have the same equations for displacement, velocity and acceleration.

In the analysis so far made, we measured angle "θ" from the horizontal position and arbitrarily decided that the time was zero at this point. Suppose we start the timing after the angle has reached a value of "φ" from this point. In these cases, "φ" is called the phase angle. The resulting equations for displacement, velocity and acceleration are then as follows:

Displacement $\quad x \quad = \quad R \cos (\omega t + \varphi)$
Velocity $\quad v = dx/dt = -\omega R \sin (\omega t + \varphi)$
Acceleration $\quad a = dv/dt = -\omega^2 R \cos (\omega t + \varphi)$

The plots of "x", "v" and "a" are the same but the vertical axis is displaced by φ as shown on figure (3-b). A point to note on figure (3-a) and (3-b) is that the velocity graph is shifted "¼" cycle (90°) to the left and the acceleration graph is shifted a further "¼" cycle making it "½" cycle out of phase with x. The frequency of the hand wheel of shelling prototype in revolutions per second is equivalent to the reciprocated shelling plate frequency. If the hand wheel rotates at "n" rev/s the time of one revolution is 1/n sec.
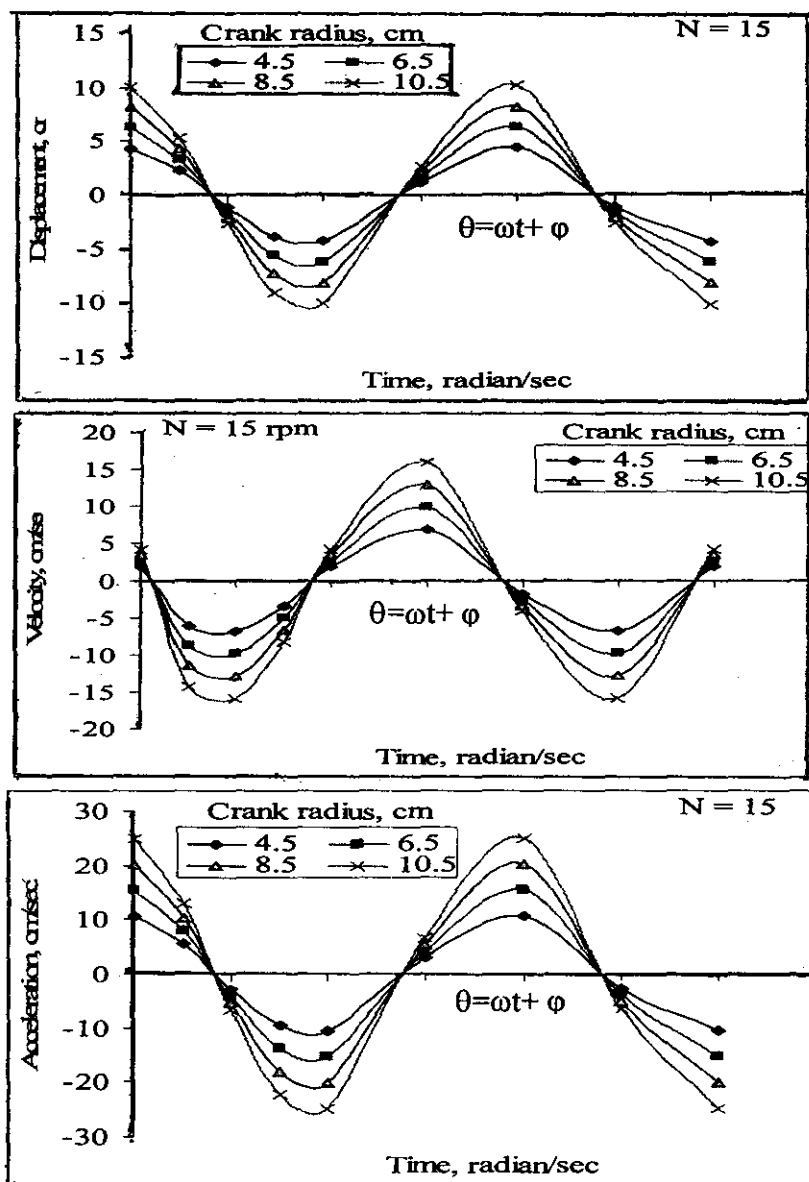
Fig. (3): The layout of displacement, velocity and acceleration of the shelling point "P"

The corn ears properties

Any cobs that were not appropriately shaped or not fully kernel were eliminated from the tests. Only straight cobs with even geometric dimensions were considered eligible for testing.

