Zagazig J. Agric. Res., Vol. 36 No. (1) 2009 213-230

DEVELOPMENT OF THE RECIPROCATING MOWER FOR HARVESTING SOME CEREAL CROPS SUCCESSFULLY IN SMALL HOLDINGS

Khalil, Nanis A. , S. Abdel-Maksoud, M. A. El-Shazly, and M. A. E. Arnaoot
Agric. Eng. Dept., Fac. of Agric., Zagazig Univ.

Accepted 21 / 1 / 2009

ABSTRACT: The investigation was conducted on the Busatis double-knife rear mounted BM 1102 mower to be modified, to increase its operating efficiency depending on horizontal flat conveyor belt to cover some of the problems facing the mower operation and to reduce the labors cost needed for carrying away the harvested crop from the next tractor lane. To increase cutting efficiency of the mower and protecting the harvested crop from damage under tractor wheels during the next run and decreasing the total grain losses during operating time, minimizing power requirements and minimizing the high direct cost. The performance of the modified rear mounted mower will be influenced by stem moisture content, mowing forward speed, knife velocity, and developed flat conveyor belt velocity, so it was evaluated by calculating the cutting efficiency, total grain losses energy requirements, height of cut residue under different moisture levels. In respect to harvesting operation.

Key words: Development , reciprocating mower, harvesting, cereal crops, energy , cost.

INTRODUCTION

The prospects of agricultural engineering technology are considered as means of minimizing labor equipment increasing yield, and reducing cost. Furthermore in Egypt. Researchers did their best to operation for different crops. Reciprocating mowers are used in harvesting wheat, barley, beans and other crops. This investigation was carried out to modify the Busatis double-knife rear mounted BM 1102 mower to improve it, cutting efficiency, increase field capacity, decrease grain losses, achieve maximum utilization efficiency of the limited capable of harvesting and cutting more than one crop under Egyptian conditions. This will encourage using mowers most suitable for Egyptian farm conditions to harvest various crops to decrease harvesting time and cost also, overcoming the shortage of hand labour and increasing of their wages in Egyptian field. This is due to harvesting operation is sensitive agric. process for a particular crop should be carried out started and completed in a certain time. Devani and Pandey (1985) listed the advantages of vertical conveyor

A)The plants are conveyed in the vertical position, gathering and collecting of standing crop towards the machine is achieved without the panicles coming into contact with the moving parts of the machine, and this may the help in minimizing the shattering losses.

B)The crop is conveyed in vertical position under control and laid on the ground in a clear windrow maintaining the direction of tiller perpendicular or direction of travel.

Arnal (1990) provided an over view of the conventional combine harvester with separate sections covering its major working components and the necessary modifications for harvesting alternative crop such as maize, sun flower, oil seed rape, soybean, lentils, and Lucerne. A section on shaking systems considers hops grain pans aerators rotary separators double flow and multiple cylinder systems. Recent developments and in innovations in grain harvester technology are highlighted along with the use of straw distributors and choppers electronic equipment in the cap and modifications for improved working on sloping grand.

Pirovani and Pozzolo (1992) found that the cutting system of self-propelled combines wears out rapidly when harvesting logged rice with low efficiency, the aim of solving both of these problems a double cutter bar with 3 and 4 inches blades was designed and tested. The performance of the cutter bar was perfectly satisfactory in rice while in low density forage crops it was not possible to achieve adequate cutting. Chung *et al.*, (1995) investigated the cutting mechanism of the reciprocating knife of a combine harvester. The cutting operation of the reciprocating knife was demonstrated through the cutting pattern diagram drawn by computer graphics. Various kinds and dimensions of standard reciprocating knives were analyzed by the developed program for the

50 mm standard. Reciprocating knife the bunching area and the maximum stalk-deflection decreased rapidly according to the increase of cutting velocity. The 76 mm standard knife showed a better cutting mechanism that the 50 mm in respects the large cutting area per stroke and the lower revolution speed of the crank shaft for the same cutting velocity.

Mahrous (1995) carried out a study to improve the rear mounted mowers widely used in Egyptian agricultural. A conveying belt for improving the performance was designed and tested comparing with the rear mounted mower without modification under actual field conditions. Results show that the average field capacity was about 1.025 fed./h. for the rear mounted mower without modification while it increased to 1.18 fed/h for the same mower after modification. David (2000) mentioned that harvesting machines are nothing new. Indeed in their simplest from-basic hand tools such as shaft and blade they date back to when humans first grew crops for food the shaft and blade then developed into its ultimate from the scythe this long handled tool with its sweeping blade is so effective that it is still in use today in environments such as reed marshes where machine can not operate. Since those early times, agricultural mechanization has brought about massive improvements in productively. Early machines were simple cutting devices, which were horse drew in and ground driven-that is the power for the mechanism was provided by a ground wheel. Finger bar mowers designed around this time and have proved so effective on dry unit angled crop. Suitable crops for this kind of challenge are maize grass and wheat. Each has different harvesting characteristics.

MATERIALS AND METHODS

Many problems was facing the use of original mower. These problems as follow:

1. High cost of labors needed for carrying away the harvested crop from the next tractor lane.
2. Decrease field capacity, cutting and field efficiency of the mower according to the difference between mower velocity and effort of labors.
3. Exposing the harvested crop for damage under tractor wheels during the next run.

