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EFFECT OF CONTOUR TILLAGE SYSTEM AND WATER HARVESTING METHOD ON MITIGATION OF SOIL WATER EROSION HAZARDS

***OMNIA.M. WASSIF[1] and ADIL. A. MESELHY[2]**

[1]Soil Erosion Unit, Soil, and Water Conservation Department - Desert Research Center- Cairo - Egypt.
[2]Agricultural Mechanization Unit, Soil, and Water Conservation Department - Desert Research Center- Cairo - Egypt.
*Corresponding author: omniawassif2016@gmail.com.

ABSTRACT

Little is known about the impact of contour tillage in NWCZ under different water harvesting methods on soil erosion hazards. The purpose of this research was studying the effect of contour tillage by conjunction with conservation tillage and catchment area of water harvesting on reduce runoff depth, decrease soil loss rate, increase soil moisture retention, improve soil properties, and increase crop yield. The treatments of contour tillage were more reduced of runoff depth and soil loss by water erosion rate than treatments of perpendicular tillage on slope. The results of contour tillage methods achieved its benefits in preserving soil from nutrient depletion; improve of some soil properties such as soil moisture and bulk density and removing some of the obstacles facing conservation tillage by perpendicular tillage system. In addition, the ratio of catchment area to cultivated area (2:1) led to an increase in the efficiency of contour tillage in retention moisture and increasing its percentage in the soil, thus improving the efficiency of conservation tillage. The results reported that the conservation tillage (No tillage and Minimum Tillage) by conjunction contour cultivation method and water harvesting catchment area had improve crop yield without affecting soil quality as compared with conventional tillage. Grain and straw yield consequently improve in biological yield as caused by contour tillage system by 12%, 14%, 13% respectively compared with perpendicular tillage system. Therefore, contour tillage system is a solution to overcome the soil water erosion hazards, water scarcity and climate change.

Keywords: conservation tillage, conventional tillage, catchment area, moisture retention, soil and water conservation, soil macronutrients, runoff, soil loss rate .

INTRODUCTION

In the Northwestern Coast Zone of Egypt (NWCZ) most yield production depends on rainfed agricultural productivity for achieve to food security [1]. An increase population has impact on food security due to agriculture intensification. Most farming rainfed dependent, facing numerous challenges due to climate change such as low soil quality, low earning, limitations of land and labor, water scarcity, reduce of soil fertility, nutrient removal from the soil and emerging with climate change conditions [2],[3],[4].

The agriculture intensification leading to soil degradation or/and desertification which leads to low soil fertility [3],[5], [6]. Which leads to an acceleration of crop residue removal consequently, increasing deterioration and leaving soil susceptible to erosion [6]. The soil can generally not absorb the amount of water which fall causing intense surface runoff, which in turn removal the nutrient from soil surface [6], [7]. Most of the soil losses by water erosion by sloping agriculture land occur during isolated high

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intensity effective rainstorms [8]. Water erosion recognized as serious problems with rates of erosion typically between 0.5 and 200 $Mg.ha^{-1}.yr^{-1}$ [9]. NWCZ is very vulnerable to erosion due to its undulating topography and aridity [1]. The relationship between the intensity of tillage and increasing soil erosion by water was well establishing [10]. lately several researchs focused the important of soil quality for achieving sustainable farming system which in turn try to balance productivity, profitability, and environmental protection. The important effect of soil tillage towards sustainability is through its impact on the environment e.g., soil and water conservation [11], [12]. The conventional soil management practices caused big amount of soil, water, and nutrients losses in the field which in turn led to yield reduction [13]. [12] reported that, scientists and policy maker emphasis on conservation tillage system alternative to conventional tillage system. [14] defined no tillage as a system in which the soil is left undisturbed from harvest to planting except for nutrient injection. Minimum tillage which involves shallow tillage using a tine cultivator has the potential to reduce soil and nutrient loss [15]. [3], [10],[12],[15],[16], [17], [18] reported that conservation tillage (no and minimum tillage) can provide environmental benefits including reduced soil erosion, improved soil moisture content in soil, healthier, more nutrient-enriched soil, beneficial soil microbes, reduced consumption of fuel to operate equipment and less sediment and chemical runoff entering streams.

