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COMPARISON BETWEEN TWO MANUFACTURE TOOLS FOR CONSERVATION AGRICLTURE UNDER RAINFED AGRICLTURE CONDITIONS

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ABSTRACT: *With fact that world population has increased over the years and more food needs to be produced, this will put more pressure on the natural resources. However, conservation agriculture which to achieve acceptable profits from agricultural production and sustain the production of resources has to be used as main aspect for arid land cultivation. Field experiments were carried out during growing season (2012 / 2013) at Ras El-Hekma area, Northwestern Coast of Egypt, to comparison between the two local manufactured machines for cultivation barley under conservation agriculture systems in rainfed areas. Rainfall is the individual source of water in the area of experiment. The first local manufactured combination unit (a) included suitable unites for tillage, planting and fertilization. While, the other local manufactured machine (b) was suitable for water harvesting and planting. The treatments of the two local equipments were achieved through applying four different forward speeds, i.e., 1.98, 2.70, 3.42 and 4.5 km/h and three different plowing depths, i.e., 10, 15 and 20 cm. Adding Farm Yard manures at level of 10 m^3/fed, and 50% of soil surface covering by crop residues (rice straw) were conducted for all treatments. Several parameters were used in comparison for the performance of the two machines, such as some soil and water properties. Results indicated that the lowest value of bulk density was observed with the forward speed of 1.98 km/h and plowing depth of 20 cm, i.e. 1.08 and 1.12g/cm^3, for the two machines (a & b), respectively, as compared to that for the other treatments. Increasing plowing depth from 10 cm to 20 cm at the forward speed of 4.5 km/h for the machine (a) and (b) led to decrease bulk density by 17% and 14%, respectively. The soil penetration resistance with the combination machine (b) is higher than that for the combination machine (a). Increasing the machine forward speed from 1.98 to 4.5 km/h at 10 cm depth tillage led to increase the soil penetration resistance by 34% and 31% for combination machines (a) and (b), respectively. The mean weight diameter of soil particles after using the combination machine (b) is higher than that for the combination machine (a). Increasing tillage depth from 10cm to 20cm by using the combination machines (a) and (b) at forward speed of 1.98 km/h led to increase the infiltration rate from 2.45 to 4.12 cm/h and from 2.32 to3.95 cm/h, respectively. The infiltration rate with using the combination machine (b) was lower than that with using the machine (a). The biological barley yield for the treatment that used machines (a) or (b) with the forward speed of 1.98 km/h and plowing depth of 20cm is equal (4100 kg/fed). The developed machines decrease runoff and improve water use efficiency. The machine (b) was more effectiveness in reducing annual surface runoff for all treatments as compared to that for machine (a). It can be concluded that in raindfed areas, the importance using developed combination machines (a or b) for cultivation barley under conservation agriculture systems. Using developed combination machines (a or b) with forward speed of 1.98 km/h and plowing depth of 20 cm, especially machine (a), for cultivation barley under conservation agriculture systems, led to: enhancing soil properties, i.e. decreasing soil bulk density and penetration resistance and increasing infiltration rate, improving water use efficiency and increasing biological barley yield. From another point, the field efficiency, field capacity and total cost for using machine (a) are higher than that for using machine (b) at any forward speed or plowing depth. Generally, the increment in the field efficiency due to using machine (a) was ranged from 6 to 7% for all treatments. The fuel consumption increased with the machine (a) as compared to that for the machine (b).*

Key words: *Conservation agriculture, Rainfed agriculture, Barley, Forward speed, Plowing depth, Local manufactured combination machine, Northwestern coast, Egypt.*

INTRODUCTION

Conservation agriculture (CA) can be defined by the statement given by the food and Agricultural Organization of the United Nations (FAO, 2007) as , a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. CA has three key principles, namely: 1 - Continuous minimum mechanical soil disturbance, 2 - Permanent organic soil cover, and 3 - Diversification of crop species grown in sequences and/or associations. Conservation has become critical on the fact that the world population has increased over the years and more food needs to be produced every year (New Standard Encyclopedia, 1992). According to Hobbs *et al.* (2008), CA led to control of disease, pests and weeds.

Excessive tillage of agricultural soils in short term may led to structural degradation, loss of organic matter by soil erosion and falling biodiversity, Benites *et al.* (2002). In the field of CA there are many benefits that both the producer and conservationist can obtain in doing this practice on the side of the conservationist. CA can be seen as beneficial because there is an effort to conserve what people use on earth every day. Since agriculture is one of the most destructive forces against biodiversity, CA can change the way humans produce food and energy for our daily lives. In the developing world, 45-60% of all agricultural land is said to be managed by conservation agriculture system (Derpsch, 2001). The story of how CA practices came to be so predominant in Brazil is skillfully related by EKboir (2002). Different environmental benefits will be expected from CA. These benefits include less erosion possibilities, better water conservation, improvement in air quality due to less emission being produced, and a chance for larger biodiversity in a given area, FAO (2002). The farmer response was to take up the crops being promoted – especially soybean. The crisis that ensued was a disquieting increase in soil erosion and land degradation. In some instances, erosion so reduced productivity that farmers were unable to repay bank loans. Many people felt that the answer lay in terracing. Early work on CA in China was begun in the early 1990s by the Mechanical Engineering College of the China Agricultural University, and the Shanxi Xinjiang Machinery Factory, aimed to respond to widespread problems of drought, poor soil fertility, and heavy wind and water erosion in the north China plain. It became clear during the late 1980s that these problems were being further exacerbated by an on –going shift from animal to mechanized traction. In response, a project was launched to develop and disseminate CA practices. This project enjoyed financial support from Australia (ACIAR) and technical mentoring from the University of Queensland (ACIAR, 2005). Patrick, *et al.* (2007) reported that reservoir tillage is an effective method of harvesting water and thus reducing erosion in semi-arid areas on light textured soils, such as sandy loam soil. Also, they showed that depressions were able to harvest up to 95% of surface run-off for slopes of up to 10% for the given geometry of the depressions used. These results suggest that, using suitable machine is the key for conservation agriculture system. Consequently, the aim of the present investigation is the comparison between the two local manufactured machines for cultivation barley under conservation agriculture systems in rainfed areas of Egypt.

