DEVELOPMENT OF A COMBINE HARVESTER FOR MEXICAN TEOSINTE CROP

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Abstract

A new combine header designed and fabricated set up on local combine axial flow constructed by AENRI to determine the perfect performance and decreasing both of combine losses and operation cost. The modified combine was tested under four forward speeds of 1.7, 1.9, 2.2 and 2.4 km/h, four drum speed of 12.39, 15.7, 17.01 and 18.32 m/s, and three cutting height of 5, 15 and 25 cm, respectively. The obtained results show that, the modified combine gave the best results at 1.9 Km/h forward speed, 15.7 m/s drum speed and 25 cm cutting height, where the maximum effective field capacity of 1.66 fed/h, field efficiency of 69.1%. and the maximum grain out put of 1.144 Mg/h. On the other hands, minimum energy consumed of 25.87 kW.h/fed, minimum of total losses and total grain damage of 5.41 and 0.41 % respectively are obtained.

Keywords. *Mexican Teosinte grains, effective field capacity, field efficiency, grain output, total grain losses, total grain damage, energy consumption.*

INTRODUCTION

Rayana corn (Mexican Teosinte) is an annual, warm-season grass introduced from Mexico. It is similar to corn in general vegetative appearance and stands of 150 to 250 cm in height. It is coarse, branches at the base, and the leaf blades are sword-shaped to 6 cm wide and 20 to 50 cm long. Clusters of slender "ears" (seed pods) are produced in each of the 5 to 7 uppermost leaf axils. Teosinte plants are so similar to maize in outward appearance (stalk, leaves, and terminal tassel) that the casual observer might mistake them for corn (Wilkes, 2004). Teosinte ears bear only about 10 kernels, enclosed in rough cellulose-lignin structures known as fruit cases, in contrast, maize ears can bear 50 or more uncovered kernels attached to the central axis of the ear. At maturity, the teosinte ear disarticulates such that the individual fruit cases become the dispersal units (Wilkes, 1997). It is adapted to fertile soils ranging from somewhat poorly to well drain. It can grow wherever corn is grown.

Conventional harvesting of Rayana corn was carried out by mowing manually and threshing under tractor's wheels. This resulted in reducing crop yield and damaged its seeds. whatever the mechanical harvesting is more efficient the traditional methods of harvesting. By the way the forage department at Gimaiza research station cultivated for seeds production. Medium size of combine harvester

developed by AENRI was applied to harvest that crop. The results reveal that increasing shoots leg with a lack ratio of grain weight to the weight of the shoot, which lead to increase the proportion of grain loss with a straw out of the machine whereas the loss can be inspected at a low reel speed or by clogging the auger of the header or by increasing the speed of air cleaning fan. Consequently combine machine is to upgrade to develop to reduce the loss rate as much as possible. Elyamani, et al (2012) make an experiment in West Nubaria by using combine harvesting machine after making some modifications to improve the performance of header unit to harvest alfalfa crop with increase productivity and minimize losses. The results indicated that, both of field capacity, field efficiency and Productivity for developed header were agreed directly with forward speed, reel speed and cutter bar speed. Ramesh *et al.* (1980) reported that, shatter loss at the self-propelled combine header is a major part of total alfalfa grain harvesting losses. These losses were measured to be as high as 400 kg/ha in high-yielding fields which are about 25 to 30% of the grain yields obtained. Many crops, environmental condition. Mosby (1995) mounted an additional sickle bar cutter on the back side of a combine header. The sickle bar was supported by tracking arms and suspension springs allowing the cutter to float along the ground surface while the combine harvester was in operation. Siebenmorgen *et al.* (1994) mentioned that, total grain yields were calculated from data collected with a commercial combine and a plot combine. Loss rates were estimated and compared using two techniques. The first technique used the total grain yield determined from the commercial combine to calculate loss rates. The second technique used the total grain yield determined the plot combine and the amount of grain collected in the grain tank of the commercial combine to calculate loss rates. Differences of as large as 50% points were observed in some test runs between the two techniques. Oliveira *et al.* (2005) stated that the mechanical damage caused by the rotation of threshing cylinder and moisture content of maize seeds at harvest may affect the germination and vigor. In direct-cut cases, all header losses are considered gathering losses. Factors effecting header losses are (1) cutting height, (2) reel position with respect to the cutter bar, and (3) reel speed with respect to the forward speed. They stated that peripheral speed, mentioned that recommended to be about 25%–50% faster than the forward speed of the combine. Mazaheri, (1997) header loss depends on: reel rotational speed and ground speed and cutting bar knives. Reel rotational speed and ground speed are mostly efficacious and it can be shown that their losses are 0.5 to 2% of field yield. Mostofi (2011) showed reel wheel should be placed in 15-25 cm above the cutter bar, also, cutting height should be lower than lowest size of crop, furthermore, the reel speed should be adjust about 1.5- 1.25 of ground speed.