Biometric indicators of corn ears were determined by measuring the length and diameter of 100 ears and counting the number of vertical and horizontal grain rows. The variety of maize under experiments was Treble Hagen 324 with the following specification as tabulated in table (1). The grains mass (measurement accuracy of 0.1g) was evaluated at definite moisture content. The moisture content (MC, %) as a percentage of moisture based on wet weight of the kernels, and the ear was determined using the oven drying method according to PN-ISO 6540. The oven drying KBC G-65/250 (PREMED) was used. The moisture content was calculated according to the formula:

$$Mc = \left[1 - \frac{m_1 \ m_3}{m_0 \ m_2} \right] \times 100, \quad \%$$

Where:

m_0 – mass of sample [g],

m_1 – mass of sample after drying [g],

m_2 – mass of sample before initial conditioning [g],

m_3 – mass of sample after initial conditioning [g].

Table (1): The biometric indices of corn ear

Ear	Bas diameter, cm	$4.84^{\pm 0.2}$
	Medium diameter, cm	$4.57^{\pm 0.225}$
	Top diameter, cm	$3.6^{\pm 0.1}$
Cob	Bas diameter, cm	$3.14^{\pm 0.15}$
	Medium diameter, cm	$2.86^{\pm 0.05}$
	Top diameter, cm	$2.12^{\pm 0.06}$
Ear length		$22^{\pm 2.0}$
No. of vertical grain in rows		$47.2^{\pm 3.0}$
No. of horizontal grain in rows		$12.8^{\pm 1.5}$
Moisture content	Ear	$10.32^{\pm 0.188}$
	Cob	$10.83^{\pm 0.057}$

The experimental variable

1- Four levels of reciprocating stroke (RS) were changed during failing the experiment. There were regulated by changing the crank radius (4.5; 6.5; 8.5 and 10.5cm).

2- Three levels of shelling teeth number (100; 125 and 150) were investigated.

3- Three levels of the hand revolution of pedal "n" namely15; 25 and 35rpm. The one hand revolution of crank recorded as one cycle, then the frequency factor of shelling surface (Ff) is equal the following equation:

$$Ff = \frac{\omega}{2\pi} = \frac{2\pi \ n}{60 \ 2\pi} = \frac{n}{60}, HZ$$

4- The clearance between the corn ear and shelling plate is identified. Three of shelling clearances were 2.5; 3.0 and 3.5mm.

5- All experiments were carried out under constant kernel and cob ear moisture content "MC" of 10.8% and 10.32 "wb" respectively and the operation force on the pedal hand may be considered constant.

General evaluations of shelling unit
The four criteria used to evaluate the performance of the sheller in the laboratory were: prototype productivity, shelling losses or un-shelling, and kernel damage.

1- The shelling efficiency (SE, %) was calculated from the expression:-

$$SE = \frac{M_1}{M_1 + M_2} \times 100$$

Where: M_1 is the mass of kernels in kernel collector in g;
M_2 is the mass of loose kernels in g.

2- The separation loss or un-shelling (USE, %) refers to the loose kernels in the shelling chamber and was calculated from the expression

$$USE = \frac{M_2}{M_1 + M_2} \times 100$$

3- The capacity (Sheller productivity) was determined as the material output per unit time, in kg h^{-1}. It was calculated for all treatments under study by feeding corn batches (15 ears per every treatment) to holding device. After the kernels shelled there were collected and massed. Also, during shelling operation the shelling times were measured. Then the following relation was used to determine the productivity:

$$P = (\frac{M \times 3600}{t}) \qquad kg \ h^{-1}$$

Where: P = the productivity in kg h^{-1}
M = mass of shelled kernel in kg
t = time in sec

All data collected for all parameters of different treatments were statistically analyzed. Statistical analyses included analysis of variance, stander deviation and least-significant difference (LSD).

