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Developing A Machine Suitable for Alfalfa Mowing in Small Farms

Refaay, M. M.* and A. R. Obaia

Agric. Eng. Res. Institute, ARC, Egypt.

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ABSTRACT

This study was carried out to investigate a horizontal mowing knife machine (HMKM) for mowing alfalfa in small fielding's and consequently reducing mowing costs. Speed ratio of 0.86, 0.94 and 0.98; working width of 0.6, 0.8 and 1.0 m and mower knife height of 4, 6 and 8 cm were studied. Mower efficiency, field capacity, fuel consumption, consumed energy and economic costs were computed. The main results showed that increasing speed ratio and working width result in increasing mower efficiency, field capacity, fuel consumption, economic cost but consumed energy decreased. Increasing mower knife height leads to increase mower efficiency while decreasing fuel consumption, consumed energy and economic cost. The maximum values of mower efficiency was 96.9%, field capacity of 0.66 *fed/h*, fuel consumption of 2.3 *lit/h*, machine consumed energy of 17.768 *kW.h/fed*, and the economic cost decreased by 54.7% at speed ratio of 0.86, working width of 0.6 m and mower knife height of 4 cm comparing to manually sickling conditions.

Keywords: mowers, consumed energy, field capacity and economic cost.

INTRODUCTION

Some researchers design modifying in mowers include different knife types for different needs and changes with weight load distribution. Most growers are rapidly switching from sickle to disc mowers due to reducing maintenance requirement. The most common are knives that are angled at about 14° to enhance picking up downed forage. Mowers with these knives really pick up downed forage better than those with flat knives. Angled knives can add 1 to 2% ash to the harvested forage. So the grower must decide which is more important – picking up downed forage or having less ash in the forage. Curved and angled knives tend to pick up downed forage better and for general purposes a flat horizontal knife is best. *(Dan Undersander, 2006)*. The newest thing on the market for balers is bale cutters. This option for either round or square bales cut the hay length. The final theoretical cut length can be as short as 1.5 inches. However, using fewer knives to get final hay to be 4 to 6 inches long will provide the most economical benefit with less knife expense and energy cost. The cut hay has no benefit in hay making or silage fermentation but data has shown that animals will have higher forage intake and less feeding losses. Additionally cut bales will break apart. *(Boland, 2008)* showed that mechanical removal involves collecting and destroying the stems and all below-ground rhizomes, which is labor and machinery intensive. Mechanical removal is prohibitively expensive except on small areas, with costs reaching $8,100 per acre *(Lawson et al. 2005). (Dan Undersander, 2008).* The movement of cutting tools creates the vacuum (under pressure) within the workspace. This vacuum decreases almost linearly from the center of the rotor towards to its periphery. Maximum reached vacuum was 2.41 kPa with original shape of cutting tools. Other sources *(Chon & Amano, 2003; Chon & Amano, 2005)* with use of mathematical model also found the highest vacuum in the center of rotor of municipal mower. Proposed shapes of the cutting tools generally lowered the maximum reached vacuum in comparison with the original cutting tool. Also, proposed shapes of the cutting tools have only a negligible effect on the course of pressure. At zero rake angle of cutting tool the maximum achieved vacuum was reduced by decreased trailing edge angle. For the rake angle of 15° and 25° it was found that decrease of the trailing edge angle conversely increases the maximum vacuum. Lower vacuum has resulted in a smaller power requirement for creating and maintaining of vacuum. But too low vacuum could significantly impair the quality of mulcher work since there would be no sufficient disruption of the plants structure by repeated contact with blades of the cutting tools. *(Čedík et al., 2017).(Saeid and Mohsen, 2012)* showed that 1 m s-1 mower forward speed, 886 rpm disc rotation speed, 4 blade numbers and serrated-edge triangular blade is optimum set up for the experimental mower. Taguchi method predicted the eigen-value of 1,991.5 for this optimum set up. The overall objective: The developing a machine suitable for alfalfa mowing in small fielding's by using a horizontal knives and reducing mowing costs.

MATERIALS AND METHODS

On the base of rotary cultivated the experiments were carried out at El-Serw Agric. Res., ARC. Station Damaitta Governorate, during the winter season 2019-2020. A small, lightweight machine was developed for mowing alfalfa in small fielding's and consequently reducing mowing costs. The motor specifications used in the experiment, as shown in table (1).

* **Corresponding author.**
E-mail address: dr.mansourr@yahoo.com
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Table1. The motor specifications used in the experiment.

1	Model	Yanmar (JAPAN)
2	Power source	7 hp gasoline engine
3	Net weight	22.5 kg
4	Speed	1800, 2000 and 2100 rpm
5	Fuel Tank Capacity(L)	3.2

The horizontal mowing knife machine (HMKM) was investigated for alfalfa mowing on small fielding's consists of a frame carried on two wheels with a diameter of 30 cm each, which takes its movement from the motor through a set of rollers, belts, gears, and tracks. frame is installed with a hand to run the machine This hand is installed with a number of tools to control the management of the machine wheels to the right or left, as well as to increase the speed of the motor by a group of wires. The frame is installed with a motor with a capacity of 7 hp, which is the power source that gives the movement a pulley installed on the motor shaft, and the transmission is transmitted to the transmission by a belt from the motor pulley to the transmission drive pulley. The transmission group consists of set of pulleys, gears, chains and belts. On the other hand developed mowing consists of collecting system. As shown in the following Figs. (1& 2) and table (2).