To overcome of climate change risks e.g., insecure rainfall and soil degradation and moisture stress. In addition, low technology levels and increasing population it poses a major threat to agricultural productivity due to moisture stress and soil loss. Recently the government mobilized its resources towards of improved soil and water conservation practices by water harvesting methods and controlled of soil erosion rates [2], [19], [20]. described the rainwater harvesting is methods of collecting and concentrating various forms of runoff. Also, they cleared that, it is relevant where problems of environmental degradation, drought and population pressure are most evident in arid and semi-arid areas where rainfall is irregular, and much water is lost through runoff.

Contour tillage is often used in combination with other practice e.g., soil conservation practices and rainwater harvesting methods [20]. The advantages of contour tillage are increasing the soil surface roughness lead to decrease runoff and reduce of the velocity of any flowing water, providing increase infiltration, moisture retention, reduce the erosion rates and reduce nutrients (N, P, and K) losses in the runoff sediments compared with other tillage [15], [21],[22].On the other hand, the limitation of contour tillage has not widely taken up due to concerns some main problems of implementation of its machinery [2], [15], [20], [23], [24].

Under NWCZ little or no available information's about contour tillage, therefore the specific objectives of this study were to i) come over of contour cultivation implementation problems by using A frame tool in Mediterranean arid conditions. ii) reveal potentially of contour tillage can be used with other tillage practices under rainwater harvesting method. iii)evaluation and prove the potentially of the effect of contour tillage on improve soil properties and reduce soil nutrients loses and reduce runoff volume and examine their cost effectiveness.

MATERIAL AND METHOD

The field experiment was carried out in Wadi El Raml area, west Mersa Matrouh city. The study area was geographically located between (latitude: between 31° 09' 20'' - 31° 21' 58'' N, and longitude: between 27° 04' 27''- 27° 12' 30'' E). It was conducted in 2019/2020 winter season. The experimental area reached about 1.5 hectare (ha)

Experimental design:

It was established as split-split plot experimental design with three replicates. The main plots occupied by two tillage systems contour tillage system and perpendicular tillage system. The sub plots were tillage types conventional tillage (CT), minimum tillage (MT), and No tillage (NT) with division of each tillage type area into two ratios 1:1 and 2:1 (catchment area: cultivated area) as sub – sub plots. So that all study treatments were twelve treatments as the following: **(A)** which carried out as the local farmers practice in this area, where it was conventional tillage parallel the direction of the soil slope and without catchment areas for harvesting rainfall water. **(B)** prependicular tillage system with conventional tillage type with 1:1 ratio. **(C)** prependicular tillage system with conventional tillage type with 2:1 ratio, **(D)** contour tillage system with conventional tillage type with 1:1 ratio, **(E)** contour tillage system with conventional tillage type with 2:1 ratio, **(F)** prependicular tillage system with min-tillage with 1:1 ratio, **(G)** prependicular tillage system with min-tillage type with 2:1 ratio, **(H)** contour tillage system with min-tillage with 1:1 ratio, **(I)** contour tillage system with min-tillage type with 2:1 ratio, **(J)** prependicular tillage system with No-tillage type with 1:1 ratio, **(K)** prependicular tillage with No-tillage type with 2:1 ratio **(L)** contour tillage system with No-tillage type with 1:1 ratio, **(M)** contour tillage with No-tillage type with 2:1 ratio,

The contour tillage system was carried out by drawing the contour lines on the soil surface of the experiment area using the (A-frame) device as shown in Fig. 1 according to [25], [26], [27], [28]. Then the ridges between different treatments were built on the contour lines. This ensures that all parts of the ridges located at an equal height level, which causes water retention in the cultivated areas as shown in Fig. 2. But the perpendicular tillage system was carried out by building ridges between different treatments perpendicular on soil slope. Thus, there are parts of the ridges between treatments located at unequal height levels, which causes the water run away from the cultivated areas as shown in Fig. 3.