RESULTS AND DISCUSSION

The shelling teeth number
The effect of the teeth number on the shelling prototype performance is illustrated in figure 4 at different of the hand revolution (n, rpm) of the pedal prototype. The general trend of above relation is that increasing the shelling plate teeth decreases the corn shelling efficiency until the minimum values of shelling after that the relation corn to increases at the 15rpm (n_1) pedal revolution number. This results in inversed at 35 rpm (n_3) because of at the low revolution number of (n_1) give the chance to move the ear corn around its center line recorded increasing the slippage around the teeth. Consequently, reduce the shelling efficiency. The shelling efficiencies are recorded the highest values "74.32; 90.18 and 74%" at 100, 125 and 150 teeth respectively. The corresponding results for the un-shelling efficiency as shown in Fig. (4-B) are similarly with the inverse trend for shelling curves.
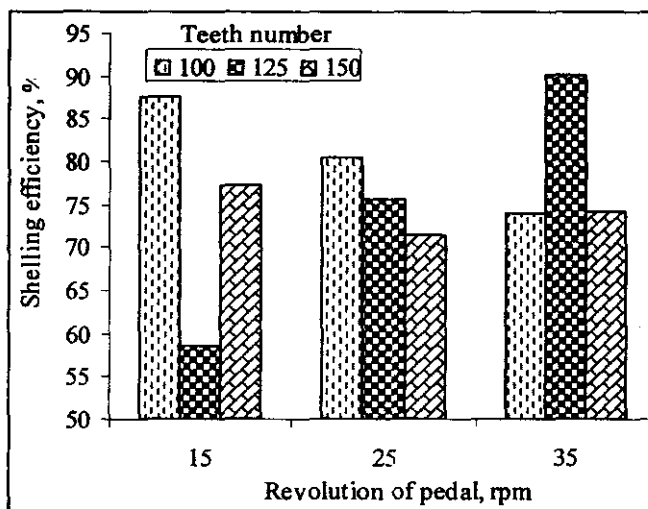
Fig. (4): The effect of teeth number on shelling efficiency

The frequency factor (Ff)

The experiments are carried out to form a good judgment of corn shelling efficiency as depended variables on un-depended parameters for the shelling prototype. Figure (5) illustrates the combination factors for two faces. Firstly, the relationship between the theoretical stroke times of hand pedal for shelling prototype and the displacement of point "P".