MATERIALS AND METHODS

Field experiments were carried out through winter season of 2012/2013 at Ras EL Hekma village, Marsa Matruh Governorate, in the Northwestern Coast of Egypt to compare between two local Equipments for conservation agriculture. Soil bulk density was measured by a core sample according to Black *et al.* (1965) method. Particle size distribution using the pipette method was determined according to Klute (1986). PH and EC were determined in the initial soil surface samples according to Page *et al.* (1982). Analysis of some soil properties is shown in Table (1). Data in Table (1) illustrate that the soil texture is sandy loam.

Table (1): Some soil characteristics of the experimental site.

Depth (cm)	PH	EC ($ds.m^{-1}$)	Bulk density (g/cm^3)	Ca CO_3 (%)	Particle size distribution,%				Soil texture
					Coarse Sand	Fine Sand	Silt	Clay	
0-20	7.6	12.3	1.58	11.6	31.8	35.2	14.4	18.6	Sandy loam
20-40	7.6	15.4	1.62	15.4	25.3	42.9	12.4	19.2	Sandy loam

Experiments were carried out in an area of 4 feddans to optimize values of the main operating parameters affecting the performance of the two manufactured equipment for planting barley. Rainfall is the individual source of water in the experimental area. In Egypt, rain is considered the main source for agricultural activity, particularly in Northwestern coast zone.

The treatments of the two local equipments were achieved through applying four different forward speeds, i.e., 1.98, 2.70, 3.42 and 4.5 km/h and three different plowing depths, i.e., 10, 15 and 20 cm. Adding Farm Yard manures at level of 10 m^3/fed, and 50% of soil surface covering by crop residues (rice straw) were conducted for all treatments.

The local manufactured combination equipments are:

(A): local manufactured combination machine (a), suitable for tillage, planting and fertilization under rainfed agricultural conditions was manufactured at local engineering workshop with low cost. The machine is mounted type, it provided with two wheels one for adjusting the required plowing depth and the other for supplying motion to planting and fertilization units, Figure (1). It consists of the following main parts: Chisel plowing unit, Pulverization unit, Planting unit and Seeding unit.

(B): local manufactured combination unit (b), suitable for water harvesting and planting under rainfed agricultural conditions, was manufactured at local engineering workshop with low cost. The developed machine, which consists mainly of screening device and feeding device, is shown in Figure (2). It consists of the following main parts: Frame and wheels, Four shares chisel plow, Seed drill, Heavy spiked roller and the transmission system.

Measurements:

1- Soil Measurements:

A- Soil Bulk Density:

Bulk density was calculated according to Black *et al.* (1965) as follows:

$$b = m / v$$

Where: b: Soil bulk density, g/cm^3,
m: Soil sample mass, g, and
v: Soil sample volume, cm^3.

B- Mean weight Diameter (MWD):

The soil mean weight diameter (MWD) was calculated according to Van Bavel (1949) by the following equation:

$$MWD = \sum_{i=1}^{n} Xi\, Wi$$

Where: MWD is soil mean weight diameter (mm),

$\sum$ is equal to the sum of products of the mean diameter, X_i (mm) , of each size fraction and the proportion of the total sample weight, W_i (g), occurring in the corresponding size fraction, where the summation is carried out over all n size fractions, including the one that passes through the finest sieve:

C– Infiltration Rate:

Infiltration rate was determined using double rings at three different sites along furrow for each treatment according to (kostiakov, 1932).

D- Penetration Resistance:

Japanese plate index pentrometer was used for measuring penetration resistance.

2- Water measurements:

A- Runoff:

Runoff volume was measured using Girlish trough (0.5 m long and 0.2 m wide), **FAO (1993)** at the end of slope, where the soil slope of experimental site is 3% approximately.

B- Water Use Efficiency:

Water use efficiency (WUE, kg / m^3) was determined as follows:

WUE = Average yield (kg/fed) / Volume of applied water (m^3/fed).

3- Field performance measurements for combination units:

A- Theoretical Field Capacity (TFC):

The theoretical field capacity is the rate of field coverage that would be obtained if the machine was performing its function 100% of the time at the rated forward speed and always covered 100% of its rated width (Kepner *et al.,* 1978). It can be calculated according to the following equation:

$$TFC = W_m\, F_s / 4.2$$

Where: TFC: Theoretical field capacity, (fed/h),

W_m: Width of machine, (m), and

F_s: Forward speed, (km/h).