Hassani *et al.* (2011) stated that grain losses induced from platform in JD1165 combine gained 1.29% and losses at the back of the combine was 0.96% on average in seven repetitions. As the results showed, the achieved amounts were in the range of acceptable ones. On the other hand, since reduction in the platform losses follows considerable decrease in losses cost, converting the forward mechanism into hydrostatic one would cause less vibration and provide more control on forward speed and as a consequence would decrease the amount of losses ascribed to the platform. They added too, the amount of broken grains in the JD1165 combine as demonstrated, gained a remarkable amount. This is mainly attributed to the imprecise adjustments of the threshing unit such as the cylinder speed and the space between the cylinder and concave. Harvest begins when grains are mature and pods and plant material are thoroughly dried. A standard combine is used to pick up the crop in the windrow, or harvest the whole plant standing in the field and thresh the grain from the pod. Damaged grain will not germinate. Losses during harvest depend on a number of factors, such as field conditions, crop conditions, machine adjustments, and operation. The grain is transferred from the combine into boxes on trucks and is then taken to the conditioning facility for cleaning and bagging (Mueller, 2008). Silberstein *et al.* (2010) found that, grain moisture content was the most reliable indicator of grain maturity and harvest timing in grass grain crops. There are two significant times during harvest that knowledge of grain moisture is critical: at swathing and at combining. Swathing within the correct range of grain moisture content will maximize grain yield and minimize grain losses during harvest. Taking an accurate measurement of grain moisture content is a key component of economic grass grain crop management than 4% of the inflorescences were still unripe. It is concluded that the optimum time to harvest red clover for grain production is about three or four weeks after the end of the period of rapid inflorescence production and that this coincides with the time when only a small proportion of unripe inflorescences remain. Therefore, the objectives of this research were to:

1 - Introduction modified header to fit combine for harvesting Mexican Teosinte grains with reduced rates of loss to allowable limits.

2 -Testing machine after adjustment for determining the rate of performance parameters to determine the optimum conditions of operation on field.

MATERIALS AND METHODS

AENRI (2007) developed and fabricated axial flow medium size combine harvester. A local combine harvester confidential to combine wheat, barley and rice

with average harvesting losses did not exceed 4%. On farm trails were conducted to harvest rayana corn but obtained results were bad. It is imperative to modify the header of local combine harvester. The main experiments were carried out at the experimental farm of Gimaza Research Station, El-Gharbia governorate during season 2013 on experiment area about two feddans, to investigate the performance and determined different combine losses. Table1 summarized some of physical properties of rayana corn (Mexican Teosinte) plants.

Table 1. Some physical properties of Mexican Teosinte (Zea mays. L variety) plants.

No. of sample	Plants length, cm	Plants diameter, cm	No. of plant ears	Mass of grain plant, g	Plant weight, g	Grain / straw ratio
1	185	2.15	7	39	113	1:2.89
2	191	1.80	6	46	91	1:1.98
3	205	1.75	7	28	85	1:3.04
4	188	2.08	8	35	108	1:3.08
5	196	1.65	6	31	99	1:3.19
mean	193	1.88	6.8	35.8	99.2	1:2.84

Combine harvester before developed:

Fig (1) and Table (2) show the main components of a local combine and indicated the combine header before modified. Combine has axial-flow threshing and straw separation units, which are better in handling wet straw and do not require straw walkers for separating the straw. Other advantages of the axial flow concept are higher throughput and gentler treatment of fragile grains, which are often cracked by the faster rotational speeds of conventional combine threshing cylinders.

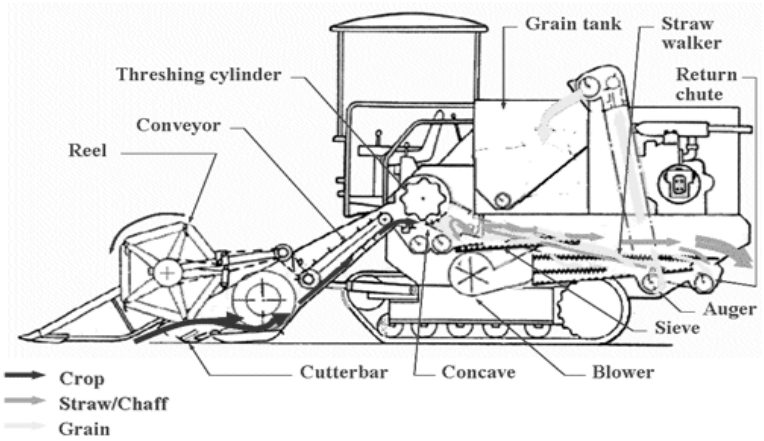


Fig. 1. Diagram scheme of combine harvester before modification.

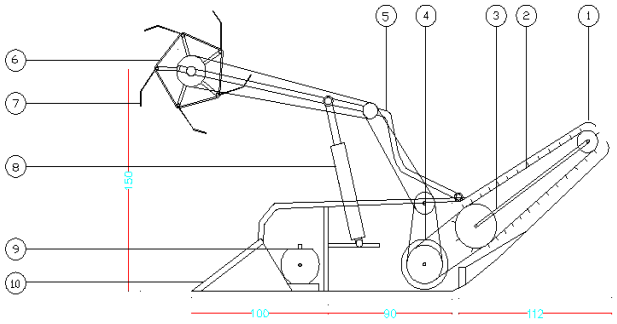
Table 2. Specification of used grain combine harvester