Secondly, the experimental lab results of shelling frequency (Hz) and shelling efficiency in percentage at constant of the hand the pedal revolution number of "15 rpm"; shelling plate clearance of "3.0 mm" and shelling teeth number of 125. The experimental data in figure 5 likes the same trend of the theoretical relationship for all treatments under study. Increasing the shelling frequency the shelling efficiency takes the shape of the cosine curve with the average fluctuation of 90; 80; 70 and 88% at crank radius of 4.5; 6.5; 8.5 and 10.5 respectively. For 4.5 crank radiuses as the example and at P displacement of 3 cm and the shelling frequency of 12 Hz the "ω t" of crank recorded 4.2 redial and 79% shelling efficiency. As the crank radius of 6.5 cm the "P" displacement increased to 6.2 cm and then the shelling frequency recorded of 11.8 Hz, the "ω t" of crank recorded 3.8 redial and 78% shelling efficiency.
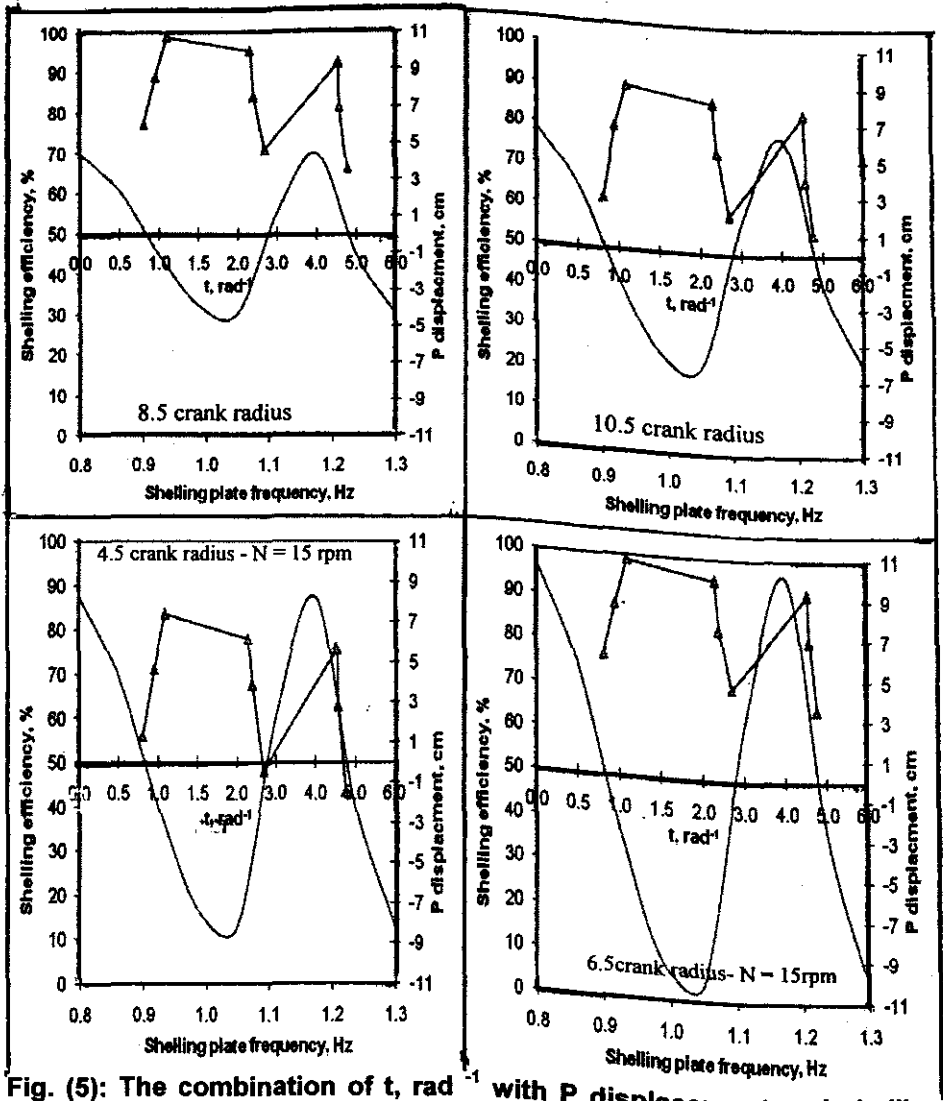
Fig. (5): The combination of t, rad $^{-1}$ with P displacement and shelling plate frequency with shelling efficiency.

The maximum of shelling efficiency (98.0%) were found at shelling plate frequency of 1.18 Hz, 10.2 shelling displacement of point 'P" and crank "ω t" of 3.8 radial. Any hand revolution of pedal recorded three linear speed of shelling plate (m/s) relative to the variation of crank radius. At decreases the crank radius increases the liner speed of the shelling plate and at the same times vice versa for stroke length. Figure (6) shows the effect of shelling plate speed (m/s) on the un-shelling efficiency. Generally, the resulted point out that, increasing the shelling plate speed decreases the un-shelling efficiency. For example, at hand pedal revolution number of 25 rpm, the shelling efficiency decreased about 1.18; 1.25 and 1.38 times at 25; 30 and 35mm shelling plate clearance respectively.