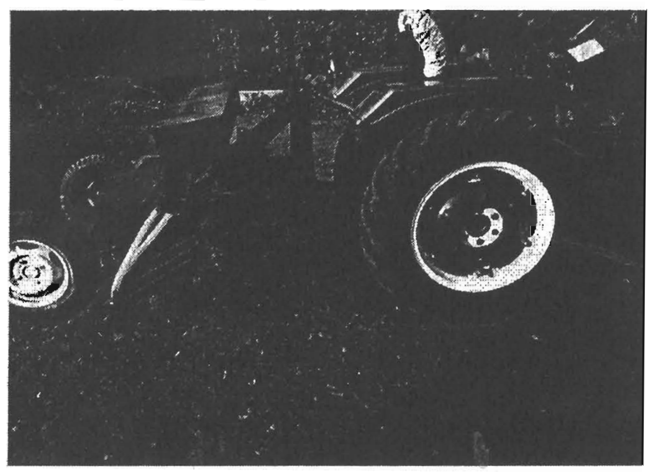

Fig.(1): local manufactured combination machine (a)

Fig.(2): local manufactured combination machine (b)

B- Actual Field Capacity (AFC):

Actual field capacity is the actual average rate of coverage by the machine, based upon the total effective operation time. It is a function of the rated width of the machine, the percentage of rated width actually utilized, the travel speed, and the amount of field time lost during operation (Kepner *et al.,* 1978). The actual field capacity was calculated by using the following equation:

AFC = 1/ T fed/h

Where:

AFC: Actual field capacity (fed / h), and

T: Total effective operating time, (h / fed)

C- Field Efficiency:

Field efficiency can be calculated using the following equation:

ηf = (AFC / TFC) x100

Where:

ηf: field efficiency (%),

AFC: Actual field capacity (fed / h), and

FC: Theoretical field capacity.

D-The Required Power:

The required power was calculated by using the following formula (**Hunt, 1977**):

RP = (Fc / 3600) x pf x CV x ηm x ηth x 427 x (1/75) x (1/1.36)

Where: RP: The required power (kW),

Fc: Fuel consumption, L / h,

Pf: Density of the fuel, (kg / L) for solar fuel = 0.85 kg/L,

CV: Calorific value of fuel, kcal / kg (CV =10000 kcal/kg)

427: Thermo mechanical equivalent, kg.m / kcal,

ηm: Engine mechanical efficiency, (assumed to be 70% for diesel engine)

ηth: Engine thermal efficiency, (assumed to be 40% for diesel engine)

E- Energy Requirements:

Energy requirements can be calculated as follows:

Energy requirements (kW. h/fed) = required power (kW)/actual field capacity (fed/h)

F– Operational Cost:

The machine cost was determined by using the following equation (Awady *et al.*, 1978):

$$C = \left(\frac{p}{h}\right) * \left(\frac{1}{L} + \frac{i}{2} + t + r\right) + (1.2 * RFC * f) + \left(\frac{m}{144}\right) + \left(\frac{P_1}{h_1}\right) * \left(\frac{1}{L_1} + \frac{i}{2} + t + r_1\right)$$

where;

C: Hourly cost, (L.E./h)

p: Initial price of the tractor, (L.E).

h: Yearly working hours of tractor. (h/year).

L: Life expectancy of the tractor (year).

t: Annual taxes and overheads ratio, (%).

f: Fuel price, (L.E./L).

m: The monthly average wage, (L.E./month).

1.2: Factor accounting for lubrications.

RFC: Actual rate of fuel consumption, (L/h).

i: Annual interest rate, (%).

r: Annual repairs and maintenance ratio for tractor, (%)

P_1: Initial price of machine, (L.E)

h_1: Yearly working hours of machine, (h/year)

r_1: Annual repairs and maintenance ratio for machine, (%)

144: Operator monthly average working hours, (h)

L_1: Life expectancy of machine, (year)

RESULTS AND DISCUSSION

1: Soil Characteristics:

1-1: Bulk Density:

Results in Table (2) show that there are differences in bulk density before and after using the two combination machine. In general, increasing machine forward speed caused increasing in bulk density for the all treatments. For example, at 10 cm tillage depth, when the forward speed for the machine (a) and the machine (b) increased from 1.98 km/h to 4.5 km/h, the soil bulk density increased from 1.18 to 1.42 gm/cm3 and from 1.25 to 1.42 gm/cm^3, respectively. This increasing in bulk density by increasing the machine forward speed because of producing fewer breakdowns of soil aggregates.

The same results found in Table (2) show that bulk density generally decreased due to tillage. The lowest value of bulk density was observed under the forward speed of 1.98 km/h and plowing depth of 20 cm, i.e. 1.08 and 1.12g/cm^3 for the two machines (a & b), respectively, as compared to that for the other treatments. This can be explained by the fact that bulk density decreased due to tillage because of the breakdown of soil structure, increase pore spaces and therefore reduce bulk density.

Also data in Table (2) show that increasing plowing depth decreased bulk density for the two machines, (a) and (b). Increasing plowing depth from 10 cm to 20 cm at the machine forward speed of 4.5 km/h for the machine (a) and (b) decreased bulk density by 17% and 14%, respectively. This decrease in bulk density by increasing plowing depth is attributed to the increase in soil crumbling and pore spaces.