No.	Item	Value
1	Cutting width, mm	2100
2	L X W X H, mm	4560x2100x3650
3	Capacity of grain tank, kg	1000
4	Engine power, kW	43 (58 hp)
5	Total weight, kg	2280
6	Reel diameter, mm	1150
7	Cutter stroke, mm	76.2
8	Reel type	Eccentric teeth platform- type
9	Reel rod number	5
10	Harvester screw diameter, mm	490

Combine harvester after developed:

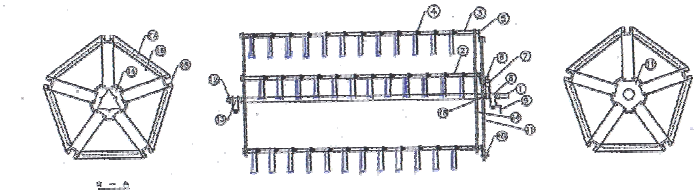
The general modification parts carried out on the combine header and some adjustments were made to suit the harvesting and threshing Mexican Teosinte corn as follows:

1- Manufacturing a new header are presented and sketched in Fig. 2. which is characterized by harvesting a stalks which should reach up to 2 meters lenght.
2- Manufacturing new reel to suit high lengths in crop, with a diameter of 50 cm installed on the perimeter of the five beams mounted on each one of them 13 glands fork with of 20 cm length, diameter of 3 cm and spacing apart of 16 cm as shown in Figs. 3 and 4.
3- Installation of gear box to control in the rotation reel speed required for harvest.
4- Replace the reel arms by another longer with 180 cm length to direct cutter bar to cut different the lengths of crop shown in Fig. 2.
5- Replace normal hydraulic of the reel piston by other piston which can run as high as 170 cm as shown in Figs. 2.
6- Installation of horizontal separator between the treads of the crop mat lifting from header to threshing room to prevent wrap around the poles of the chains and gears.
7- Setting threshing rasp bar axial cylinder and adjusting them to fit threshing the Mexican Teosinte corn ears as shown in Fig. 5.
8- Setting other parts of combine like sieves and cleaning fan speed and lifting augers to fit the size of the Mexican Teosinte corn.



1. Feeder conveyer
2. Conveying mat
3. plate
4. Harvester screw auger
5. Reel bar stay
6. Reel
7. Reel teeth
8. Hydraulic piston
9. Knife gear box
10. Stalk divider

Fig. 2. Schematic diagram of combine harvester header after modification.



1 Main shaft
2 Fork beam
3 Fork beam
4 Fork support
5 support
6 Support
7 Cam clutch
8 Reel bearing support
9 support
10 Bearing corer
11 flange
12 Set collar
13 Reel bearing support
14 flange
15 Spider reinforcement arm
16 Spider plate
17 support
18 stay

Fig. 3. Elevation and side view of modifying harvesting reel

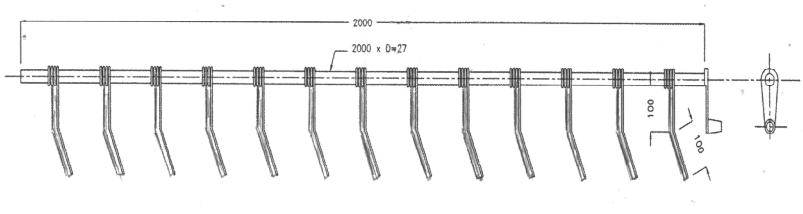


Fig. 4. Modifying of front reel forks

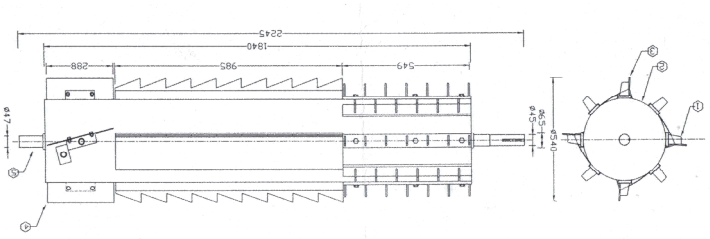


Fig. 5. Threshing rasp bar axial cylinder

Investigated variables:

The present study was carried out in about two feddans to evaluate the effect of forward speed of (1.7, 1.9, 2.2 and 2.4 km/h), drum speed of (12.39, 15.7, 17.01 and 18.32 m/s) and height cutting stalks of (5, 15 and 25 cm) on combine field capacity, field efficiency, grain output, percentage of total grain damage, total grain losses, energy required. Where forward speed determined by estimated the times which combine run at different distance. Next plotted the curve between the distance as x axis and time as y axis then selected from the curve the studied speeds. The threshing and separating drum (axial flow) provided with hydraulic motor. So a changing drum speeds from driver cabin.

Measurements:

1) Effective and theoretical field capacity: The effective field capacity was calculated as follows:

$$E.F.C = \frac{1}{\text{Total operation time, h/fed.}} \text{ , fed./h} \quad \ldots\ldots 1$$

Also, theoretical field capacity was calculated as follows:

$$Th.F.C = \frac{\text{Width of combine, m} \times \text{forward speed, km/h}}{4.2} \text{ , fed./h} \quad \ldots\ldots 2$$

2) Field efficiency (F.E.): The field efficiency was calculated from the following equation:

$$\xi f = \frac{E.F.C}{Th.F.C} \times 100, \% \quad \ldots\ldots 3$$

Where:

ξf = Field efficiency, %,

$E.F.C$ = Effective field capacity, fed/h, and

$Th.F.C$ = Theoretical field capacity, fed/h.