On the other hand, the minimum un-shelled efficiency was recorded at greatest shelling clearance. For example, the un-shelled efficiencies were 2.12; 11.06 and 22.88% at shelling clearance of 25, 30 and 35mm respectively during regulating the crank radius at 10.5cm.
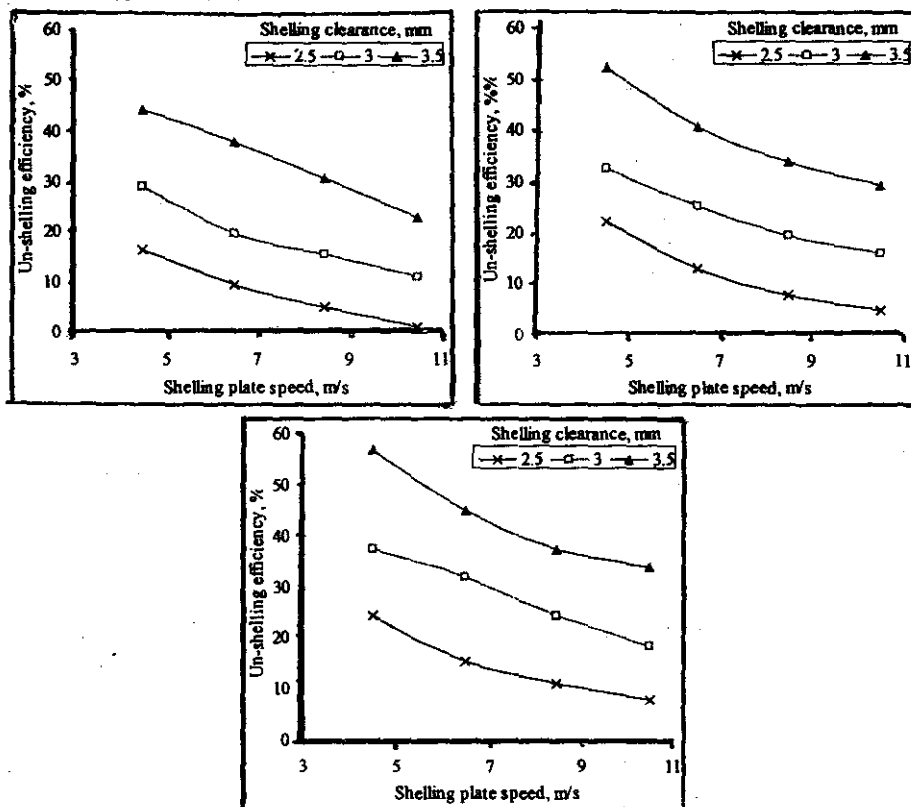
Fig.(6): The un-shelling efficiency via the shelling plate speed

The shelling plate clearance

The relationship between the shelling efficiency of corn and crank radii at different shelling plate clearance (25; 30 and 35 mm) and average different of hand the pedal revolution number (15; 25, 35 and 45rpm) are illustrated in figure (7-a). Generally, the resulted point out that, increasing the crank radius of operating mechanisms increases the grain shelling efficiency. For example, at hand pedal revolution number of 45 rpm, the shelling efficiency increased about 1.18; 1.25 and 1.38 times at 25; 30 and 35mm shelling plate clearance respectively. On the other hand, the maximum shelling efficiency were recorded at lowest shelling clearance. For example, the shelling efficiency is 98.98; 88.94 and 77.15 at shelling clearance of 25, 30 and 35mm respectively during regulating the crank radius on 10.5cm.

From figure (7-b), the un-shelled efficiency increased as increasing the shelling plate clearances at all different of crank radius. From the other's sides, by increasing the crank radius the un-shelled efficiency also decreased. For example, at hand pedal revolution number of 35 rpm, the un-shelling efficiency