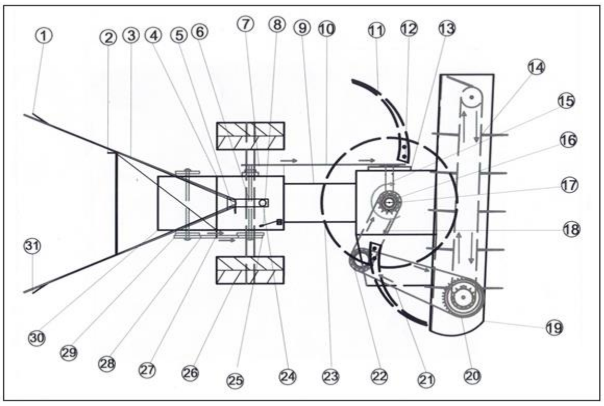

Fig. 1. The machine after modification

1-handle to right turn of machine, 2- handle to separate or connect movement of machine, 3- handle machine, 4- body of machine, 5- bolt to control of handle machine for lower or higher, 6- bar, 7- gear (15 teeth), 8- handle to control of machine forward speed, 9- square bar, 10- chain, 11- flabellate knife, 12- gear (38 teeth), 13- gearbox, 14- collect system, 15- horizontal gear column of the gearbox, 16- vertical gear column of the gearbox, 17- gear (15 teeth) fixed on vertical column of the gearbox, 18- chain, 19- box of collect system, 20- gear (38 teeth), 21- chain, 22- two gears (15 teeth) fixed on one column, 23- disc, 24- bolt to control of handle machine rotation , 25- driven pulley, 26- wheel, 27- stern, 28- belt, 29- leader pulley, 30- motor 7 hp and 31- handle to left turn of machine.

Fig. 2. The machine after modification

Knife:

In this study used a new shape of knife (lunar knife) with mower to alfalfa mow. It's fixed with circle disc by two bolts and fixed angle of flabellate knife 18^{o} with horizontal axis. It is found that the bracketed angle fixed start point of flabellate knife and flabellate knife edge end 34^{o}. Where used two knives, as shown in Fig. (3)

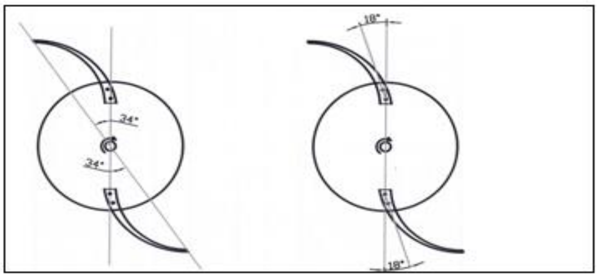

Fig.3. Knife shape (lunar knife) of a developed mower of alfalfa

Table 2. The machine developed specifications.

1	Industry	Local (Egypt)
2	Operating width, m	1
3	Knives number	2
4	Net weight, kg	120
5	Steering	Manually
6	The transmission system	Two pulleys, one belt, eight gears and five tracks

The transmission system:

The transmission group consists of a pulley that takes its movement from the motor pulley. This pulley is fixed on a column on one side and on the other side of the column is a gear (15 teeth) which transmits the movement with a gear chain (35 teeth) larger diameter fixed on the horizontal gear column of the gearbox that transmits the movement to the vertical gear of the gearbox mounted on a shaft, thus converting the horizontal movement to a vertical movement. It is installed on the vertical gear column of the gearbox (15 teeth), which transmits the movement with a gear track (15 teeth) fixed on a column from the bottom, and installed on this column from the top gear (15 teeth), transmits the movement with a gear chain (35 teeth), a larger diameter fixed to a column From the top, this column has two gears (15 teeth) attached to it. Each gear manages a set of plastic nails fixed to the track of the boat on one side and on the other side installed on the track chain where there are two rows of plastic nails that transfer the clover after being stuffed by the fan knife fixed at the end of the gear shaft of the gearbox to the right side of the machine.

The floating mower operation:

mowing method of left turn is the standard operation method, as shown in Fig. (4).

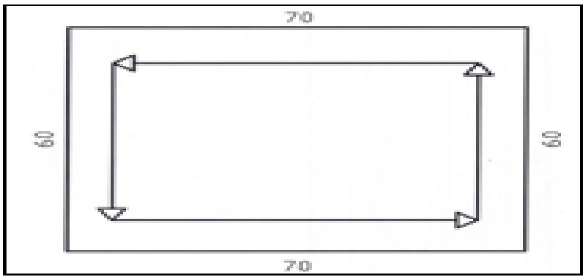

Fig. 4. Left turn mowing method. (Dimension by meter)

The tested variables:

The following factors were studied to evaluate the performance of the used mowing machine.