3) Productivity of the machine: It was determined by collecting and weighted yield output from the experimental unit area.

4) Total grain losses: The total losses of combine harvester were those occurred in front, behind the combine and during harvesting operations and it includes the following main sources (NSAE/NCAM/SON, 1995):

$$Total\ cutterbar\ losses, \% = \frac{Total\ header\ losses, kg/fed}{Total\ yield, kg/fed} x100 \quad \ldots\ldots 4$$

Total cutterbar losses (sum of shatter, lodged, stalk and stubble loss).

$$Unthreshed\ grain\ losses, \% = \frac{Unthreshed\ grain\ losses, kg/fed}{Total\ yield, kg/fed} x100 \quad \ldots\ldots 5$$

$$Threshed\ grain\ losses, \% = \frac{Threshed\ grain\ losses, kg/fed}{Total\ yield, kg/fed} x100 \quad \ldots\ldots 6$$

$$Total\ losses, \% = \frac{H_L + U_L + T_L}{H_L + U_L + T_L + T_Y} x100 \quad \ldots\ldots 7$$

Where:

H_L Total header losses, kg/fed,

U_L Unthreshed grain losses, kg/fed,

T_L Threshed grain losses, kg/fed and

T_Y Total grain yield, kg/fed.

5) Grain damage (visible and invisible):

Visible grain damage: It was determined by separating the damage grain by hand from the sample of 100g the samples were taken randomly from the threshed grain. The percentage of seed damage was calculated as follows (NSAE/NCAM/SON, 1995*)*:

$$Visible grain damage, \% = \frac{Mass of broken grains in sample, g}{Total mass of grains in sample, g} x100 \quad \ldots\ldots 8$$

Invisible grain damage: A germination test was carried out using Petri dishes. The samples of these tests were taken randomly after separating the damage grain (visible damage). One hundred grains were put in Petri dish on a filter paper, covered

with water and incubated at 25°C for 24h. The germinated grains were collected from each dish and expressed as a percentage of the original number of seed.

$$Total\ grain\ damage, \% = (Visible\ grain\ damage, \% + Invisible\ grain\ damage, \%) \quad \ldots\ldots\ldots 9$$

6) Power consumption: The fuel consumption was measured by using an especial device consists of 3 liter graduated cylinder was connected to the fuel pump. The amount of fuel in tube after executing each treatment was recorded. Then Power consumption was calculated according the principles and assumption of Hunt (1983):

$$EP = \frac{FC\ x\ \rho f\ x\ LCV\ x\ 427\ x\ \eta_m\ x\ \eta_{th}}{3600\ x\ 75\ x\ 1.36}, kW \quad \ldots\ldots\ldots 10$$

Where:

EP Power requirements consumption during the cutting operation, kW,

FC Fuel consumption, l/h,

ρf Density of the fuel, (850 kg/m^3),

LCV Lower calorific value of fuel, (10000 kcal/kg),

427 Thermo mechanical equivalent, kg.m/kcal,

η_m Mechanical efficiency of engine, (80%) and

η_{th} Thermal efficiency of the engine, (considered to be about 35 for diesel engine).

7) Data analysis: multi factors random complete block design was used as experimental design and computer statistical program named SPSS run the study the effect of elevated parameters on combine performance variables. The main treatment were forward speed (Fs), drum speed (Ds) and cutting height (Ct).

RESULTS AND DISCUSSION

I) Primordial Test:

Primary experiment was carried out during summer 2013, to determine total grain losses and total grain damage with harvesting Mexican Tenisnte crop by combine harvester. The effect of forward speed and drum speed on total grain losses and damage were determined. Results indicate that, rate of losses and damage were very high because combine harvester have great cutting height ranged from 25 to 40 cm above ground surface. Where, the average of length plants was 200 cm. The maximum of grain losses was 16.65% recorded at forward speed of 2.8 km/h and drum speed of 10.8 m/s while, maximum of grain damage was 7.67%, recorded at forward speed of 2.8 km/h and drum speed of 20.38 m/s.

Π) Development combine harvester performance:

1- Actual Field Capacity and Field Efficiency:

The results of the analysis of variance indicated that both of actual field capacity and field efficiency were significant at the 0.01 level for combine forward speed and cutting height stalks while drum speed was not significant as shown in Table 3. Also, the interaction between height cutting stalks and forward speed was significant effects while, the interaction between height cutting × drum speed and between forward speed × drum speed were not significant. Fig. 6 shows the effect of combine forward speed at different of height cutting stalks on both of actual field capacity and field efficiency. The results indicated that, actual field capacity was increased with increasing both of forward speed and height cutting stalks while, field efficiency was decreased with increasing both of forward speed and cutting height. The maximum value of field capacity was 1.66 fed/h recorded at forward speed of 2.4 km/h, and height cutting stalks of 25 cm. While, maximum value of field efficiency was 69.1% recorded at forward speed of 1.7 km/h, and height cutting stalks of 25 cm.