decreased about 15.9; 2.61 and 1.93 times at 35 rpm crank revolution and 25; 30 and 35mm shelling plate clearance respectively. On the other hand, the minimum un-shelling efficiency was recorded at crank radius of 10.5 and shelling plate clearance of 2.5 and crank radius revolution of 35 rpm.
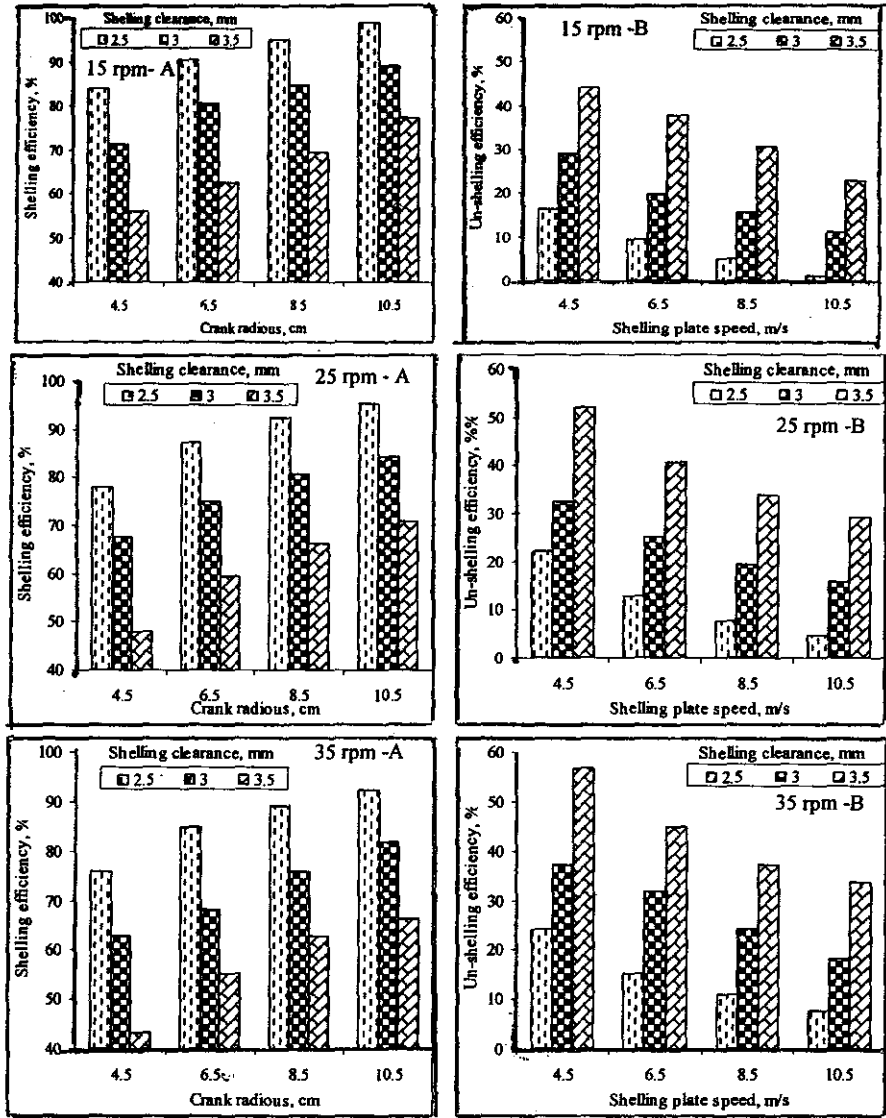

Fig. (7): Effect of radius of shelling pedal on the shelling and un-shelling efficiency

The machine productivity recorded as the function of crank radius revolution as shown in figure 8. Generally, increasing the crank radius of the shelling prototype increases the productivity. The maximum prototype productivity (79.23kg/h) was recorded at displacement of crank radius of 10.5