So, this work was concentrated on study the developed horizontal flat conveyor belt manufactured to over-come the above problems of the Busatis double-knife rear mounted BM 1102 mower and also, to increase field capacity, and cutting efficiency of the mower according to the difference between mower velocity and decreasing the total grain losses of operating time, the power requirements and minimizing the high direct cost. The performance of the modified rear mounted mower will be influenced by stem moisture content, mowing forward speed, knife velocity, and flat conveyor belt velocity.

This study was conducted on the Busatis double-knife rear mounted BM 1102 mower, (Figs. 1 and 2), to be modified, to depend on horizontal flat conveyor belt for improving its harvesting efficiency. The experimental field work was executed at the farms of Gemmiza Research Station- Gharbia Governorate-Egypt in the field grown with wheat and barley of three feddan crops (Gemmiza 9 and Balady 16 varieties respectively) through two successful seasons of 2004 and 2005.

Materials

Tractor

Nasr model has 46.26 kW, mass 3370 kg.

Machine before Development

Mower

Bustatis BM mower 1102 model,

Knife: reciprocating motion, 150 cm width, cutting space 7.6 cm, stroke 7.6 cm.

Machine after Development

1. Horizontal flat conveyor belt was used to cover the problems of the original mower. One parallelogram chassis of 108 cm width, 176cm length and 20 cm high.

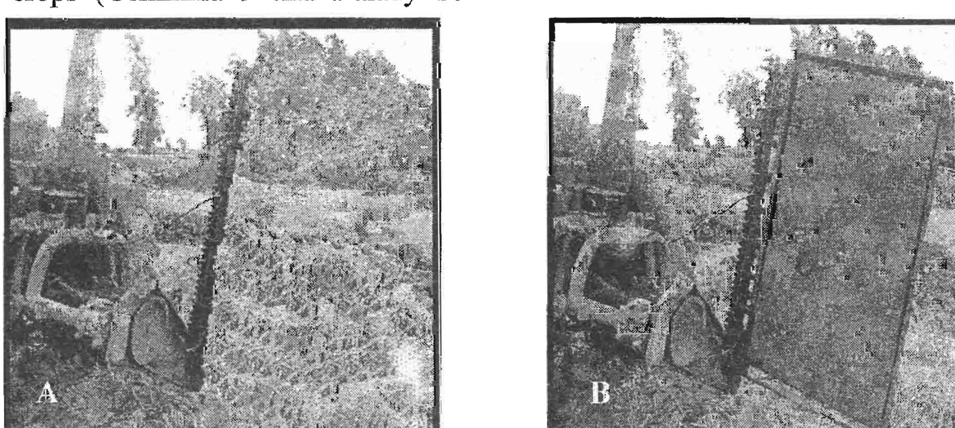

Fig. 1. The rear–mounted mower before modification (A) and after modification (B)

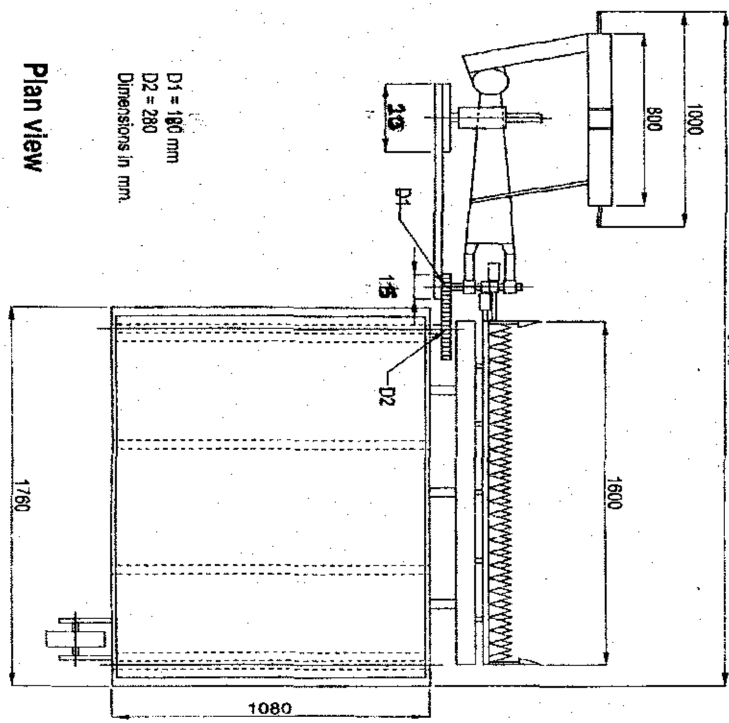

Fig. 2. Schemes for rear-mounted mower and flat conveyor belt

2. Two drums of 7cm diameter and 120 cm width per each
3. Flat conveyor belt of 372cm length, 108cm width, and 0.7cm thickness
4. Two plates of 176 cm length, 108cm width, and 0.2 thicknesses.
5. Two wheels of 25 cm diameter and fixed in the rear of flat conveyor belt to adjust its high upper the surface of soil and to easy its motion on the land. The total mass of developed device 85 kg

Transmission system

The motion is transmitted from tractor to the mower by means of P.T.O shaft, pulleys and V-belt. Four pulleys, divided into, main driver pulley of 20 cm diameter to transmit motion from P.T.O, three pulleys transmit motion from knife crank to gears of flat conveyor belt. Universal Joint Yoke to transmit motion from P.T.O to rear mounted mower and flat conveyor 50 cm length.