1- **Speed ratio (K):** was adjusted at three levels (ratio of speed of knifes to forward speed of machine) they were (0.86, 0.94 and 0.98) named K_1, K_2 and K_3 respectively.

2- **Working width (W):** Working width (W): was adjusted at three widths (0.6, 0.8 and 1.0 m) named W1, W2 and W3 respectively.

3- **Mower knife height (H):** was adjusted at three widths (4, 6 and 8 cm) named H1, H2 and H3 respectively.

Measurements:

1- **The Mower efficiency (Mη),% :** It calculated from the following equation (1):

$$M\eta = [(Y - L)/ Y] \times 100 \quad \ldots\ldots (1)$$

Where: **Mη: the machine efficiency, %,**
Y: number of alfalfa stalks before mowing,
L: number of alfalfa stalks after mowing.

2- **Theoretical field capacity (Fc_{th}):** The field capacity means number of feddans per hour estimated from the equation (2):

$$Fc_{th} = [(W \times S)/ 4200], \text{ fed/h} \quad \ldots\ldots (2)$$

Where: **Fc_{th} = Field capacity, fed/h**
W = Working width of mower, m
S = Forward speed of mower, m/h

3- **The fuel consumption (F),** ***lit/h*****:** Fuel consumption was determined by measuring the volume of fuel consumed during the operation time for each run and calculated in liter per hour. It was measured by completely filling the fuel tank then before each end run and refilling the fuel tank using a scaled container. The fuel consumption rate was calculated from the following equation (3):

$$F = \frac{V}{T} \quad L/h \quad \ldots\ldots (3)$$

Where: **F: rate of fuel consumption, L/h, V: rate of consumed fuel, L ; T: time, h**

4- **The machine consumed energy (CE), kW.h/fed (CE),** ***kW.h/fed*****:** It was estimated by using equation: (Hunt, 1983)

$$CE = \left(\frac{Fs \times \rho_f \times C.V}{3600}\right) \times \left(\frac{427 \times \eta_{th} \times \eta_m}{75 \times 1.36 \times FC}\right) (kW.h / fed) \quad \ldots\ldots (4)$$

Where: **CE: machine requirements, (kW.h/fed);**
Fs: fuel consumption rate, (L/h);
ρ_f: density of fuel, kg/L, (for gasoline = 0.76 kg/L);
C.V: calorific value of fuel, (Kcal/kg);
427: thermal-mechanical equivalent, (kg.m/Kcal);
η_{th}: thermal efficiency of the engine; [%]
η_m: mechanical efficiency to engine; [%]
Fc: actual field capacity, m^2/h.

5-**The economic cost (Ec),** ***L.E/fed*****:** The operating cost was determined using the following formula:

$$\text{Operating cost}(L.E/fed) = \frac{\text{Machine hourly cost}(L.E/h)}{\text{Actual machine capacity}(fed/h)} \quad \ldots\ldots (5)$$

Actual machine capacity = theoretical machine capacity x the mowing efficiency, fed/h

$$= Fc_{th} \times M\eta \quad \ldots\ldots (6)$$

Where: Fc_{th} = theoretical machine capacity, fed/h
Mη= the mowing efficiency, %

The labor cost was estimated actually according to the currently labors wage which was about 50 L.E/fed includes fuel consumption, lubrication costs and maintenance costs.

Statistical analysis: All obtained data was tabulated and analyzed in split-split plot design [main treatment (speed ratio), sub main treatment (working width) and sub sub main treatment (mower knife height)] by Minitab program under level of probability of 5%.

RESULTS AND DISCUSSION

1- Mower efficiency (Mη), %

By increasing speed ratio from (K_1= 0.86 to K_2= 0.94) the mower efficiency increased from 76.6 to 84.8% and increasing speed ratio from (K_2= 0.94 to K_3= 0.98) the mower efficiency increased from 84.8 to 92.6%. All these results were obtained under working width (W_1= 0.6 m) with mower knife height (H_1= 4 cm). As shown in Fig. (5).

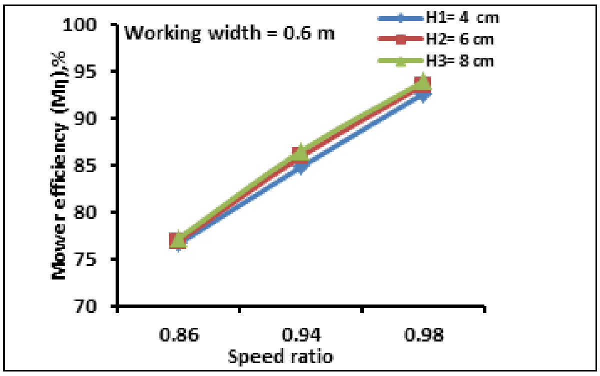

Fig .5. The effect of the speed ratio on the mower efficiency.

On the other hand increasing working width from (W_1= 0.6 to W_2= 0.8, m) the mower efficiency increased from 76.6 to 78.0% and increasing speed ratio from (W_2= 0.8 to W_3= 1, m) the mower efficiency increased from 78.0to 80.5%. All these results were obtained under speed ratio (K_1= 0.86) with mower knife height (H_1= 4 cm). As shown in Fig (6).