1-2: Penetration Resistance:

The effect of both forward speed and plowing depth on penetration resistance is shown in Table (3). Obtained results show that the soil penetration resistance decreased with increasing in plowing depth at four different forward speeds for two machines (a & b). For example, when plowing depth increased from 10 to 20 cm, the soil penetration resistance decreased from 42.1 N/cm^2 to 34.3 N/cm^2 and from 44.2 N/cm^2 to 34.2 N/cm^2 at forward speed 4.5 km/h for the combination machines (a) and (b), respectively .The same results also show that increasing the machine forward speed led to increase the soil penetration resistance. Increasing the machine forward speed from 1.98 to 4.5 km/h at 10 cm depth tillage led to increase the soil penetration resistance by 34% and 31% for combination machines (a) and (b), respectively. This can be explained by the fact that soil penetration resistance decreased with increased of plowing depth are because of the breakdown of soil structure, increase pore spaces and therefore reduce soil penetration resistance. These increases in soil penetration resistance by increasing the machine forward speed are because of producing fewer breakdowns of soil aggregates.

The obtained data in Table (3) also show that the soil penetration resistance with the combination machine (b) is higher than that for the combination machine (a). The increase in soil penetration resistance with the combination machine (b) is due to the increase of heaviness and state of soil compaction of soil.

Table (2): Effect of forward speed (km/h) for both combination machines at different plowing depth on bulk density.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	Bulk density (g/cm^3)							
10	1.18	1.30	1.34	1.42	1.25	1.32	1.38	1.42
15	1.12	1.18	1.24	1.28	1.16	1.24	1.30	1.33
20	1.08	1.16	1.20	1.18	1.12	1.18	1.21	1.23

Table (3): Effect of the forward speed of the tested combination machines and plowing depth on the soil penetration resistance.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	penetration resistance (N/cm^2)							
10	31.22	35.20	37.43	42.10	33.80	36.20	38.10	44.20
15	28.15	32.18	34.10	38.40	31.40	35.10	35.20	37.40
20	24.80	28.48	32.20	34.30	29.80	34.30	32.10	34.20

1-3: Mean Weight Diameter (MWD) of Soil Particles:

The effects of the forward speed and tillage depth on mean weight diameter of soil particles was presented in Table (4). In general, increasing the forward speed for the two machines, (a) and (b), caused decreasing in mean weight diameter of soil particles for all treatments. The results show that, when the forward speed increased from 1.98 to 4.5km/h for the machines (a) and (b) at tillage depth 10cm, the mean weight diameter of soil particles decreased from 5.53 to 4.12mm and from 6.76 to 5.52mm, respectively.

The same results also show that increasing plowing depth led to decrease the mean weight diameter of soil particles. For example, increasing plowing depth from 10 cm to 20 cm led to decrease the mean weight diameter of soil particles from 5.53mm to 3.79mm and from 6.76mm to 4.88mm for the combination machines (a) and (b) at forward speed 1.98km/h. The obtained data also show that the mean weight diameter of soil particles for the combination machine (b) is higher than that for the combination machine (a).

1- 4: Infiltration Rate:

Results in Table (5) show that the infiltration rate generally increased due to tillage. The highest infiltration rate of 4.12 cm/h was observed under the forward speed of 1.98 km/h for the combination machine (a) and plowing depth of 20 cm. But, the lowest infiltration rate of 1.08 cm/h was observed under the forward speed of 4.5 km/h for the combination machine (b) and tillage depth of 10 cm. The infiltration rate increased due to tillage because of the breakdown of soil structure and consequently, increasing soil pore spaces.

The results also show that by increasing the machine forward speed for the tested combination machines, the infiltration rate was decreased. Increasing the machine forward speed from 1.98 to 4.5 km/h for the combination machines (a) and (b) decreased the infiltration rate from 4.12 to 1.95 cm/h and 3.96 to 1.82 cm/h at a tillage depth of 20 cm, respectively. This decrease in infiltration rate by increasing the forward speed is because of producing fewer breakdowns of soil aggregates. Increasing tillage depth results in increasing the infiltration rate. Increasing tillage depth from 10cm to 20cm by using the combination machines (a) and (b) at forward speed of 1.98 km/h led to increase the infiltration rate from 2.45 to 4.12 cm/h and from 2.32 to3.95 cm/h, respectively. This increasing is attributed to the increase in the soil pore spaces.

The obtained data also show that the infiltration rate with using the combination machine (b) was lower than that with using the machine (a). The increase in infiltration rate with the machine (a) is due to the increase of heaviness and state of soil compaction of soil.

Table (4): Effect of the forward speed of the tested combination machines and plowing depth on the soil mean weight diameter.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	soil mean weight diameter (mm)							
10	5.53	4.75	4.39	4.12	6.76	6.22	5.98	5.52
15	4.72	4.18	3.86	3.42	5.92	5.54	5.21	4.97
20	3.79	3.29	2.89	2.62	4.88	4.69	4.25	4.02

Table (5): Effect of the forward speed of the tested combination machines and plowing depth on the infiltration rate.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	infiltration rate (cm/h)							
10	2.45	1.86	1.48	1.20	2.32	1.69	1.32	1.08
15	3.48	2.38	1.98	1.65	3.22	2.18	1.71	1.32
20	4.12	2.98	2.41	1.95	3.96	2.58	2.18	1.82

2: Biological Yield of Barley:

Table (6) shows that increasing the plowing depth led to increase the grain, straw and biological yield of barley at each forward speed. In contrast, increasing the forward speed for both combination machines led to decrease barley yield at each plowing depth. This was true for both machines.