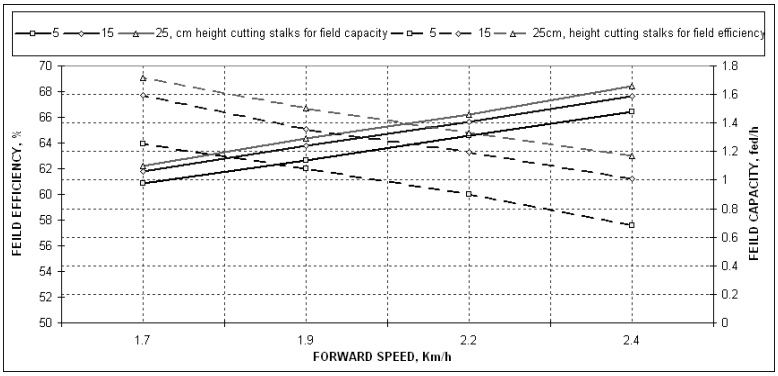


Fig. 6. Effect of forward speed and height cutting stalks on actual field capacity, fed/h and field efficiency, %.

2- Grain Output:

Grain output was significantly different at the 1% level for height cutting stalks, forward speed while drum speed was no significant. On other hand, cutting height stalks × forward speed and height cutting× forward speed ×drum speed interactions were high significant. While, interaction between height cutting stalks × drum speed and between forward speed × drum speed were significant as shown in Table 3, with coefficient of determination (R^2) of 0.99936 and coefficient of variation of0.488%. Data presented in Fig. 7 illustrated that, grain output was increased with increasing forward speed and cutting height. The maximum of grain output was 2.05 Mg/h recorded at forward speed of 2.4 Km/h, drum speed of 17.1 m/s and cutting height stalks of 25 cm.

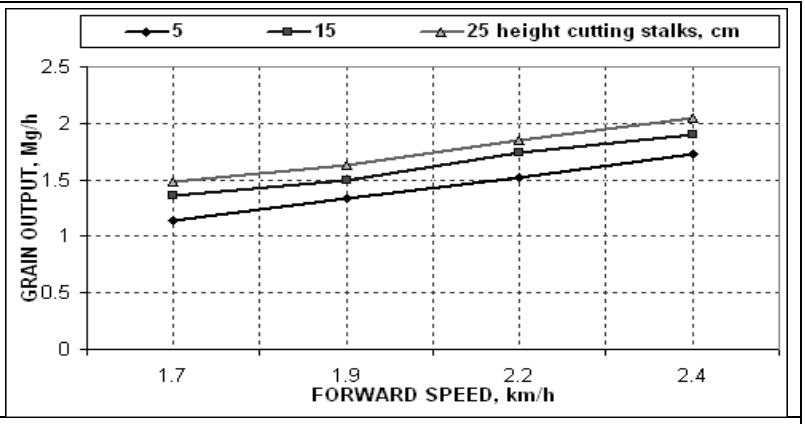


Fig. 7 .Effect of forward speed and height cutting stalks on grain output, Mg/h.

Table 3. Analysis of variance (mean squares) for variables evaluated

Source	Actual Field Ca	Field Efficiency	Grain Output	Total Grain Losses	Total Grain Damage	Energy Requirement
Blocks	0.065269**	0.079464**	.2588ns	0.00881*	0.005869**	0.00713*
Main Effects						
Height Cutting Stalks	4.598336 **	317.8047**	1.2768**	28.15089**	4.28375**	1620.168**
Forward Speed	3.249891 **	260.3747**	2.1667**	13.59187**	1.164945**	634.9762**
Drum Speed	4.798408ns	8.6759ns	3.5248ns	2.17172**	1.136822**	115.5242**
Interaction						
Height Cutting× Forward Speed	0.117225**	0.4503**	0.0027**	0.153485**	0.039297**	10.8497**
Height Cutting× Drum Speed	0.005325ns	8.6759ns	1.6553*	0.03146**	0.00971**	0.492284**
Forward Speed ×Drum Speed	0.021556*	9.1204**	1.8587*	0.01041**	0.007945**	1.104162**
Height Cutting× Forward Speed ×Drum Speed	0.010917 **	9.1204*	2.4819**	0.00447**	0.011786**	0.256672**
Coefficient of determination (R^2)	0.99498	0.9964	0.99936	0.99872	0.9980	0.9998
Coefficient of Variation (CV)	0.889%	0.1153%	0.448%	0.590%	1.744%	0.079%

** Significant at 0.01 level of probability,
* Significant at 0.05 level of probability,
ns Not significant.

3- Total Grain Losses:

Total grain losses were significantly influenced by height cutting stalks, forward speed and drum speed main effects as well as the following interactions: height cutting stalks × forward speed, height cutting stalks × drum speed, forward speed ×drum speed and height cutting stalks × forward speed × drum speed (Table 3) with coefficient of determination (R^2) of 0.9987 and coefficient of variation of 0.59%. Fig. 8 show total grain losses as affected by different variables. The obtained results as shown in Table 4 indicated the relation between header losses and forward speed,

drum speed and cutting height. Where, results indicate that, increasing forward speed and cutting height led to increase cutter bar losses.