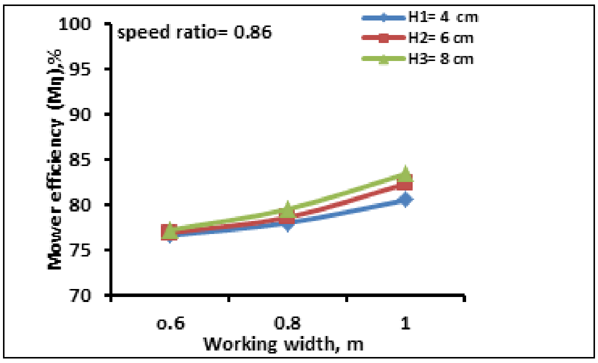

Fig .6. The effect of the working width on the mower efficiency.

Increasing mower knife height from (H_1= 0.4 to H_2= 0.6, cm) the mower efficiency increased from 76.6 to 78.0% and increasing mower knife height from (H_2= 0.6 to H_3= 8, cm) the mower efficiency increased from 78.0to 80.5%. All these results were obtained under working width (W_1= 0.6, m) with speed ratio (K_1= 0.86). As shown on Fig (7).

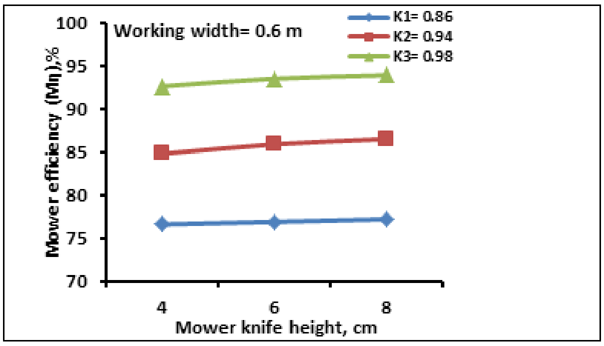

Fig.7. The effect of the mower knife height on the mower efficiency.

These results may be due to that the increase of speed ratio led to increase of knife speed more than forward speed of machine lead to low increasing mower efficiency. Statically there are high significant effects for the different treatments with ($P < 0.05$) for the mower efficiency values. From table (3) regression analysis it should be concluded that speed ratio affects mower efficiency more than working width and mower knife height. While mower knife height showed be less effect on mower efficiency than working width. The effects of different parameters on mower efficiency could be summarized as follows (speed ratio > working width> mower knife height). ANOVA analysis indicated highly significant differences between the treatments. The obtained regression equation was in the form of:

$$(M\eta), \% = -40.71 + 126.54\,K + 10.74\,W + 0.375\,H$$

Table 3. Regression analysis: Mower efficiency versus speed ratio; operating width and mower knife height.

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	1169.11	389.70	505.23	**
Speed ratio	1	1075.99	1075.99	1394.98	**
Working width	1	82.99	82.99	107.59	**
Mower knife height	1	10.13	10.13	13.13	**
Error	23	17.74	0.77		
Total	26	1186.85			

S	R-sq	R-sq(adj)	R-sq(pred)
0.878254	98.51%	98.31%	97.89%

2- Mower field capacity (Fc_{th}), *fed/h*

Increasing speed ratio from (K_1= 0.86 to K_2= 0.94) the field capacity increased from 0.36 to 0.38, *fed/h* and increasing speed ratio from (K_2= 0.94 to K_3= 0.98) field capacity increased from 0.38 to 0.40, *fed/h*. All these results were obtained under working width (W_1= 0.6 m) with mower knife height (H_1= 4 cm), as shown in Fig. (8).

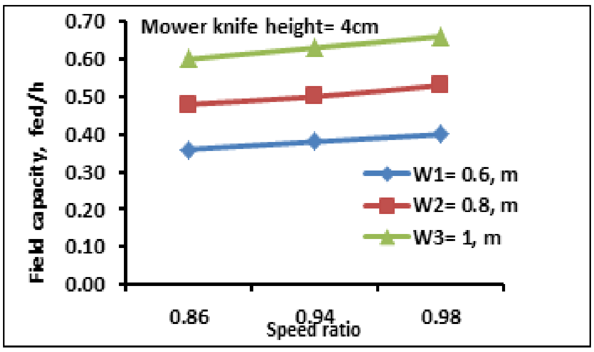

Fig.8. The effect of the speed ratio on the field capacity.

By increasing working width from (W_1= 0.6 to W_2= 0.8, m) the field capacity increased from 0.36 to 0.48, *fed/h* and increasing working width from (W_2= 0.8 to W_3= 1, m) the field capacity increased from 0.48 to 0.60, *fed/h*. All these results were obtained under speed ratio (K_1= 0.86) with mower knife height (H_1= 4 cm). As shown in Fig. (9).