For all treatments except the control treatment were applied with 30 cm^3 of organic manure (FYM) and covered by 60 % plant residue (rice straw). The seeds of wheat were cultivated in late of November 2019 in all treatments by seeder machine that have working width with 180 cm, with a rate of 119 kg ha^{-1} and harvested on April 2020.

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Each treatment with its 3 replicates was carried out in a rectangular plot (50×12 m) for oriented in NW to SE direction. The distance between treatments kept at 2 m, which created a buffer zone area between treatments. At harvesting, three randomized samples were taken from each plot using a square wooden frame (1 m^2) to determine the yield. Finally, the wheat crop harvested for conservation tillage (MT and NT) by cutting by sickle at 5 cm above the soil surface. While the conventional tillage (CT) harvested by pulling by hand.

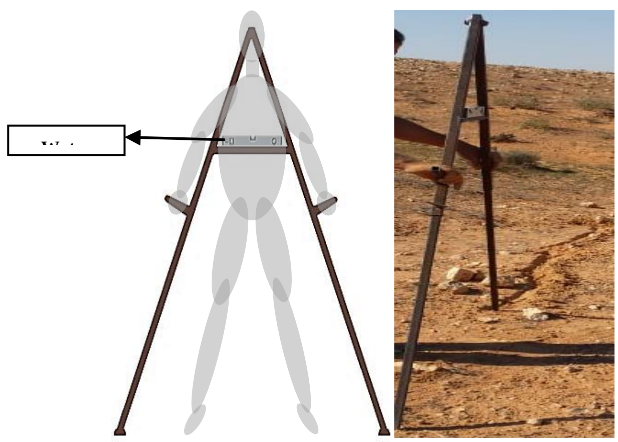

Fig. 1. A-frame tool to draw contour lines in the field.

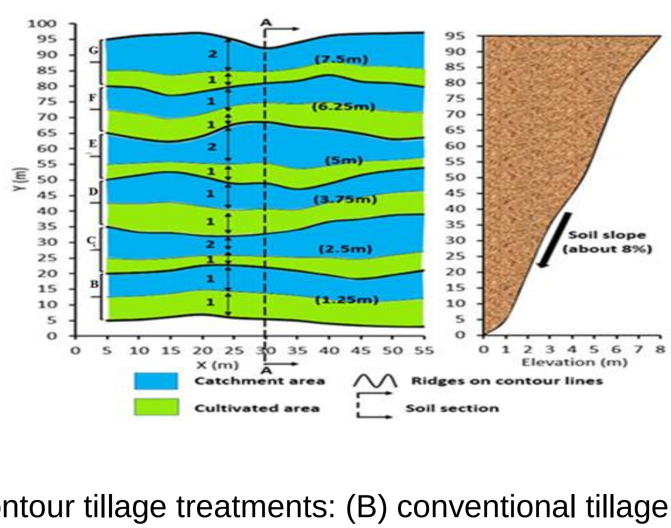

Fig. 2. Map of contour tillage treatments: (B) conventional tillage with 1:1 ratio, (C) conventional tillage with 2:1 ratio, (D) min-tillage with 1:1 ratio, (E) min-tillage with 2:1 ratio, (F) No-tillage with 1:1 ratio and (G) No-tillage with 2:1 ratio.

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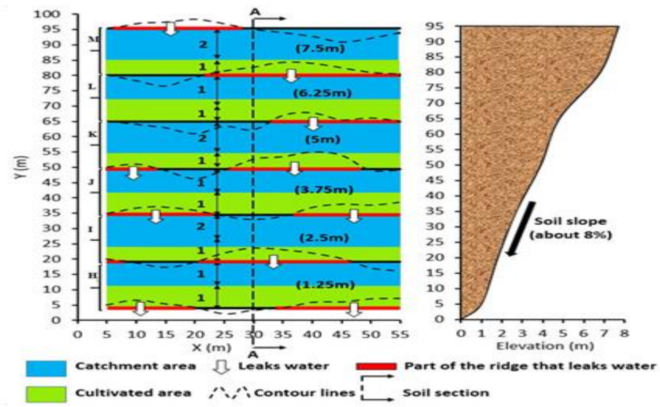

Fig. 3. Map of perpendicular tillage treatments: (H) conventional tillage with 1:1 ratio, (I) conventional tillage with 2:1 ratio, (J) min-tillage with 1:1 ratio, (K) min-tillage with 2:1 ratio, (L) No-tillage with 1:1 ratio and (M) No-tillage with 2:1 ratio.