There are two wheels have a diameter of 25 cm and fixed in the rear of flat conveyor belt to adjust its high upper the surface of soil and to ease its motion on the land. The knife takes its motion from tractor P.T.O shaft by pulleys and V-belt. The main driver pulley of 20 cm diameter, fixed on the end of shaft linked with P.T.O of tractor, and different three driven pulleys are fixed on the end of crank shaft having 25, 20 and 15 cm diameter to produce 405, 540 and 675 r.p.m respectively, to transfer the motion from tractor P.T.O to knife and gears of flat conveyor belt. These pulleys connected by V-shape belt that has 110 cm length. There are ten straight spur gears, one used as driver straight spur gear having an outside circle diameter 8 cm and 18 teeth while; the nine others used as driven gears at three mentioned velocities of knife shaft (405, 540, and 675 r.p.m) each of them reduced the velocity to 180, 230 and 280 r.p.m respectively.

The main treatments used in this study were as follow:

Grain and Stem Moisture Content (Percentage)

Three levels of grain and stem moisture contents (Mc percentage) have been considered. For wheat crops were 19.61, 16.44, 14.36 and 15.21, 12.52, 10.43% for grain and stem respectively. For barley crop, 18.45, 15.12, 13.61 and 14.35, 11.73, 9.75% for grain and stem respectively.

Mowing Forward Speed (m/s)

The harvesting process was performed at four levels of forward speeds (F) 0.69, 0.97, 1.25, and 1.66 m/s, for wheat and barley crops. The speeds were adjusted by the stop watch and the throttle lever.

Knife Velocity (m/s)

The knife velocity (Vk) were set and adjusted by tachometer device. The knife velocity (Vk) used during the study for wheat and barley were 1.03, 1.37, and 1.71 m/s.

Belt Velocity (m/s).

Three levels of flat conveyor belt velocity (Vb) have been used. These flat conveyor belt velocities were 180, 230, and 280 r.p.m that mean 0.65, 0.84 and 1.03 m/s respectively.

The field experiments were designed to test the effect of the developed mounted mower in respect to operating conditions such as stem moisture content, tractor forward speed (m/s), flat conveyor belt velocity (m/s) and knife velocity (m/s) on the mounted mower cutting efficiency, grain losses, and energy requirements. These measurements were measured and estimated as follow :

Cutting Efficiency

Cutting efficiency was calculated by using the following formula according to Hanna and Suliman (1986) as follow:

$$Ec = \frac{Ha - Hb}{Ha} x100 ----------3.1$$

Ec= Cutting efficiency (%)

Ha= Height of plant stand above the soil before cutting in cm,.

Hb= Height of the stubble after cutting (height of cut) in cm.

Grain Loss by Shattering:

The grain falling on the ground measured by means of square meter markers in the harvested field due to the cutting action of the cutter bar. Samples were estimated at each rotating and forward speed by weighing the grain left on the ground after harvesting.

Energy Requirements (PR)

The following formula was used to estimate the power according to Embaby (1985).

$$E.P = Fc(\frac{1}{60x60})P.FxLCVx\ 427\ x\eta_{th}x\eta_m\ x\ \frac{1}{75}\ x\ \frac{1}{1.36}\ kW \quad ..(3.2)$$

Where:

Fc = the fuel consumption L/h.

P.F= the density of fuel, kg/L (for solar = 0.85).

L.C.V=Lower calorific value of fuel (k.cal/kg) average L.C.V of solar is 10000 k.Cal/kg).

η_{th} = thermal efficiency of engine, to be about 40% for diesel engine).

427=thermomech. equivalent, kg.m/kcal.

η_m= mechanical efficiency of the engine, to be 80 percentage for diesel engine).

The required Power

So, the energy requirement in (kW.h/fed.), was calculated as follow:

$$Enreq.= \frac{\text{the required power(kW)}}{\text{Actual field capacity(fed/h)}}\ kW.h/fed \text{-------}(3.3)$$

Criterion Cost

The following equation of Awady (1978) was taken into account to calculate the cost per hour for two different types of transplanting machine determine

$$C=\frac{P}{h}(\frac{1}{L}+\frac{i}{2}+a+r)+(0.9W\times F\times U)+b$$

$$(0.9W \times F \times U)+b \quad (3.4)$$

Where:

C=Cost per hour of operation. L.E/h.

P=Estimated price of the machine L. E.
h=Estimated yearly hrs. operation (450 h).
L=Life expectancy of machine (10 years).
i = Annual interest rate (10%)
a=Annual taxes and overheads (2%)
r = Annual repair and maintenance (18%) 0.9= factor for rated load and lubrication
w = Engine power, hp.
F=Specific fuel consumption L/hp.h.
U = Fuel price L.E/L.
b = Hourly labor wage L.E/h.