The minimum of header losses was 2.10% recorded at forward speed of 1.7 km/h,drum speed of 12.39 m/s and height cutting stalks of 25 cm. Results indicated also that, increasing forward speed led to increase of grain losses in straw, while increasing cutting height and drum speed led to decrease of threshing losses. The minimum value of grain losses with straw was 0.96 % recorded at forward speed of 1.7 km/h, drum speed of 12.39 m/s and cutting height of 25 cm and maximum value of grain losses with straw was 1.8 % recorded at forward speed of 2.8 km/h, drum speed of 18.32 m/s and cutting height of 5 cm. Also, data in Table 4 represented the effect of forward speed, drum speed and cutting height on unthreshed grain losses. Where, the increasing of forward speed led to increase of unthreshed grain losses. While, increasing both of drum speed and cutting height led to decrease of unthreshed grain losses. The maximum of unthreshed grain losses was 3.5 % recorded at forward speed of 2.4 km/h, drum speed of 12.39 m/s and cutting height of 5 cm. Also, minimum of unthreshed grain losses was 1.5 % recorded at forward speed of 1.7 km/h, drum speed of 18.32 m/s and cutting height of 25 cm.

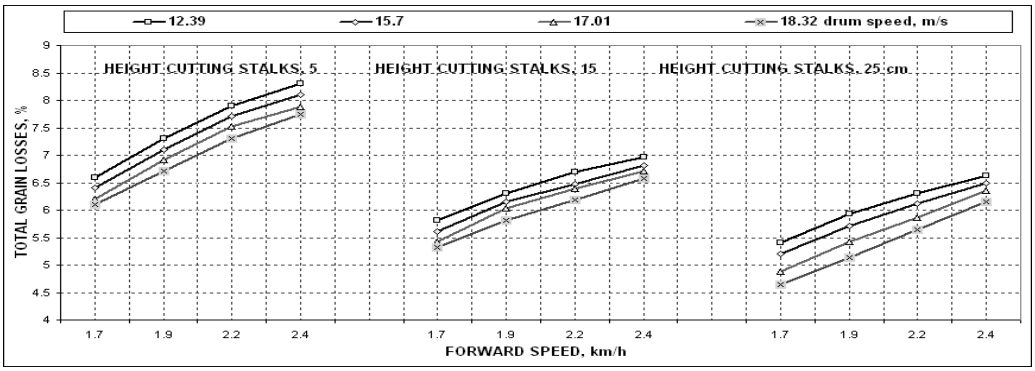


Fig. 8. Effect of forward speed and drum speed at different of height cutting stalks on total grain losses, %.

Table 4. Effect of forward speed and drum speed at different of height cutting stalks on header losses, unthreshed grain losses and grain losses in straw, %.

height cutting stalks, cm		Header Losses, %				Unthreshed Grain Losses, %				Grain Losses In Straw, %			
	Drum speed, m/s / Forward speed , km/h	12.39	15.7	17.01	18.32	12.39	15.7	17.01	18.32	12.39	15.7	17.01	18.32
5	1.7	2.39	2.47	2.50	2.58	2.9	2.4	2.1	1.8	1.31	1.53	1.60	1.72
	1.9	2.70	2.73	2.75	2.78	3.1	2.8	2.5	2.2	1.51	1.58	1.67	1.73
	2.2	2.94	2.98	3.00	3.04	3.4	3.1	2.8	2.5	1.56	1.65	1.75	1.81
	2.4	3.00	3.05	3.06	3.07	3.6	3.4	3.1	2.9	1.61	1.70	1.73	1.80
15	1.7	2.20	2.25	2.3	2.41	2.6	2.2	1.9	1.6	1.02	1.16	1.23	1.31
	1.9	2.35	2.36	2.43	2.42	2.8	2.6	2.3	2.1	1.16	1.20	1.31	1.37
	2.2	2.48	2.49	2.57	2.81	3.0	2.7	2.4	2.2	1.21	1.27	1.36	1.48
	2.4	2.57	2.65	2.7	2.72	3.1	2.8	2.6	2.3	1.28	1.31	1.40	1.52
25	1.7	2.10	2.12	2.17	2.19	2.3	2.1	1.7	1.5	0.96	1.03	1.11	1.20
	1.9	2.44	2.41	2.41	2.43	2.5	2.2	1.8	1.6	0.99	1.10	1.17	1.23
	2.2	2.54	2.58	2.59	2.62	2.7	2.4	2.1	1.8	1.07	1.13	1.20	1.26
	2.4	2.64	2.68	2.72	2.78	2.8	2.6	2.4	2.0	1.14	1.21	1.27	1.37

4- Total Grain Damage:

Total grain damage contains visible grain damage and invisible grain damage that is reducing the quality of grain as it leads to a reduction in the percentage of germination. Analysis of variance indicated that total grain damage were significantly influenced by height cutting stalks, forward speed and drum speed main effects as well as the following interactions: height cutting stalks × forward speed, height cutting stalks × drum speed, forward speed ×drum speed and height cutting stalks × forward speed × drum speed (Table 3) with coefficient of determination (R^2) of 0.99801and coefficient of variation of 1.744%. Results in Fig. 9 show that, total grain damage (visible and invisible grain damage) was increased with increasing of drum speed and cutting height while it was decreased with increasing forward speed. Results as shown in Table 5 indicated also that, the minimum of visible and invisible grain damage were 0.18 and 0.23 % recorded at forward speed of 2.4 km/h, drum speed of 12.39 m/s and cutting height of 5 cm. While the maximum of visible and invisible grain damage was 0.85 and 0.84 % recorded at forward speed of 1.7 km/h, drum speed of 18.32 m/s, cutting height of 25 cm.