Study parameters:

Soil samples were collected at triplicate of surface soil layer (0-20 cm) The particle size distribution using the pipette method, was 68.43% sand, 17.37% silt and 14.2 % clay. The field slope degree 7% South-North direction. Table 1 shows some physical and chemical properties of the initial soil before cultivated. Such properties were measured according to methods described by [29], [30].

Soil erodibility was measured according to [31]. This area is suffering from water erosion as cleared in table (1) because the soil erodibility (K) was > 0.50 as according to [32] soils most susceptible to water erosion which is a serious problem for agricultural productivity. Soil loss plots (50×0.1m) were used to measure soil loss and runoff using Gerlesh trough [33], which existed at the end of slope Fig 4. The amount of rainfall was measured with rain gauge for study area as show in Fig. 5. Runoff and associated soil loss for every effective rainstorm were determined according to [33]. The Enrichment Ratio (ER) was calculated as the following equation: ER= Ce/Co Where, Ce is the concentration of nutrient in the sediment, and Co is the concentration of soil nutrients in the bare soil according to [34]. Total hourly cost was determined according to [35] as follows:

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

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

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and overhead 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) and L_1: Life expectancy of machine. Total cost per unit area was determined as follows: $TCA = C/AFC$ ***Where:*** **TCA** = Total cost per unit area, (L.E./ha), **AFC** = Actual field capacity, (ha/h) and **C** = Hourly cost, (L.E./h). Net profit estimated as follows: **NP = P – TCA** ***Where:*** **NP** = Net profit, (L.E./ha), **P** = Profit, (L.E./ha) and **TCA** = Total cost per unit area, (L.E./ha).

Table 1. Some soil properties and soil erodibility for the studied area at Wadi El-Raml at NWCZ, Egypt.

Treatment	pH	EC (ds/m)	$CaCo^3$ (%)	Particle Size Distribution (%)				Texture class	Soil erodibility (t.ha.mj^{-1}.mm^{-1})
				Coarse sand	Fine sand	Silt	Clay		
Initial soil	7.5	1.08	10.5	56.65	11.78	17.37	14.2	Sandy Loam	0.63

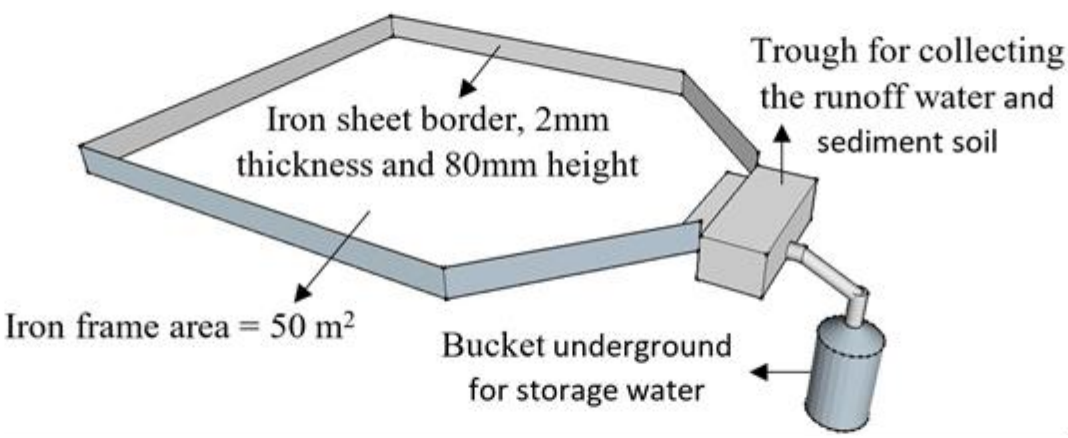

Fig. 4. Schematic diagram showing iron sheet border installed around the study treatment and trough to collect runoff water and sediment soil