RESULTS AND DISCUSSION

Field experiments were carried out to evaluate the effects of stems moisture content, mowing forward speed, knife velocity, and conveyor belt velocity treatments, used with the developed Busatis double-knife rear mounted BM 1102 mower of each crop under study harvesting Barley (Balady-16) and Wheat (Gemmiza-9) comparing with mower before development.

Effect of Operational Factors on Cutting Efficiency

Data illustrated in Tables (1, 2) shows that increasing forward speed, knife velocity, conveyor belt velocity and stem moisture content decreased cutting efficiency. It was noticed that at stem moisture content of 15.21 %, knife velocity 1.03 m/s and conveyor belt velocity 0.65 m/s increasing forward speed from 0.69 to 1.66 m/s decreased cutting efficiency from 96.84 to 96.35 % and from 96.72 to 96.26 % for wheat and barley crops respectively. It is obvious that increasing forward speed tends to decrease the cutting efficiency; this is due to decrease of chance for the knife to accomplish cutting action thoroughly. Such as, for the same conditions of stem moisture content 15.21 % and mowing forward speed 0.69 m/s and conveyor belt velocity 0.65 m/s, increasing knife velocity from 1.03 to 1.71 m/s decreased the cutting efficiency from 96.84 to 95.51 % and from 96.72 to 95.39 %, for wheat and barley crops respectively. This result means that, the optimum knife velocity for increasing cutting efficiency was achieved at knife velocity (1.03 m/s). This behavior is due to that the high knife velocity means less chance of cutting action added to scattering of the crop containing percent of uncut crops. These data indicated that for the same stem moisture content, mowing forward speed and knife velocity increasing the conveyor belt velocity decreased the cutting efficiency and there was a negative relationship between the conveyor belt velocity and the cutting efficiency.

Table 1. The cutting efficiency (%) for the developed mower at the tested stem moisture content (%), forward speed (m/s), knife speed (m/s) and conveyor belt velocity for wheat crop (Gemmiza 9).

Treatments		V_{k1}				V_{k2}				V_{k3}				Mean
		V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	
Mc_1	F_1	96.84	95.71	95.57	94.88	95.71	95.49	95.27	94.33	95.51	95.29	95.12	94.22	95.33
	F_2	96.78	95.51	95.28	94.41	95.62	95.35	95.05	94.17	95.34	95.14	95.02	94.09	95.15
	F_3	96.54	95.12	95.09	94.24	95.33	95.21	95.08	94.09	95.07	94.85	94.67	93.89	94.93
	F_4	96.35	95.05	94.95	94.11	95.13	95.04	94.61	94.01	94.88	94.64	94.45	93.55	94.73
Mc_2	F_1	97.01	95.97	95.81	94.97	96.62	96.24	96.07	95.09	96.33	96.20	96.01	95.08	95.95
	F_2	96.89	95.88	95.61	94.75	96.47	96.11	95.74	94.66	96.24	96.08	95.98	94.59	95.75
	F_3	96.67	95.74	95.41	94.31	96.34	96.01	95.57	94.64	96.11	95.94	95.44	94.31	95.54
	F_4	96.47	95.66	95.11	94.27	96.12	95.84	95.21	94.31	96.04	95.49	95.17	94.24	95.33
Mc_3	F_1	97.25	96.91	96.74	95.66	96.69	96.57	96.41	95.39	96.58	96.33	96.20	95.34	96.34
	F_2	97.05	96.78	96.41	95.18	96.58	96.42	96.32	95.47	96.40	96.11	96.01	95.11	96.15
	F_3	96.78	96.51	96.28	95.12	96.62	96.38	96.06	95.07	96.41	96.14	96.03	95.05	96.04
	F_4	96.74	96.21	96.07	95.27	96.37	96.20	96.14	95.22	96.07	95.84	95.72	94.88	95.89
Mean		96.78	95.92	95.69	94.76	96.13	95.91	95.63	94.70	95.92	95.67	95.49	94.53	95.59

- F (m/s) = Forward speed, MC (%) = Moisture content, Vk (m/s) = Knife velocity, Vb (m/s) = Belt velocity, W.M = Without modification

Table 2. The cutting efficiency (%) for the developed mower at the tested stem moisture content (%), forward speed (m/s), knife speed (m/s) and conveyor belt velocity for barley crop (Balady).