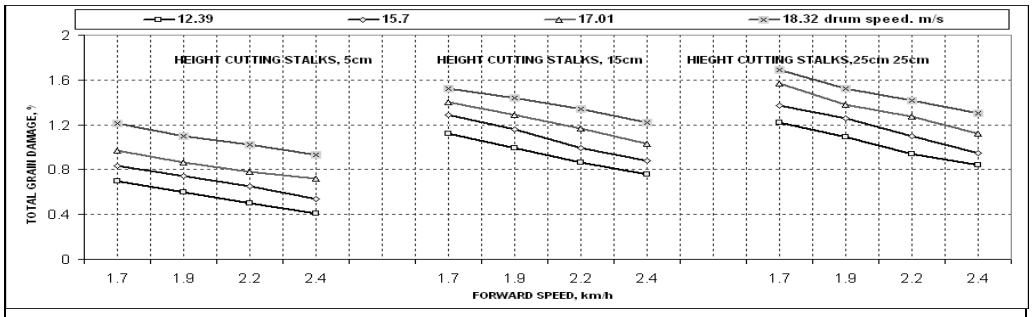


Fig. 9. Effect of forward speed and drum speed at different of height cutting stalks on total grain damage, %.

Table 5. Effect of forward speed, drum speed and cutting height on visible grain damage and invisible grain damage, %.

height cutting stalks, cm		Visible grain damage, %				Invisible grain damage, %			
	Drum speed, m/s / Forward speed , km/h	12.39	15.7	17.01	18.32	12.39	15.7	17.01	18.32
5	1.7	0.30	0.38	0.44	0.58	0.40	0.45	0.53	0.63
	1.9	0.27	0.33	0.39	0.54	0.33	0.41	0.47	0.56
	2.2	0.22	0.29	0.36	0.51	0.28	0.36	0.42	0.51
	2.4	0.18	0.23	0.31	0.46	0.23	0.31	0.41	0.47
15	1.7	0.51	0.58	0.63	0.71	0.61	0.71	0.77	0.81
	1.9	0.46	0.52	0.59	0.68	0.53	0.64	0.70	0.76
	2.2	0.42	0.46	0.54	0.65	0.45	0.53	0.63	0.69
	2.4	0.36	0.42	0.50	0.60	0.40	0.46	0.53	0.62
25	1.7	0.57	0.63	0.76	0.85	0.65	0.74	0.81	0.84
	1.9	0.51	0.58	0.65	0.74	0.58	0.68	0.73	0.78
	2.2	0.45	0.51	0.60	0.68	0.49	0.59	0.67	0.74
	2.4	0.41	0.46	0.54	0.63	0.43	0.49	0.58	0.67

5- Energy Requirement:

The effects of forward speed, drum speed and height cutting stalks on energy requirement illustrated in Fig.10. Results noticed that, energy requirement led to decrease with increasing both of forward speed and height cutting stalks, while it was led to increase with increasing drum speed. Cutting height was more important factor affecting on energy requirement. Results also show that, low value of energy requirement was 25.87 kw.h/fed recorded at forward speed of 2.4 km/h, drum speed of 12.35 m/s and height cutting stalks of 25 cm, respectively. Analysis of variance indicated that energy requirement was significantly influenced by cutting height stalks, forward speed and drum speed main effects as well as the following interactions: height cutting stalks × forward speed, height cutting stalks × drum speed, forward speed ×drum speed and height cutting stalks × forward speed × drum speed (Table 3) with coefficient of determination (R^2) of 0.9998 and coefficient of variation of 0.079%.

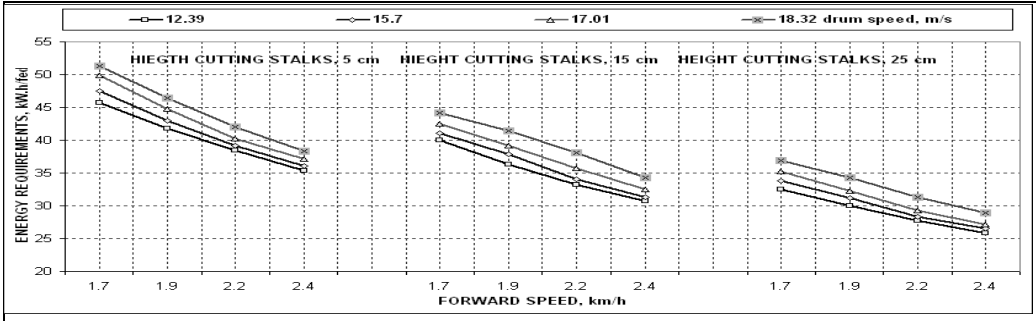


Fig. 10. Effect of forward speed and drum speed at different of height cutting stalks on energy requirement, kw.h/fed.

CONCLUSION

The obtained results of this study could be concluded as follows:

1- The development combine during harvesting Mexican Teosinte grain gave to maximum actual field capacity of 1.66 fed/h, field efficiency of 69.1% and out put of 2.05 Mg/h.

2- Minimum value of total grain losses was 4.96% recorded at forward speed of 1.7 km/h, drum speed of 18.32 m/s and height cutting stalks of 25 cm respectively.