cm, 25mm corn shelling clearance and 0.94 Hz frequency factor. Whereas, the lower value of productivity (26.8 kg/h) was found at frequency factor of shelling plate of 1.23 Hz with corresponding lower crank radius and the highest clearance values of 4.5 cm and 2.5 mm respectively.
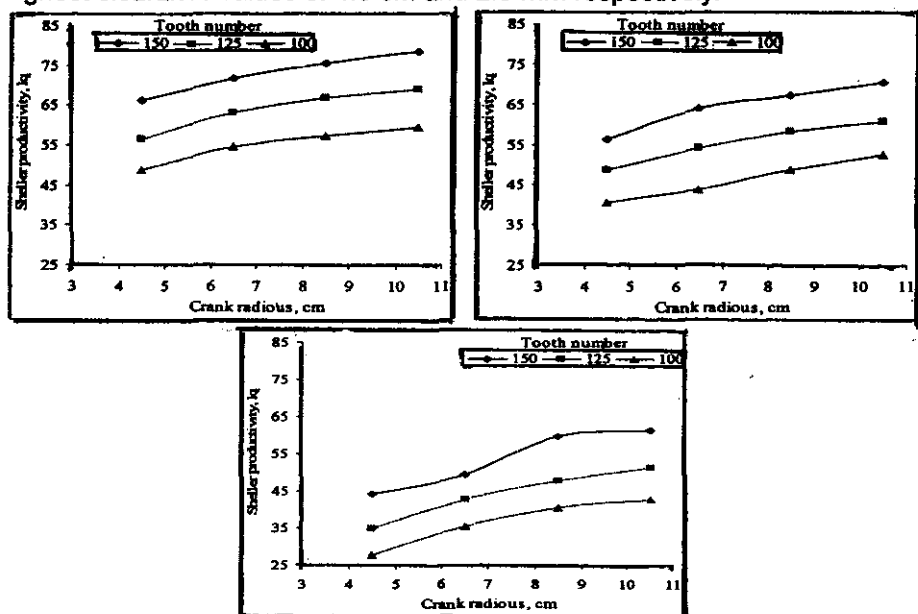
Fig.(8): The shelling prototype productivity

REFERENCES

Akubuo C. O. (2002). PH-Postharvest Technology: Performance Evaluation of a Local Maize Sheller. Biosystem Engineering, V 83, Issue 1, September, P 77-83.

Bermundo, E.A.Z.; E.B.Testa, and E.D.Flores, (Bureau of Postharvest Research and Extension, Munoz, Nueva Ecija (Philippines)) (2002). Technology interventions for bulk handling of corn at farmers-cooperative level. Email: agris_phils@yahoo.com.ph; URL: http://www.uplb.edu.ph/

Choe, K.J.; P.K.Baek, ; N.H. Cho, ; and D.H. Jung (1985). Study on the development of a drum type corn sheller. Research Reports of The Rural Development Administration. v. 27-1(E.Fm.Sc) p. 25-32.

Ismail, Z.E. (2009). Evaluation of some parameter affecting corn thresher performance. Misr. J. Ag. Eng., 5 (3) : 393 - 404.

Kovacevic, S. ; R.Supic, Z. Stanisic and M. Brkic, (1997). Damaged grains of seed maize at shelling of ear with higher moisture content. Novi Sad (Yugoslavia), V. 1(1-2) p. 29-31.

Nkakinia S.O., M.J. Ayotamunoa, G.P.D. Maebaa, S.O.T. Ogajib, and S.D. Probertb (2007). Manually-powered continuous-flow maize-sheller. Applied Energy, volume 84, issue12, Pages 1175-1186.

Nkokini, S.O.; M.J. Ayotamuno and G.P.D. Maeba (2007). Manually-powered continuous-flow maize-sheller. Vol. 84 (12): 1175-1186.

Penelitian Pertanian (1991). Influence of shelling methods on corn quality and store-ability. Soemardi (Balai Penelitian Tanaman Pangan Bogor (Indonesia)). V. 11(2) p. 100-104.

Petkevichius, S.; L. Shpokas and H.D. Kutzbach (2008). Investigation of the maize ear threshing process. Biosystems engineering 99, 532–539.

Rudakov, N.A. (2002). Izuchenie obmolota pochatkov kukuruzy s pomoshtju oscillografirovanija i skorostnoj kinosyemki. [Study of threshing ears of maize with the aid of the oscillography and the high-speed filming.]. Vestnik Seljskokhozjajstvennoj Nauki, Moskva, 4, 142–147.

Sudajan, S.; V.M. Salokhe and K. Tritatanasirichai (2002). Effect of type of drum, drum speed and feed rate on sunflower threshing. Biosystem Engineering, 83 (4): 413-421.