The highest grain yield of 950 and 880kg/fed for machines (a) and (b), respectively, were obtained under the forward speed of 1.98 km/h and plowing depth of 20cm, Table (6). However, the biological barley yield for the treatment that used machines (a) or (b) with the forward speed of 1.98 km/h and plowing depth of 20cm is equal (4100 kg/fed). This indicated that the conditions of the treatments under using machine (a) led to increase the grain barley yield and the conditions of the treatments under using machine (b) led to increase the straw barley yield. Consequently, using the developed machine, i.e. combination machine (a) or (b) in cultivation barley under rainfed agriculture is very important to enhance soil properties and increase the agricultural productivity. The obtained data also show that increasing plowing depth led to increase the grain and straw yield of barley. However, increasing the machine forward speed was associated with decreasing grain and straw yield of barley. The highest straw yield of 3150 and 3220 kg/fed for machines (a) and (b), respectively, was recorded under forward speed of 1.98 km/h and plowing depth of 20cm. Also, the lowest biological barley yield was associated with the treatment of forward speed of 4.5 km/h for both machines and plowing depth of 10 cm, Table (6). The lowest biological barley yield of 2210 and 2340 Kg/fed was noticed under plowing depth of 10 cm and forward speed of 4.5 km/h for machines (a) and (b), respectively.

Table (6): Effect of the forward speed of the tested combination machines and plowing depth on the grain, straw and biological yield of barley.

Machine type		Machine (a)			Machine (b)		
Plowing depth (cm)	Forward speed (km/h)	Grain yield (kg/fed)	Straw yield (kg/fed)	Biological yield (kg/fed)	Grain yield (kg/fed)	Straw yield (kg/fed)	Biological yield (kg/fed)
10	1.98	850	2650	3500	810	2730	3540
	2.7	730	2570	3300	760	2680	3440
	3.42	645	2200	2845	610	2420	3030
	4.5	560	1650	2210	520	1820	2340
15	1.98	910	2950	3860	860	3120	3980
	2.7	830	2780	3610	715	2830	3545
	3.42	780	2450	3230	630	2500	3130
	4.5	690	1860	3550	550	1960	2510
20	1.98	950	3150	4100	880	3220	4100
	2.7	860	2995	3855	750	3180	3930
	3.42	825	2640	3465	670	2780	3450
	4.5	750	2100	2850	610	2210	2820

The decrease in biological yield of barley reached 37% by increasing machine forward speed from 1.98 km/h to 4.5km/h for machine (a) with plowing depth of 10 cm and machine (b) with plowing depth of 15 cm. This is due to the fact that the increase in machine forward speed during tillage operation affected soil structural stability and state of soil compaction. While, the increase in biological yield by increasing plowing depth for both machines, i.e. machine (a) and (b), is due to the increase in soil pulverization and consequently infiltration rate, which allows the roots to grow deeper and wider, giving more chance to conserve water in the soil and getting the necessary water more easily resulting in higher yields. Data also show that, the straw yield was increased with using the machine (b) compare to that for the machine (a). This is due to the stored water in the mini reservoirs, which made by the machine (b).

3: Field Capacity:

The data in Table (7) show that the field capacity increased as the machine forward speed increased with any plowing depth, while the vice versa is noticed with the plowing depth. Increasing forward speed from 1.98 to 4.5 km/h with plowing depth of 10cm, led to increase the field capacity from 1.15 to 1.92 fed/h and from 1.08 to 1.8 fed/h for machine (a), and (b), respectively. The field efficiency for using machine (a) is higher than that for using machine (b) at any forward speed or plowing depth. Generally, the increment in the field efficiency due to using machine (a) was ranged from 6 to 7% for all treatments. The data also show that increasing plowing depth led to decrease field capacity. Increasing plowing depth from 10 cm to 20 cm decreased field capacity by 15%, 24%, 30 and 30% for machine (a) forward speed of 1.98, 2.7, 3.42 and 4.5 km/h, respectively. For machine (b) the percentage decrement in the field capacity at plowing depth of 20cm reached 15%, 24%, 29% and 32% as compared to that with plowing depth of 10cm at a forward speed of 1.98, 2.7, 3.42 and 4.5 km/h, respectively. The decreasing in field capacity by increasing plowing depth is attributed to the increase in soil resistance under high depths. The obtained data also show that the field capacity with machine (b) is lower than that with machine (a). The decrease in field capacity with machine (b) is due to the increase of heaviness and state of soil compaction.

Table (7): Effect of the machine forward speed and plowing depth on the field capacity.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)				Forward speed (km/h)			
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	field capacity (fed/h)							
10	1.15	1.45	1.73	1.92	1.08	1.39	1.63	1.80
15	1.05	1.23	1.42	1.62	1.00	1.17	1.36	1.49
20	0.98	1.10	1.21	1.32	0.92	1.05	1.15	1.23

4: Field Efficiency:

Obtained results in Table (8) show that the field efficiency decreased as the machine forward speed increased, while the vice versa is noticed with the plowing depth. Increasing machine (a) forward speed from 1.98 to 4.5 km/h led to decrease the field efficiency from 82.4 to 64.4%, from 84.6 to 67.4% and from 86.2 to 72.3 % at plowing depths of 10, 15 and 20 cm, respectively. While with using machine (b), increasing forward speed from 1.98 to 4.5 km/h led to decrease the field efficiency from 79.4 to 61.5%, from 82.5 to 64.9 % and from 85.8 to 69.2% at plowing depths of 10, 15 and 20 cm, respectively. The major reason for the reduction in field efficiency as the machine forward speed increased is due to the less theoretical time consumed in comparison with the other items of time losses.