Treatments		V_{k1}				V_{k2}				V_{k3}				Mean
		V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	
Mc_1	F_1	96.72	95.60	95.47	94.77	95.62	95.39	95.17	94.22	95.39	95.19	95.01	94.12	95.22
	F_2	96.65	95.42	95.17	94.32	95.51	95.25	94.94	94.06	95.23	95.04	94.93	93.97	95.04
	F_3	96.42	95.01	94.99	94.15	95.23	95.10	94.97	93.98	94.93	94.75	94.47	93.79	94.82
	F_4	96.26	94.94	94.86	94.00	95.03	94.96	94.53	93.91	94.77	94.54	94.35	93.44	94.63
Mc_2	F_1	96.99	95.88	95.72	94.88	96.53	96.13	95.94	94.90	96.22	96.10	95.92	94.92	95.84
	F_2	96.79	95.77	95.53	94.65	96.38	96.01	95.63	94.55	96.12	95.97	95.87	94.49	95.65
	F_3	96.56	95.63	95.32	94.23	96.23	95.91	95.46	94.51	96.01	95.84	95.34	94.22	95.44
	F_4	96.36	95.55	95.00	94.16	96.01	95.74	95.10	94.21	95.91	95.39	95.06	94.14	95.22
Mc_3	F_1	97.16	96.82	96.63	95.55	96.58	96.47	96.30	95.29	96.47	96.22	96.11	95.23	96.24
	F_2	96.98	96.69	96.32	95.08	96.47	96.33	96.21	95.37	96.28	96.01	95.90	95.01	96.05
	F_3	96.67	96.42	96.17	95.02	96.52	96.28	95.94	94.93	96.32	96.03	95.94	94.96	95.93
	F_4	96.62	96.11	95.97	95.16	96.27	96.10	96.03	95.12	95.93	95.73	95.61	94.78	95.79
Mean		96.68	95.82	95.60	94.66	96.03	95.81	95.52	94.59	95.80	95.57	95.38	94.42	95.49

At stem moisture content 15.21 %, knife velocity 1.03 m/s and mowing forward speed 0.69 m/s, increasing conveyor belt velocity from 0.65 to 1.03 m/s decreased the cutting efficiency from 96.84 to 95.57 %.and from 96.72 to 95.47 % for wheat and barley crops respectively. It is interested to know that, the highest cutting efficiency (97.25 %) and (96.72 %) were recorded at the lowest stem moisture content (10.43 %). Whereas the lowest cutting efficiency (94.22 %) and (94.35 %) were remarked at the high stem moisture content (15.21%) for wheat and barley crops respectively. This can be explained by the fact that, more moisture content obliges the stem to bending decrease the chance of cutting. Also, one can said that increasing cutting efficiency after modification than before modification with nearly 2% that getting developed mower more efficiency.

Effect of Operational Factors on Grain Losses

Data illustrated in represents Tables (3, 4) shows the effect of studied factors on the grain losses. It is noticed that, increasing forward speed, knife velocity, conveyor belt velocity increased grain losses and there was a direct relationship between them. While increasing stem moisture content decreased grain losses and there was an indirect relationship between them. Such as, at same conditions of stem moisture content 15.21 %, knife velocity 1.03 m/s and conveyor belt velocity 0.65 m/s increasing forward speed from 0.69 to 1.66 m/s increased grain losses from 5.23 to 5.81 % and at moisture content 15.21 % and mowing forward speed 0.69 m/s and conveyor belt velocity 0.65 m/s, increasing knife velocity from 1.03 to 1.71 m/s increased the grain losses from 5.23 to 8.94 % and from 4.91 to 5.81 for wheat and barley crops respectively. These data indicated that at the same conditions of stem moisture content 15.21 %, knife velocity 1.03 m/s and mowing forward speed 0.69 m/s, increasing conveyor belt velocity from 0.65 to 1.03 m/s increased the grain losses from 5.23 to 7.62 % and from 4.91 to 7.33 % for wheat and barley crops respectively. These data indicated that, the highest grain losses (10.35%) was recorded at the lowest stem moisture content (10.43%). Whereas the lowest grain losses (5.23 %) was found at the highest stem moisture content (15.21 %). These results occurred due to the fact of increasing the strength band of stalks at the largest stem moisture content.

Table 3. The grain losses (%) for the developed mower at the tested stem moisture content (%), forward speed (m/s), knife speed (m/s) and conveyor belt velocity for wheat crop (Gemmiza 9)

Treatments		V_{k1}				V_{k2}				V_{k3}				Mean
		V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	
Mc_1	F_1	5.23	6.24	7.62	8.11	5.60	6.15	7.30	8.57	6.11	7.26	8.35	8.94	7.12
	F_2	5.36	6.36	7.82	8.25	5.72	6.31	7.46	8.71	6.31	7.46	8.51	9.01	7.27
	F_3	5.69	7.71	8.09	8.36	5.90	6.57	7.61	8.89	6.51	7.59	8.69	9.25	7.57
	F_4	5.81	7.92	8.25	8.59	5.93	6.68	7.79	8.91	6.68	7.68	8.79	9.36	7.70
Mc_2	F_1	5.96	7.04	8.34	8.68	6.11	6.76	7.86	9.00	6.79	7.78	8.90	9.47	7.72
	F_2	6.09	7.13	8.46	8.74	6.26	6.85	7.91	9.06	6.81	7.86	8.92	9.68	7.81
	F_3	6.15	7.26	8.58	8.85	6.35	7.01	8.00	9.11	6.92	7.91	8.99	9.74	7.91
	F_4	6.23	7.32	8.63	8.96	6.42	7.90	8.12	9.24	7.02	8.01	9.04	9.82	8.06
Mc_3	F_1	6.01	7.41	8.71	9.02	6.51	7.12	8.21	9.36	7.16	8.12	9.11	9.90	8.05
	F_2	6.11	7.51	8.88	9.11	6.62	7.19	8.30	9.42	7.20	8.29	9.25	10.00	8.16
	F_3	6.23	7.62	8.89	9.18	6.79	7.25	8.42	9.61	7.32	8.32	9.35	10.25	8.27
	F_4	6.42	7.71	8.90	9.24	6.81	7.37	8.60	9.69	7.41	8.41	9.41	10.35	8.36
Mean		5.94	7.27	8.43	8.76	6.25	6.93	7.97	9.13	6.85	7.89	8.94	9.65	7.83

Table 4. The grain losses (%) for the developed mower at the tested stem moisture content (%), forward speed (m/s), knife speed (m/s) and conveyor belt velocity for barley crop (Balady).