Tec, A.B. Jr. (1987). Varietal characteristics of corn for optimum shelling Philippines Univ., Los Banos, College, Laguna PH

Vindizhev, N.L. and V.V. Blaev (2003). Povrezhdaemostj semjan kukuruzy raznyh gibridov pri obmolote i puti ee snizhenija. [Damage of maize grains different crossbreeds by threshing and ways for their reduction.]. Materialy nauchnoj-prakticheskoj konferencii "Molodezhj, nauka, tehnika". Naljchik, 187–190.

استخدام سطح الاحتكاك الترددي لتفريط الحبوب من كوز الذرة

زكريا إبراهيـــــم إسماعـــيل
قسم الهندسة الزراعية – كلية الزراعة – جامعة المنصورة

على أساس الخصائص الفيزيائية ذات الصلة بتفريط الذرة قد تم تصميم النموذج الأولي لتحقيق أعلى كفاءة لتفريط الذرة بأقل فاقد (كوز به نسبة من الحبوب الغير مفرطه) وأعلى كفاءة للتفريط في الوقت المناسب. لذلك تم تجهيز لوحة ترددية ذات سطح أحتكاك وذلك لسهولة نزع حبة الذرة من على سطح الكوز. بهذه الطريقة نكون قد تغلبنا على الحد من حركة كوز الذرة في مختلف اتجاهات الحركة (طرق التفريط العادية والمنتشرة في الأسواق المحلية المصرية) وبالتالي تزيد كفاءة التفريط ويقل في نفس الوقت الفواقد (كوز خالي من الحبوب).

والوحده المقترحة تتكون من قسمين اساسين. القسم الأول وهو تفريط كوزان الذرة والقسم الأخر وهو تجميع الحبوب التي تم تفريطها. انصبت الدراسة علي الجزء الأول بأعتباره الأهم. اختبر القسم الأول بتأرجح سطح الأحتكاك بأربع مستويات من التردد وذلك بتغير نصف قطرها عند تغيير كرنك (٤.٥ ؛ ٦.٥ ؛ ٨.٥ و ١٠.٥سم). ثلاثة مستويات من الأسنان الموزعة علي اللوح المتردد وهم ١١٠؛ ١٢٥ و ١٥٠ سنة حيث توزيعها لوحده المساحة التي تمثل الأسقاط الراسي للمحيط السطحي لكوز الذره. اربع مستويات دورانية ليد البدال المحرك للوحدة المقترحة (١٥و ٢٥ و ٣٥ و٤٥ لفه/ دقيقة. ثلاث مستويات للخلوص بين سطح الكوز وسطح التفريط المتردد وهم ١.٥ و ٢.٥ و٣.٥ مم. اربعة مستويات لدوران عمود يد الدوران وهم ١٥ و ٢٥ و ٣٥ لفة/ دقيقة. أجريت جميع التجارب في إطار نسبة رطوبة ثابتة لكل من كوز الذرة والحبوب من ١٠.٨ ٪ ١٠.٣٢ على التوالي. هذه الدراسة تعطي مؤشرا للتحكم في مستوي التشغيل ونستنتج ان أفضل العوامل التي تعطي أعلى كفاءة للتفريط (٩٨.٠ ٪) لسرعة لوحة التردد ١.١٨ هرتز، ١٠.٢ لازاحة نقطة التأثير علي لوح الأحتكلك "P "وكرنك" ر ٣.٨ "بنسبة ٣.٨ وسجلت أعلى إنتاجية (٢٣. ٧٩ كنم / ساعة) لنصف قطرها ١٠.٥ سم للكرنك، والذرة، وإزالة ٢٥mm للخلوص Hz٠.٩٤ عامل التردد. في حين، تم العثور على أقل قيمة من الإنتاجية (٢٦.٨ كجم / ساعة) في معامل تكرار للوح التفريط من ١.٢٣ هرتز مع دائرة نصف قطرها أقل المقابلة كرنك ٤.٥ سم وأعلى قيم تطهير ٢.٥ ملم على التوالي.

قام بتحكيم البحث

أ.د/ مصطفى الدسوقي أبوحباجة   كلية الزراعة – جامعة المنصورة

أ.د / محمود علي محمد   كلية زراعة شبين الكوم – جامعة المنوفية