3- Minimum value of total grain damage was 0.41% recorded at forward speed of 2.4 km/h, drum speed of12.39 m/s and height cutting stalks of 5 cm respectively.

4- Minimum value of cutter bar losses, unthreshed grain losses and grain losses in straw were 2.1%, 1.5% and 0.96% respectively. While minimum value of visible grain losses and invisible grain losses were 0.18 % and 0.23% respectively.

5- Energy requirement was increased with increasing of drum speed and decreased with increasing both of forward speed and height cutting stalks. Also, minimum value of energy requirement was 25.87 kW.h/fed recorded at forward speed of 2.4 km/h, drum speed of 12.39 m/s and height cutting stalks of 25 cm.

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تطوير آلة حصاد جامعة لتناسب الذرة الريانة

عاطف عزت اليماني ، أشرف السيد الشاذلي ، وائل فتحي المتولي

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تزرع الذرة الريانة كمحصول علف أخضر صيفي. حيث تعطى الذرة الريانة ثلاث حشات ويستعمل المجموع الخضري في هذه الحالة كعلف أخضر للمواشي وتستعمل الحبوب في حالة النضج التام كتقاوي. ومحصول الذرة الريانة يكون ذات طبيعة خاصة عند حصاده ميكانيكيا حيث تزداد نسبة النموات الخضرية بالساق مع قلة نسبة وزن الحبوب إلى وزن المجموع الخضري مما يؤدى إلى زيادة نسبة الفقد بالحبوب مع القش الخارج من الآلة مما يسهل من فقدها حيث يمكن أن تفقد عند أ انخفاض سرعة دوران الدرفيل أو بواسطة التذرية بالرداخات أو عند زيادة سرعة هواء مروحة التنظيف ولهذا فأن معظم مزارعي الذرة الريانة لا يفضلون الحصاد الميكانيكي للمحصول. و لهذا فأن الآلة الجامعة تكون في حاجة إلى تطوير خاص ليناسب حصاد الذرة الريانة لتقليل نسبة الفقد قدر الامكان. و قد كانت فكرة البحث تهدف إلى تصميم وتصنيع صدر كومباين متوسط الحصاد ذو سريان أفقي مع تعديل المضرب ليناسب حصاد المحصول و استبدال بستم رفع و خفض المضرب بأخر يناسب أطوال المحصول و تركيب فاصل افقآ بين جنازير حصيرة رفع المحصول و ضبط باقي أجزاء الكومباين بما يناسب حجم بذور الذرة الريانة.

المعاملات التجريبية للدراسة:

أ- سرعة التقدم الأمامية حيث يتم إجراء الدراسة عند ثلاثة سرعات (١.٧- ١.٩- ٢.٢- ٢.٤كم/ س).
ب- سرعة دوران اسطوانة الدراس حيث يتم إجراء الدراسة عند أربعة سرعات (١٢.٣٩- ١٥.٧٠- ١٧.٠١- ١٨.٣٢م/ث).
ج- ارتفاع مستوى قطع الأعواد (٥ – ١٥- ٢٥ سم).

القياسات المطلوبة:

السعة الفعلية للآلة، فدان/ساعة- الكفاءة الحقلية، % – إنتاجية الآلة، ميجا جرام/ساعة – نسبة الحبوب المفقودة، ٪ – نسبة الحبوب التالفة، %- الطاقة المستهلكة، ك.وات.ساعة/فدان- تكاليف التشغيل للآلة، جنيها/فدان- الدالة المعيارية للتكاليف، جنيها/فدان.

وقد أمكن الحصول على النتائج التالية:-

١- كل من السعة الحقلية والإنتاجية للآلة المصنعة كانت تتناسب طرديا مع زيادة كل من سرعة التقدم و ارتفاع القطع.وكانت أقصى قيم لها هي١,٦٦فدان /ساعة و ٢,٠٥ ميجا جرام/ساعة على الترتيب .سجلت عند سرعة تقدم ٤, ٢ كم/س، ارتفاع القطع ٢٥ سم. بينما الكفاءة الحقلية كانت تتناسب عكسيا مع كل من سرعة التقدم و ارتفاع القطع.وكانت أقصى قيم لها هي٦٩,١ %.

٢ – أقصى قيمة للحبوب المفقودة و نسبة التلف الكلية في البذور قبل التعديل كانت ٣,٦٧ %، ١٣,٦٥% على الترتيب بينما كانت بعد التعديل ٣١, ٨ %، ١,٦٩ % على الترتيب.

٣- اقل قيمة فقد لصدر الآلة و نسبة حبوب عير مدروسة و الحبوب المفقودة مع القش كانت ٢,١%، ١,٥%، ٠,٩٦% على الترتيب. بينما كانت اقل قيمة للحبوب التالفة ظاهريا و للحبوب التالفة غير ظاهريا هي ٠,١٨%، ٠,٢٣% على الترتيب.

٤- اقل قيمة للطاقة المستهلكة في التشغيل هي ٢٥,٨٧ ك وات.ساعة/فدان و قد سجلت عند سرعة تقدم ٤, ٢ كم/س، سرعة دوران اسطوانة الدراس ١٢,٣٩ م/ث، ارتفاع القطع ٢٥ سم.