The data in Table (8) also show that increasing plowing depth led to decrease field efficiency. This decrease in field efficiency by increasing plowing depth is attributed to the increase of soil resistance under high depths. The obtained data also show that the field efficiency with the machine (b) is lower than that with the machine (a) for all treatments. The decrease in field efficiency with the machine (b) is due to the increase of heaviness and state of soil compaction.

5: Runoff and Water Use Efficiency:

The developed machines decrease runoff and improve water use efficiency. Data in Tables (9 & 10) show that the water runoff and water use efficiency were more responsive to plowing depth and machine forward speed.

The lowest value of runoff was 2.42 and 2.10 mm for the machine (a) and (b), respectively, under the forward speed of 1.98 km/h and plowing depth of 20 cm, Table (9). While, the highest values were 4.65 and 4.23 mm for the machine (a) and (b), respectively, under the forward speed of 4.5 km/h and plowing depth of 10 cm, Table (9). Data also show that the runoff decreased with increased plowing depth and increased with increasing the forward speed for the two machines (a & b). Consequently the machine (b) was more effectiveness in reducing annual surface runoff for all treatments as compared to that for machine (a). This is due to the mini-reservoirs that created on the soil surface and compression of the soil that originated because of the running of the Rolla on the surface by using machine (b).

The highest value of water use efficiency was 2.62 and 2.40 kg/m^3 for the machine (a) and (b), respectively, under the forward speed of 1.98 km/h and plowing depth of 20 cm, Table (10). While the lowest values of water use efficiency were 0.76 and 0.85 kg/m^3 for the machine (a) and (b), respectively, under the forward speed of 4.5 km/h and plowing depth of 10 cm, Table (10).

The decrease in runoff and the increase in water use efficiency by increasing plowing depth are due to the fact that rainfall was collected in the mini-reservoirs made by the developed machines, allows more time for infiltration, which reduced runoff and increased water use efficiency. While, the increasing in runoff and the decrease in water use efficiency by increasing the machine forward speed are attributed to the fact that the mini-reservoirs created by the local machines at high speeds can not collect or store rainfall due to its bad form resulting from machines vibration.

Table (8): Effect of some operating parameters on the field efficiency.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)				Forward speed (km/h)			
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	Filed efficiency (%)							
10	86.2	84.3	80.4	72.3	85.8	82.4	76.8	69.2
15	84.6	81.4	77.9	67.4	82.5	79.6	74.2	64.9
20	82.4	78.2	72.3	64.8	79.4	75.4	69.9	61.5

Table (9): Effect of some operating parameters on runoff.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	Runoff (mm)							
10	2.82	3.21	3.65	4.65	2.52	2.80	3.50	4.23
15	2.65	3.00	3.22	4.20	2.35	2.50	3.00	3.91
20	2.42	2.85	3.00	3.95	2.10	2.28	2.65	3.45

Table (10): Effect of some operating parameters on water use efficiency.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	Water use efficiency (kg/m^3)							
10	1.73	1.55	1.10	0.76	1.95	1.72	1.35	0.85
15	2.59	2.28	1.98	1.68	2.25	2.00	1.82	1.38
20	2.62	2.42	2.22	1.65	2.40	2.28	2.10	1.88

6: Fuel Consumption:

In general, increasing forward speed and plowing depth for two machines caused increasing in fuel consumption in all treatments. Data in Table (11) show that the fuel consumption increased with the machine (a) as compared to that for the machine (b) for all treatments. Increasing forward speed from 1.98 to 4.5 km/h with the plowing depth of 10cm led to increase the fuel consumption by 27%, 22% for the machine (a) and machine (b), respectively. At 20cm plowing depth, the fuel consumption for machine (a) and (b) with the forward speed of 4.5 km/h was increased by 11% and 10%, respectively, as compared to that for the forward speed of 1.98 km/h. Increasing plowing depth from 10 to 20 cm increased the fuel consumption from 8.41 to 9.35 L/h for machine (a) and from 7.7 to 8.25 L/h for machine (b) at the forward speed of 4.5 km/h. This increase in fuel consumption by increasing plowing depth is attributed to the increase in soil resistance.

Table (11): Effect of some operating parameters on fuel consumption.

Plowing depth cm	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	Fuel consumption (L/h)							
10	6.62	6.92	7.45	8.41	6.33	6.45	7.14	7.7
15	7.92	8.18	8.67	8.98	6.62	6.75	7.35	7.95
20	8.41	8.68	9.12	9.35	7.20	7.48	7.89	8.25

7: Power and Energy Requirements:

Forward speed and plowing depth are highly effected on both power and energy requirements. In general, increasing forward speed and plowing depth for the two tested machines caused increasing in the power for all treatments. The obtained data in Tables (12 & 13) show that increasing plowing depth led to increase both of the power and energy requirements. Increasing plowing depth from 10 cm to 20 cm increased the required power from 26.32 to 33.20 kW for the machine (a) and from 23.79 to 28.98 kW for the machine (b) at the forward speed of 4.5 km/h Table (12). Also, the data in Table (13) show that the energy requirements increased from 13.71 to 25.15 kW-h/fed for the machine (a) and from 13.22 to 23.56 kW-h/fed for the machine (b) at the forward speed of 4.5 km/h. Also, data show that any further increase in the machine forward speed more than 3.42 km/h up to 4.5 km/h, the energy will increase, while required power increased all time by increasing forward speed. Increasing forward speed from 1.98 to 4.5 km/h increased the required power from 18.28 to 26.32 kW and from 19.5 to 29.41 kW and from 21.38 to 33.20 kW for the machine (a) and from 16.85 to 23.79 and from 17.78 to 26.36 and from 19.22 to 28.98 kW for the machine (b) at plowing depth of 10, 15 and 20 cm, respectively. Increasing the forward speed from 1.98 to 4.5 km/h at plowing depth of 10 and 15 cm led to decrease energy requirements from 15.89 to 13.71 kW-h/fed and from 18.57 to 18.15 kW-h/fed for the machine (a), respectively, and from 15.6 to 13.22 kW-h/fed and from 17.78 to 17.69 kW-h/fed for the machine (b), respectively. Any further increase in plowing depth from 15 up to 20 cm, energy requirements will increase from 21.81 to 25.15 kW-h/fed for the machine (a) and from 20.89 to 23.56 kW-h/fed for the machine (b) under the same previous conditions. The decrease in energy requirements by increasing forward speed is attributed to the increase in field capacity, while the increase in energy requirements by increasing forward speed at plowing depth 20cm is due to that the rate of increase in power is more than the rate of increase in field capacity.

8: Total Cost:

Effect of forward speed and plowing depth on total cost was presented in Table (14). In general, increasing the machines forward speed caused decreasing in total cost, while the vice versa was noticed with the total cost which increased in the plowing depth. Results show that increasing forward speed from 1.98 to 4.5 km/h with plowing depth of 10, 15 and 20 cm led to decrease total cost from 212.50 to 188.30, from 215.45 to 201.00 and from 219.40 to 204.20 L.E/fed for the machine (a), respectively, and from 204.30 to 183.00, from 206.30 to 186.30 and from 208.60 to 189.20 L.E/fed for the machine (b), respectively. The decrease of operational cost by increasing forward speed is attributed to the increase of machine field capacity.

Table (12): Effect of some operating parameters on the required power.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	Power requirements (kW)							
10	18.28	22.14	24.28	26.32	16.85	18.32	20.98	23.79
15	19.50	23.28	26.18	29.41	17.78	19.88	22.46	26.36
20	21.38	24.58	28.45	33.20	19.22	22.38	25.80	28.98

Table (13): Effect of some operating parameters on the energy requirements.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	Energy requirements (kW-h/fed)							
10	15.89	15.27	14.03	13.71	15.60	13.18	12.87	13.22
15	18.57	18.93	18.44	18.15	17.78	16.99	16.51	17.69
20	21.81	22.35	23.51	25.15	20.89	21.31	22.43	23.56

Table (14): Effect of some operating parameters on total cost.

Plowing depth (cm)	Machine (a)				Machine (b)			
	Forward speed (km/h)							
	1.98	2.7	3.42	4.5	1.98	2.7	3.42	4.5
	Total cost (L.E/fed)							
10	212.50	205.40	198.60	188.30	204.30	198.40	192.70	183.00
15	215.45	209.60	204.35	201.00	206.30	202.60	194.20	186.30
20	219.40	213.00	206.70	204.20	208.60	206.40	197.80	189.20

The obtained data also show that increasing plowing depth increased total cost. Increasing plowing depth from 10 to 20 cm increased the total cost from 212.50 to 219.40, from 205.40 to 213, from 198.60 to 206.70 and from 188.30 to 204.20 L.E/fed for the forward speed of machine (a) at 1.98, 2.7, 3.42 and 4.5km/h, respectively, and from 204.30 to 208.60, from 198.40 to 206.40, from 192.70 to 197.80 and from 183.00 to 189.20 for the forward speed of machine (b) at 1.98, 2.7, 3.42 and 4.5km/h, respectively, This increase in total cost by increasing plowing depth is attributed to the increase in soil resistance resulting in high fuel consumption and low field capacity under high depths.

Generally, the total cost for using machine (a) in cultivation barley under conservation agriculture in rainfed areas is higher than that for machine (b) at any forward speed or plowing depth. The total cost for machine (a) and machine (b) to cultivate barley with the forward speed of 1.98 Km/h and plowing depth of 20 cm was 219.40 and 208.60 L.E/fed, respectively. The increment in total cost for using machine (a) with the forward speed of 1.98 Km/h and plowing depth of 20 cm to cultivate barley reached 5% as compared to that for the machine (b). This increment in the total cost is relatively small, when compared with the benefits that achieved from using it to cultivate the barley under conservation agriculture in rainfed areas.

CONCULUSION

From abovementioned results, it can be concluded that in raincfed areas, the importance using developed combination machines (a or b) for cultivation barley under conservation agriculture systems. Using developed combination machines (a or b) with forward speed of 1.98 km/h and plowing depth of 20 cm, especially machine (a), for cultivation barley under conservation agriculture systems, led to:

Enhancing soil properties, i.e. decreasing soil bulk density and penetration resistance and increasing infiltration rate.

Increasing biological barley yield.

Improving water use efficiency.

From another point, the field efficiency, field capacity and total cost for using machine (a) is higher than that for using machine (b) at any forward speed or plowing depth. The fuel consumption increased with the machine (a) as compared to that for the machine (b). The machine (b) was more effectiveness in reducing annual surface runoff for all treatments as compared to that for machine (a).