Treatments		V_{k1}				V_{k2}				V_{k3}				Mean
		V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	
Mc_1	F_1	4.91	5.89	7.33	7.78	5.31	5.86	7.00	8.26	5.81	6.96	8.05	8.61	6.81
	F_2	5.07	6.06	7.51	7.94	5.41	6.01	7.14	8.40	6.03	7.17	8.22	8.75	6.98
	F_3	5.38	7.42	7.73	8.06	5.63	6.27	7.30	8.58	6.22	7.28	8.38	8.93	7.27
	F_4	5.52	7.61	7.94	8.29	5.65	6.37	7.48	8.62	6.39	7.37	8.49	9.04	7.40
Mc_2	F_1	5.63	6.72	8.01	8.20	5.81	6.45	7.58	8.70	6.51	7.46	8.61	9.23	7.41
	F_2	5.76	6.81	8.15	8.31	5.95	6.57	7.63	8.78	6.55	7.55	8.63	9.37	7.51
	F_3	5.86	7.00	8.27	8.53	6.06	6.74	7.76	8.84	6.68	7.61	8.69	9.32	7.61
	F_4	6.01	7.11	8.36	8.64	6.15	7.61	7.79	8.91	6.74	7.76	8.75	9.48	7.78
Mc_3	F_1	5.78	7.13	8.42	8.67	6.24	6.81	7.91	9.05	6.82	7.86	8.81	9.58	7.76
	F_2	5.86	7.22	8.59	8.75	6.33	6.89	8.00	9.11	6.93	7.96	8.96	9.71	7.86
	F_3	5.92	7.33	8.59	8.84	6.49	6.95	8.15	9.33	7.02	8.01	9.04	9.96	7.97
	F_4	6.12	7.42	8.63	8.91	6.52	7.08	8.33	9.39	7.12	8.11	9.11	10.05	8.07
Mean		5.65	6.98	8.13	8.41	5.96	6.63	7.67	8.83	6.57	7.59	8.65	9.34	7.53

Required Energy for Wheat and Barley Crops Harvesting

Data illustrated in Tables (5, 6) indicated that the actual field capacity for the mechanical harvesting was two times more than of the manual harvesting. Also, it is clear that the mechanical harvesting saves up to nearly 48% of the required time of the harvesting operation. Also, it is obvious that the mechanical harvesting operation consumed nearly 20 times the energy consumed in manual harvesting by labors (men). In fact these big differences in the consumed energy could be accepted with satisfaction due to the high quality perform-ance of developed mower, when compared that with that of the labors, since the mower always kept regular spacing between windrows and always kept a rapidly mowing of crops.

Cost of Manual and Mechanical Harvesting

The values of hourly cost, were16.16 and 4.95 L.E/h. of tractor and mower respectively. While, the highest values of harvesting cost with manual harvesting (250L.E./fed) and the cost values of mechanical harvesting were 88.03, 68.19, 55.52 and 46.86 L.E/fed for harvesting wheat crop at forward speed of 0.69, 0.97, 1.25 and 1.66 m/s respectively, and this values were 72.83, 57.00, 46.86 and 39.05 L.E/fed for harvesting barley crop at the same previous conditions. It obvious that the developed mower save nearly 3 times from manual and before modification cost at recommended forward speed.

Conclusions

According to the obtained results, it can be concluded that increasing field capacity, cutting efficiency and field efficiency of the mower. The factors affecting the quality work were forward speed, knife velocity, conveyor velocity and moisture content.

The main results of the present study could be summarized in:

1. The developed horizontal flat conveyor belt is considered a new technology especially under Egyptian conditions.
2. The optimum conditions for wheat and barley harvesting that obtained symmetric (positive effect) between independent variables, economic cost is straw of wheat and barley moisture content 10.43 % and 11.75 % respectively, mowing forward speed 0.69 m/s, knife velocity 1.03 m/s, and developed flat conveyor belt velocity 0.65m/s.

Table 5. The energy requirements (kW.h/fed) for the developed mower at the tested stem moisture content (%), forward speed (m/s), knife speed (m/s) and conveyor belt velocity for wheat crop (Gemmiza 9).