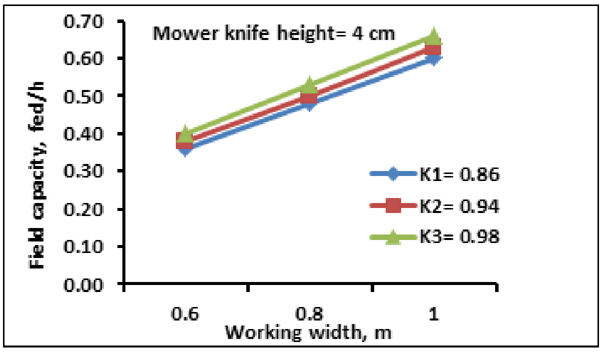

Fig. 9. The effect of the working widths on the field capacity.

These results may be due to that change of forward speed of machine resulted in remove the belt from pulley less diameter to pulley more diameter led to increasing forward speed thus increasing of speed ratio led to increasing of field capacity. Statically there are high significant effects for the different treatments with ($P < 0.05$) for the mower efficiency values. Through regression analysis it could be concluded that working width affects field capacity more than speed ratio. While mower knife height no affects field capacity. The effects of different parameters on field capacity could be summarized as follows (working width > speed ratio). ANOVA analysis indicated highly significant differences between the treatments. As shown in table (4). The obtained regression equation was in the form of:

$$(Fc_{th}), fed/h = -0.3651 + 0.3988\,K + 0.62500\,W + 0.000000\,H$$

Table 4. Regression analysis: Theoretical field capacity versus speed ratio; working width and mower knife height.

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	0.291938	0.097313	2410.36	**
Speed ratio	1	0.010688	0.010688	264.74	**
Working width	1	0.281250	0.281250	6966.35	**
Mower knife height	1	0.000000	0.000000	0.00	1.000
Error	23	0.000929	0.000040		
Total	26	0.292867			

S	R-sq	R-sq(adj)	R-sq(pred)
0.0063539	99.68%	99.64%	99.57%

3- Mower fuel consumption (F), *lit/h*

Increasing speed ratio from (K_1= 0.86 to K_2= 0.94) the fuel consumption increased from 1.55 to 1.80, *lit/h* and increasing speed ratio from (K_2= 0.94 to K_3= 0.98) the fuel consumption increased from 1.80 to 2.05, *lit/h*. All these results were obtained under working width (W_1= 0.6 m) with mower knife height (H_1= 4 cm). As shown in Fig. (10).

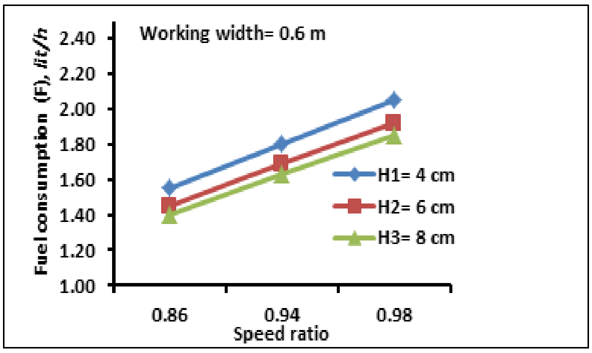

Fig. 10. The effect of the speed ratio on the fuel consumption.

Increasing working width from (W_1= 0.6 to W_2= 0.8, m) the fuel consumption increased from 1.55 to 1.75, *lit/h* and increasing working width from (W_2= 0.8 to W_3= 1, m) the fuel consumption increased from 1.75 to 1.85, *lit/h*. All these results were obtained under speed ratio (K_1= 0.86) with mower knife height (H_1= 4 cm). As shown in Fig. (11).

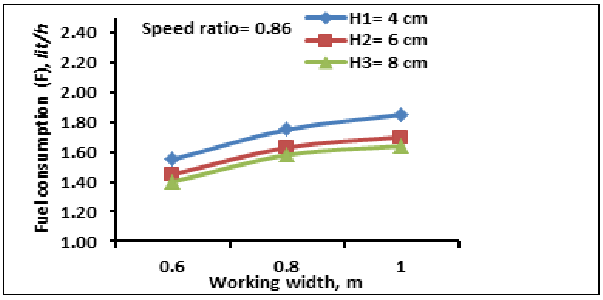

Fig .11. The effect of the working widths on the fuel consumption.

By increasing mower knife height from (H_1= 4 to H_2= 6, cm) the fuel consumption decreased from 1.55 to 1.45, *lit/h*. While increasing mower knife height from (H_2= 6 to H_3= 8, cm) the fuel consumption increased from 1.45 to 1.4, *lit/h*. All these results were obtained under working width (W_1= 0.6, m) with speed ratio (K_1= 0.86), as shown on fig. (12).

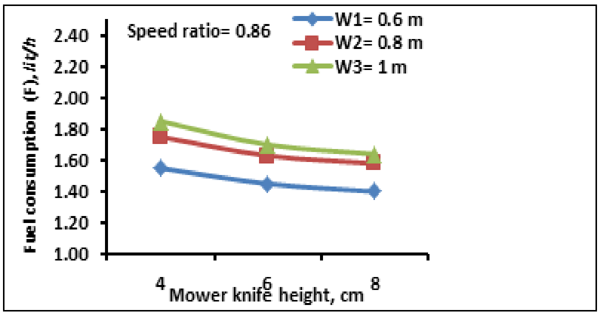

Fig. 12. The effect of the mower knife height on the fuel consumption.