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مقارنة بين ألتين محليتن الصنع للزراعة الحافظة تحت ظروف الزراعة المطرية

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الملخص العربي

مع حقيقة زيادة عدد سكان العالم على مر السنين و الطلب الزائد على الاحتياجات الغذائية المطلوب إنتاجها ، وهذا سوف يضع المزيد من الضغوط على الموارد الطبيعية . ومع ذلك ، الزراعة الحافظة التي تودى الى تحقيق أرباح مقبولة من الإنتاج الزراعي واستدامة إنتاج الموارد يجب استخدامها كجانب رئيسي لزراعة الأراضي القاحلة . أجريت تجارب حقلية خلال الموسم الزراعي (2012 / 2013) في منطقة رأس الحكمة ، الساحل الشمالي الغربي لمصر ، للمقارنة بين التين محلية الصنع لزراعة الشعير في إطار نظم الزراعة الحافظة في المناطق المطرية . الأمطار هو المصدر الوحيد من المياه في منطقة التجربة . الوحدة المجمعة ألاولى محلية الصنع (أ) شملت وحدات مناسبة للحرث ، والزراعة و التسميد . في حين ، الالة الآخرى المصنعة محليا (ب) هى مناسبة لحصاد المياه و الزراعة. وقد اجريت المعاملات لكل من الالتين من خلال تطبيق أربعة سرعات امامية مختلفة ، أي: 1.98، 2.70، 3.42 و 4.5 كم / ساعة وثلاثة أعماق مختلفة للحرث ، أي: 10 و 15 و 20 سم . تم إضافة اسمدة مخلفات المزرعة العضوية بمستوى 10 م^3 / فدان لكل المعاملات ، وأجريت تغطية 50 ٪ من سطح التربة ببقايا المحاصيل (قش الأرز) لكل المعاملات . وقد استخدمت العديد من المعايير في مقارنة لأداء الالتين ، مثل بعض خصائص التربة والمياه .

أشارت النتائج إلى أن أقل قيمة للكثافة الظاهرية لوحظت تحت السرعة الأمامية 1.98 كم / ساعة و عمق الحرث 20 سم ، أي: 1.08 و 1.12 جم / سم^3, لكل من الالتين (أ & ب) ، على التوالي ، بالمقارنة مع قيم الكثافة الظاهرية للمعاملات الأخرى . زيادة عمق الحرث من 10 سم إلى 20 سم عند السرعة الأمامية 4.5 كم /

ساعة للالة (أ) و (ب) ادى الى انخفاض الكثافة الظاهرية بنسبة 17 ٪ و 14 ٪ , على التوالي . مقاومة اختراق التربة مع استخدام آلالة الموحدة (ب) كانت أعلى من مقاومة اختراق التربة فى حالة استخدام آلالة الموحدة (أ) . زيادة السرعة الأمامية للالة من 1.98 الى 4.5 كم / ساعة عند عمق الحراثة 10 سم أدى إلى زيادة مقاومة اختراق التربة بنسبة 34 ٪ و 31 ٪ للآلات المجمعة (أ) و (ب) ، على التوالي . متوسط القطر الموزون لحبيبات التربة فى حالة استخدام الالة المجمعة (ب) كان أعلى من مثيله فى حالة استخدام الالة المجمعة (أ) . زيادة عمق الحراثة من 10سم إلى 20سم باستخدام آلالات المجمعة (أ) و (ب) بسرعة أمامية 1.98 كم / ساعة أدى إلى زيادة معدل الرشح من 2.45 الى 4.12 سم / ساعة و من 2.32 الى 3.95 سم / ساعة ، على التوالي. كان معدل الرشح باستخدام آلالة المجمعة (ب) أقل من مثيله فى حالة استخدام الالة المجمعة (أ) . المحصول البيولوجى للشعير للمعاملة التى استخدمت آلالات المجمعة (أ) أو (ب) عند السرعة الأمامية 1.98 كم / ساعة و عمق الحرث 20سم متساوي (4100 كجم / فدان) . الآلات المطورة ادى الى خفض الجريان السطحى للمياه وتحسين كفاءة استخدام المياه . وكان الالة المجمعة (ب) أكثر فعالية في الحد من الجريان السطحي السنوي لجميع المعاملات بالمقارنة مع مثيلتها فى حال استخدام الآلة المجمعة (أ) .

يمكن الاستنتاج بأنه في المناطق المطرية ، أهمية استخدام آلالات المجمعة المتطورة (أ أو ب) لزراعة الشعير في إطار نظم الزراعة الحافظة . استخدام آلالات المجمعة المتطورة (أ أو ب) مع السرعة الأمامية 1.98 كم / ساعة و عمق الحرث 20 سم ، وخاصة آلالة (أ) ، لزراعة الشعير في اطار نظم الزراعة الحافظة ، أدى إلى : تحسين خواص التربة ، أي: خفض الكثافة الظاهرية للتربة و مقاومة الاختراق ، وزيادة معدل الرشح ، وتحسين كفاءة استخدام المياه وزيادة المحصول البيولوجى للشعير . و من جهة أخرى ، الكفاءة الحقلية و السعة الحقلية و التكلفة الإجمالية لاستخدام آلالة المجمعة (أ) كانت أعلى من مثيلتها فى حال استخدام آلالة المجمعة (ب) عند أي سرعة أمامية أو عمق حرث . عموما ، تراوحت الزيادة في الكفاءة الحقلية بسبب استخدام آلالة (أ) 6- 7 ٪ لجميع المعاملات . زيادة استهلاك الوقود مع استخدام الالة المجمعة (أ) بالمقارنة مع المستهلك فى حال استخدام الالة المجمعة (ب) .