Treatments		V_{k1}				V_{k2}				V_{k3}				Mean
		V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	
Mc_1	F_1	19.68	21.64	23.80	19.01	20.68	21.52	22.99	20.23	21.21	22.81	23.68	21.12	21.53
	F_2	21.58	23.08	24.32	18.87	21.21	22.72	23.51	20.49	21.86	23.48	24.07	21.24	22.20
	F_3	22.11	23.50	25.10	19.40	22.16	24.03	24.42	20.77	22.46	23.89	24.05	21.97	22.82
	F_4	22.39	24.52	25.70	19.71	23.52	24.98	26.77	21.35	23.20	24.31	25.48	22.29	23.69
Mc_2	F_1	19.01	20.74	22.63	17.24	19.99	20.85	22.04	18.71	20.64	22.06	22.67	20.14	20.56
	F_2	19.76	20.76	23.17	18.11	21.09	21.21	22.63	19.17	20.71	22.64	23.10	20.46	21.07
	F_3	20.89	21.55	23.48	18.87	21.86	22.19	23.75	19.63	21.65	23.11	23.89	20.60	21.79
	F_4	21.53	22.20	23.89	19.43	22.93	22.99	24.94	20.34	22.12	23.14	23.72	20.72	22.33
Mc_3	F_1	17.79	19.20	21.56	17.41	19.06	19.97	21.26	18.17	19.78	21.24	22.41	18.65	19.71
	F_2	19.48	20.19	22.01	17.31	20.53	21.01	22.32	18.59	20.03	21.28	22.64	19.19	20.38
	F_3	20.41	21.06	21.82	17.81	21.65	22.15	23.74	19.10	21.11	21.97	22.86	19.14	21.07
	F_4	20.75	21.28	22.42	18.63	22.38	23.15	24.54	19.36	22.05	23.12	24.04	19.61	21.78
Mean		20.45	21.64	23.33	18.48	21.42	22.23	23.58	19.66	21.40	22.75	23.55	20.43	21.58

Table 6. The energy requirements (kW.h/fed) for the developed mower at the tested stem moisture content (%), forward speed (m/s), knife speed (m/s) and conveyor belt velocity for barley crop (Balady).

Treatments		V_{k1}				V_{k2}				V_{k3}				Mean
		V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	V_{b1}	V_{b2}	V_{b3}	W.M	
Mc_1	F_1	18.62	20.63	22.90	18.06	19.63	20.56	21.93	19.12	20.23	21.83	22.64	20.11	20.52
	F_2	20.53	22.01	23.30	17.82	20.23	21.76	22.51	19.41	20.84	22.64	23.08	20.23	21.20
	F_3	21.10	22.51	24.12	18.46	21.13	23.04	23.35	19.16	21.63	22.91	23.01	20.95	21.78
	F_4	21.32	22.35	24.76	18.72	22.56	23.92	25.49	20.36	22.19	23.38	24.41	21.26	22.56
Mc_2	F_1	18.06	19.66	21.53	16.23	19.96	19.86	21.07	17.76	19.67	21.64	21.63	19.11	19.68
	F_2	18.71	19.72	22.13	17.12	20.06	20.13	21.61	18.16	19.82	21.69	22.13	19.56	20.07
	F_3	19.82	20.56	22.52	17.83	20.84	21.17	22.79	18.34	20.69	22.16	22.84	19.63	20.77
	F_4	20.53	21.23	22.91	18.53	21.95	21.96	23.91	19.35	21.34	22.64	22.78	19.75	21.41
Mc_3	F_1	16.78	18.26	20.53	16.52	18.08	18.93	20.23	17.16	18.76	20.34	21.41	17.96	18.75
	F_2	18.46	19.16	21.03	16.39	19.56	20.06	21.36	17.59	19.08	20.38	21.63	18.16	19.41
	F_3	19.43	20.05	20.83	16.82	20.53	21.16	22.76	18.16	20.61	20.92	21.69	18.34	20.11
	F_4	19.51	20.26	21.43	17.62	21.83	22.13	23.51	18.34	21.06	22.06	23.09	18.63	20.79
Mean		19.41	20.53	22.33	17.51	20.53	21.22	22.54	18.58	20.49	21.88	22.53	19.47	20.59

REFERENCES

Arnal, A.P. 1990. New developments in grain harvesting machinery" Noredades enla recollect-tion de cereals maquinasy , Tractors Agricolas (5) pp. 24-35.

Awady, M. N. 1978. Tractors and farm machinery textbook, Ain Shams Univ., (Arabic Edition) pp. 289.

Chung, C.J.; H.S. Lee, and H.S. 1995. Cutting pattern and cutting characteristics of the reciprocating cutter-bar of combine harvester (1) cutting mechanism and cutting characters of the standard type reciprocating Knife. J. of the Koreansociety for Agr. Mach. 20: 1,3-12.

David, B. 2000. Giant mower, cutting a swathe in a battle of wills scrap heap's page on the cranfield University Site 2000..

Devani R. S. and M. M. Pandey. 1985. Design development and field evaluation of vertical conveyor reaper Am. 16 (2) pp. 41-50.

Embaby, A.T. 1985. A comparison of different mechanization systems for cereal crop production M.Sc. Thesis, Agric. Eng. Dept., Fac. of Agric., Cairo University.

Hanna, G.B.; and Suliman, A.E. 1986. Appropriate harvesting equipment for small Egyptian farms Misr J. Agric. Eng., 3(1) pp. 58-72.

Mahrous, A.M. 1995. Improvement of reciprocating mower efficiency under different crops M.Sc. Thesis. Ag. Eng. Zagazig Univ.

Pirovani, A.F.; and O.R. Pozzolo. 1992. Evaluation of a prototype blade cutter bar proceeding conference reciprocating knife J. of the Korean society for Agriculture Mach. 20 pp. 1-12.