These results may be due to that change of forward speed of machine resulted in remove the belt from pulley less diameter to pulley more diameter led to increasing forward speed thus increasing of speed ratio led to increasing of fuel consumption. Statically there are high significant effects for the different treatments with ($P < 0.05$) for the mower efficiency values. Regression analysis shows that speed ratio affects fuel consumption more than working width and mower knife height. While mower knife height showed be less effect on fuel consumption than working width. The effects of different parameters on fuel consumption could be summarized as follows (speed ratio > working width> mower knife height). ANOVA analysis indicated highly significant differences between the treatments. As shown in table (5). The obtained regression equation was in the form of:

(F), *lit/h* = -1.841 + 3.760 K + 0.6333 W - 0.04917 H

Table 5. Regression analysis: Fuel consumption versus speed ratio; working width and mower knife height.

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	1.41286	0.470952	171.34	**
Speed ratio	1	0.95001	0.95001	345.63	**
Working width	1	0.28880	0.28880	105.07	**
Mower knife height	1	0.17405	0.17405	63.32	**
Error	23	0.06322	0.002749		
Total	26	1.47607			

S	R-sq	R-sq(adj)	R-sq(pred)
0.0524270	95.72%	95.16%	94.29%

4- Mower consumed energy (CE), *kW.h/fed*

By increasing speed ratio from (K_1= 0.86 to K_2= 0.94) the machine consumed energy decreased from 17.78 to 17.67, *kW.h/fed* and increasing speed ratio from (K_2= 0.94 to K_3= 0.98) the machine consumed energy decreased from 17.67 to 17.51, *kW.h/fed*. All these results were obtained under working width (W_1= 0.6 m) with mower knife height (H_1= 4 cm), as shown in Fig. (13).

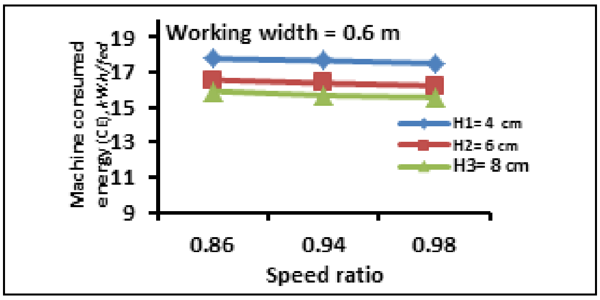

Fig. 13. The effect of the speed ratio on the machine consumed energy.

Increasing working width from (W_1= 0.6 to W_2= 0.8, m) the machine consumed energy decreased from 17.78 to 14.78, *kW.h/fed* and increasing working width from (W_2= 0.8 to W_3= 1, m) the machine consumed energy decreased from 14.78 to 12.11, *kW.h/fed*. All these results were obtained under speed ratio (K_1= 0.86) with mower knife height (H_1= 4 cm). As shown in Fig. (14).

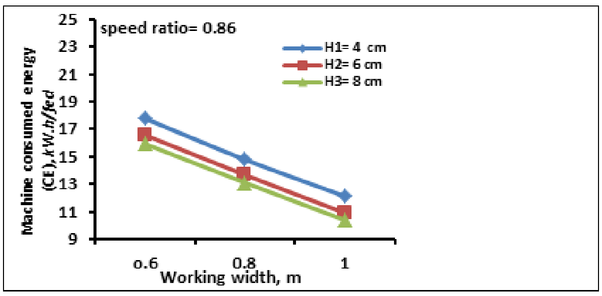

Fig. 14.The effect of the working width on the machine consumed energy.

Increasing mower knife height from (H_1= 4 to H_2= 6, cm) the machine consumed energy decreased from 17.78 to 16.57, *kW.h/fed* and increasing mower knife height from (H_2= 6 to H_3= 8, cm) the machine consumed energy decreased from 16.57 to 15.93, *kW.h/fed*. All these results were obtained under working width (W_1= 0.6, m) with speed ratio (K_1= 0.86). Similar trends were shown under different speed ratios and mower knife heights. As shown on Fig. (15).

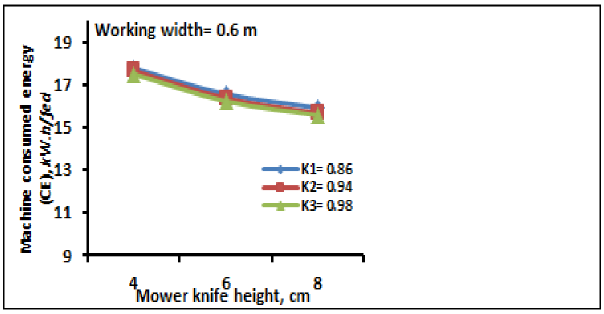

Fig. 15. The effect of the mower knife height on the machine consumed energy.

These results may be owing to by increasing the speed ratios and working width, the consumed fuel increases also and vice versa the consumed energy decreased because of increasing the field capacity.

Statically there are high significant effects for the total interaction between different treatments with ($P < 0.05$) for the mower efficiency values. Regression analysis to show that working width effect on machine consumed energy more than mower knife height and speed ratio. While speed ratio showed be affects machine consumed energy less than mower knife height. The effects of different parameters on machine consumed energy could be summarized as follows (working width > mower knife height > speed ratio). ANOVA analysis indicated highly significant differences between the treatments. As shown in table (6). The obtained regression equation was in the form of:

(CE), *kW.h/fed* = 30.003 - 2.675 K - 14.078 W - 0.4189 H

Table 6. Regression analysis: Consumed energy versus speed ratio; working width; and mower knife height.

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	155.806	51.935	1760.79	**
Speed ratio	1	0.481	0.481	16.31	**
Working width	1	142.693	142.693	4837.79	**
Mower knife height	1	12.632	12.632	428.29	**
Error	23	0.678	0.029		
Total	26	156.484			

S	R-sq	R-sq(adj)	R-sq(pred)
0.171742	99.57%	99.51%	99.40%

5- Mower economic cost (Ec), *L.E/fed*

By increasing speed ratio from (K_1= 0.86 to K_2= 0.94) the economic cost decreased from 181.16 to 155.28, *L.E/fed* and increasing speed ratio from (K_2= 0.94 to K_3= 0.98) the economic cost increased from 155.28 to 135.13, *L.E/fed*. All these results were obtained under working width (W_1= 0.6 m) with mower knife height (H_1= 4 cm), as shown in Fig. (16).

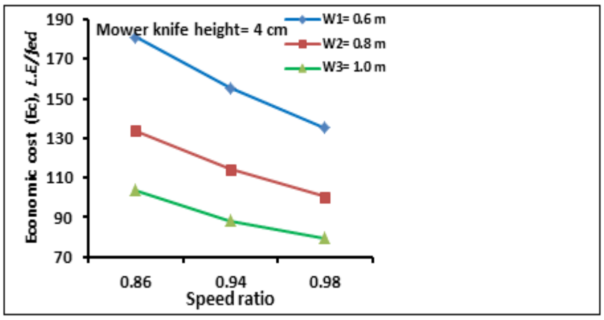

Fig. 16. The effect of the speed ratio on the economic cost.

Increasing mower knife height from (H_1= 4 to H_2= 6, cm) the economic cost decreased from 181.16 to 180.5, *L.E/fed*. While increasing mower knife height from (H_2= 6 to H_3= 8, cm) the economic cost decreased from 180.5 to 179.85, *L.E/fed*. All these results were obtained under working width (W_1= 0.6, m) with speed ratio (K_1= 0.86), as shown on Fig. (18).

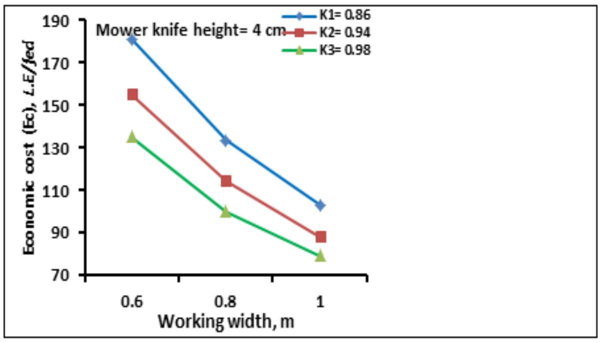

Fig. 17. The effect of the working width on the economic cost.

Increasing mower knife height from (H_1= 4 to H_2= 6, cm) the economic cost decreased from 181.16 to 180.5, *L.E/fed*. While increasing mower knife height from (H_2= 6 to H_3= 8, cm) the economic cost decreased from 180.5 to 179.85, *L.E/fed*. All these results were obtained under working width (W_1= 0.6, m) with speed ratio (K_1= 0.86), as shown on Fig. (18).

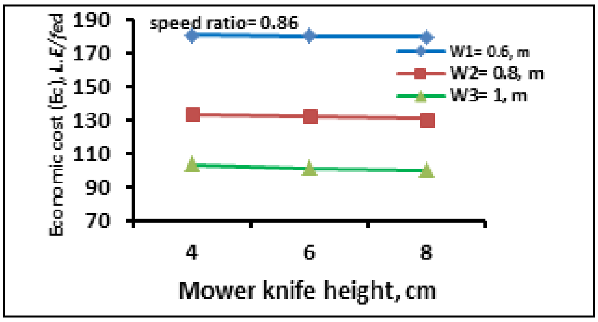

Fig. 18. The effect of the mower knife height on the economic cost

These results may be espoused of by increasing the speed ratios the consumed fuel increases also and vice versa the economic costs decreased because of increasing the field capacity. Statically there are high significant effects for the total interaction between different treatments with ($P < 0.05$) for the economic costs values. Data of regression analysis to show that working width affects economic cost more than speed ratio and mower knife height. While mower knife height showed be less effect on economic cost than speed ratio. The effects of different parameters on economic cost could be summarized as follows (working width > speed ratio > mower knife height). ANOVA analysis indicated highly significant differences between the treatments. As shown in table (7). The obtained regression equation was in the form of:

(Ec), *L.E/fed* = 514.9 - 278.7 K - 166.71 W - 0.530 H

Table 7. Regression analysis: Economic cost versus speed ratio; working width and mower knife height

Source	Degree of freedom	Adj (SS)	Adj (MS)	F value	Probability
Regression	3	25249.6	8416.5	237.51	**
Speed ratio	1	5218.7	5218.7	147.27	**
Working width	1	20010.7	20010.7	564.68	**
Mower knife height	1	20.2	20.2	0.57	0.458
Error	23	815.1	35.4		
Total	26	26064.6			

S	R-sq	R-sq(adj)	R-sq(pred)
5.95291	96.87%	96.47%	95.54%

CONCLUSION

The main results could be summarized as follows:

1- The maximum value of mower efficiency was ((96.9%) at K_3, W_3 and H_3, when the lowest value of mower efficiency was ((76.6%) at K_1, W_1 and H_1.

2- The maximum value of field capacity was (0.66, *fed/h*) at K_3, W_3 and H_3, when the lowest value of field capacity was (0.36, *fed/h*) at K_1, W_1 and H_1.

3- The maximum value of fuel consumption was (2.30, *lit/h*) at K_3, W_3 and H_1, when the lowest value of fuel consumption was (1.40, *lit/h*) at K_1, W_1 and H_3.

4- The maximum value of the consumed energy was ((17.78, *kW.h/fed*) at K_1, W_1 and H_1, when the lowest value of the consumed energy was (10.14, *kW.h/fed*) at K_3, W_3 and H_3.

5- The maximum value of economic cost was 181.16, *L.E/fed*) at K_1, W_1 and H_1, when the lowest value of economic cost was (78.12, *L.E/fed*) at K_3, W_3 and H_3.

6- If what is the comparison between the costs of operating a mowing of one fadden alfalfa found that mowed manually its cost about 400 *L.E/ fad*. While mowing by a developed mower machine its cost 181.16, *L.E/fed* at speed ratio 0.86, working width 0.6 m and mower knife height 4 cm. Recommended that working developed mower machine at K_3, W_3 and H_2**.**

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تطوير الة تناسب حش البرسيم فى المزارع الصغيرة.

محمد منصور شلبى رفاعي و عبد الوهاب رمضان عبيه

معهد بحوث الهندسة الزراعية- مركز البحوث الزراعية- مصر.

اجريت هذه الدراسة بهدفين تطوير الة تناسب حش البرسيم فى المزارع الصغيرة وكذلك خفض تكاليف الحش. تم استخدام عزاقة لفرم التربة يابانية الصنع تعمل بموتور 7 حصان حيث تم فك الفرامه واستبدالها بالجزء المطور المكون من سكينة هلالية الشكل تناسب حش البرسيم الراقد وجهاز لتجميع البرسيم المحصود على يسار الالة وجيربوكس لتحويل الحركة الدورانية من افقية الى راسية ومجموعة نقل الحركة المكونة من (مجموعة طارات وتروس وسير وجنازير) المثبتة على مجموعة اعمدة. تم دراسة ثلاثة عوامل دراسية كالاتى: أولا: السرعة النسبية: حيث تم اسخدام ثلاث مستويات منها هم (0.86 ، 0.94 و 0.98). ثانيا: عرض التشغيل تم استخدام ثلاث مستويات منه هم (0.6 ، 0.8 ، 1.0 متر). ثالثا: ارتفاع سكينة المحشة تم استخدام ثلاث مستويات من ارتفاع السكينة (4، 6 و8 سم). وكانت نتائج القياسات كالآتي : زيادة السرعة النسبية و عرض التشغيل ادى الى (زيادة كفاءة الالة، السعة الحقلية، معدل استهلاك الوقود والتكلفة الاقتصادية ولكن انخفضت الطاقة المستهلكة). بينما زيادة ارتفاع سكينة المحشة ادى الى (زيادة كفاءة الالة، انخفاض معدل استهلاك الوقود، انخفاض الطاقة المستهلكة وانخفاض التكلفة الاقتصادية). وكانت اعلى القيم لكفاءة الالة 96.9%, السعة الحقلية 0.66 فدان/ ساعة، معدل استهلاك الوقود 2.3 لتر/ ساعة، الطاقة المستهلكة 17.768 كيلووات.ساعة/ فدان والتكلفة اقتصادية 181.16 جنيه/ فدان. من خلال دراسة نتائج التجربة وجد ان تكاليف حش فدان برسيم يدويا 400 جنيه، بينما كانت باستخدام المحشة المطورة 181.16 جنيه عند سرعة نسبية 0.86 ، عرض تشغيل 0.6 متر وارتفاع سكينة المحشة 4 سم اى خفضت تكاليف حش الفدان بنسبة 54.7% . نوصى باستخدام الالة المطور عند سرعة نسبية 0,98 وعرض تشغيل 1 متر وارتفاع سكينة الحش 6 سم.