Robert, and Cathy. 2001. Giant mower, cutting a swathe in a battle of wills Cited in network.

تطوير المحشة الترددية لحصاد بعض محاصيل الحبوب بنجاح في الحيازات صغيرة

ناتيس أحمد خليل - صلاح عبد المقصود -
محمود عبدالرحمن الشاذلى - مراد علي إبراهيم ارناوؤط
قسم الهندسة الزراعية - كلية الزراعة – جامعة الزقازيق

يعتبر كلاً من محصولى القمح والشعير من أهم محاصيل الحبوب الأساسيه فى مصر حيث تبلغ مساحة الشعير المنزرعه فى مصر ١١٠,٠٠٠ فدان تقريباً وتبلغ إنتاجيته ١٦٥,٠٠٠ طن وكذلك مساحة القمح المنزرعه فى مصر ٣,٠٠٠,٤٠٠ فدان تقريباً وتبلغ إنتاجيته ٨,١٠٠,٠٠٠ طن. (النشرة الدوريه لوزارة الزراعة المصريه ٢٠٠٤م). وبناءً عليه كانت

عملية الحصاد لكلاً من هذين المحصولين من أهم العمليات الزراعيه التى تحتاج ألى عماله كثيره ومدربه لتقليل نسبة الفقد في المحصول، ونظراً لإنتشار إستخدام المحشات الترددية فى الآونة الأخيرة للتغلب على مشكلة نقص العماله من حيث العدد والكفاءة فى الحصاد فقد تمت محاولة للمساهمة فى التغلب على مشكلة تقليل تكلفة العمالة المنوطة بنقل المحصول بحيث لا يدوسه الجرار أثناء الجرة التاليه وأيضاً زيادة معدل الأداء للمحشة ورفع الكفاءة الحقلية وكفاءتى القطع والحصاد والمحافظه على القش من التلف بالحقل.

الهدف من البحث:

١. زيادة سعة الآله والسعه الحقليه وكفاءة الحصاد لها بتعديل سير نقل المحصول إلى الجانب مما يقلل من معدل تلف المحصول وتقليل تكلفة العمالة القائمة بنقل المحصول جانباً .

٢. محاولة الوصول إلى أنسب عوامل التشغيل (سرعة تقدم المحشة، سرعه سكينة القطع، سرعة السير المعدل، المحتوى الرطوبى للقش والحبوب والتي تحقق أعلى معدل أداء وكفاءة حصاد .

- النتائج الحقلية:

أظهرت النتائج أن هناك علاقه عكسيه بين كفاءة القطع وكل عوامل الدراسه المتمثله فى السرعه الأماميه للمحشه وسرعة سكينة القطع وسرعة سير النقل والمحتوى الرطوبى للقش وذلك فى محصولى القمح والشعير. وُجد أن النسبه المئويه لفواقد الحبوب فى كل من محصولى القمح والشعير تتناسب عكسياً مع المحتوى الرطوبى للقش بينما تتناسب طردياً مع السرعه الأماميه للمحشه وسرعة سكينة القطع وسرعة سير النقل. متطلبات الطاقه للمحشة المعدله فى كل من محصولى القمح والشعير تتناسب طردياً مع السرعه الأماميه للمحشه وسرعة سكينة القطع وسرعة سير النقل والمحتوى الرطوبى للقش. أوضحت التجارب أن إرتفاع القطع فى المحشة المعدله فى كل من محصولى القمح والشعير تتناسب طردياً مع السرعه الأماميه للمحشه والمحتوى الرطوبى للقش بينما تتناسب عكسياً مع سرعة سكينة القطع وسرعة سير النقل. وجد أنه من خلال التجارب الحقليه أن تفوقت المحشه المعدلة بصورة واضحه من حيث إرتفاع كفاءات القطع والحصاد والكفاءة الحقليه ومعدل الأداء الحقلى الفعلى فى وحدة الزمن وقلة الفاقد من الحبوب وإرتفاع طفيف فى متطلبات القدره والطاقة.تكلفة الحش اليدوى لمحصولى القمح والشعير بلغت ٢٥٠ جنيهاً فى حين أنها للمحشة المطورة بلغت ٨٨,٠٣ للقمح و ٧٢,٨٣ جنيهاً للشعير على التوالي بفارق تكلفة مرتين ونصف تقريباً للمحشة المعدلة أقل من اليدوى والغير معدله كما أن تكلفة السير الملحق بالمحشة لنقل المحصول تعتبر تكلفة زهيده بالمقارنه بالمميزات النسبيه فى المحشة بعد التعديل والتى سبق ذكرها.

التوصيات:

١- الدراس عند محتوى رطوبى لقش الشعير ١١,٧٥ % أما بالنسبه للقمح عند محتوى رطوبى للقش ١٠,٤٣%.

٢- يفضل الحصاد عند سرعه أماميه للمحشة المعدلة ٠,٦٩ م/ث وذلك لزيادة السعه الحقليه الفعليه للآله لكل من محصولى القمح والشعير.

٣- السرعه المثلى لسكينة القطع ١,٠٣ م/ث لكل من محصولى القمح والشعير .

٤- السرعه المثلى للسير المصنع لنقل المحصول ٠,٦٥ م/ث لكل من محصولى القمح والشعير .