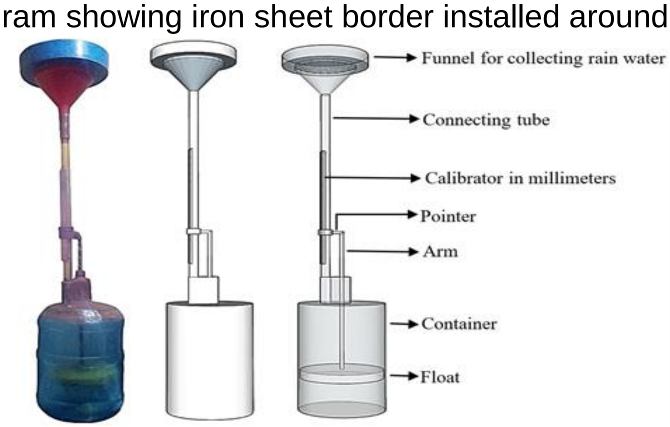

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Fig. 5. A locally made rain gauge for recording rainfall at the experimental site in the field study area

Statistical Analysis

Data were analyzed by the Computer Program, [36], using the General Linear Model (GLM) procedure. The significant differences among treatments means were evaluated by Duncan's Multiple Range-Test [37].

RESULT AND DISCUSSION

The climatic condition:

The rainfall events for winter season 2019/2020, are shown in Fig. 6. There were five effective storms. The effective storm was exceeded at 10 mm according to [38] for study area in Wadi El-Raml. The total annual rainfall was 156 mm/year for study area. The highest effective storm events occurred in Jan. and March, exhibited 37 mm and 43 mm, respectively.

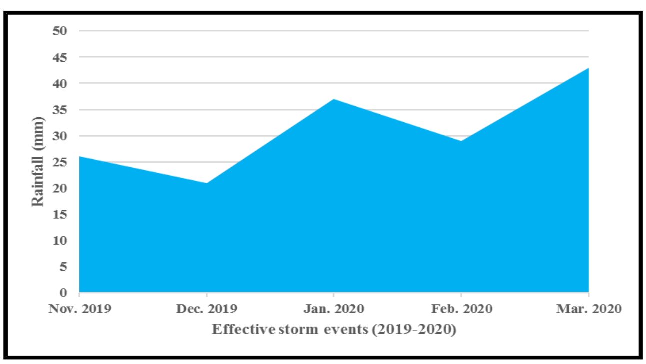

Fig. 6. Effective storm events through winter season (2019-2020) and precipitation depth of rainfall (mm) at the study area recoded by rain gauge.

Tillage types and water erosion hazards:

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The results of soil loss and runoff obtained by significant (P≤ 0.05) during effective storms are given in Fig. 7 showed the treatments of (L, M), (H, I) and (D, E), respectively were more reduced of runoff depth and soil loss rate than (J, K), (F, G) and (B, C) treatments, respectively in effective storms.

The highest runoff depth and soil loss rate was recorded in the A treatment reached 9.84 mm and 7.19 t/.h/yr (table 2). Moreover, the total depth of runoff during the cropping season was significantly (p<0.05) reduced. The runoff and soil loss rate in CT, MT and NT treatments by perpendicular tillage types (B, C), (F, G), and (J, K) were (14.91mm, 10.96 t/h/y), (10.47mm, 6.7 t/ha/y) and (6.06 mm , 2.28 t/h/y) respectively more than contour tillage types (D,E), (H,I), and (L,M) (12.87mm, 9.78 t/h/y) , (8.44mm, 4.53 t/h/y) and (4.03 mm, 2.08 t/h/y) respectively. These results could be explained because of the efficient of contour tillage practice and it reduced the annual runoff as about 10% in compared with cultivation perpendicular on the slope in each tillage type. These results agree with [19], [20], [21]. Moreover, contour farming system in conjunction with other conservation tillage such as MT and NT can be valuable

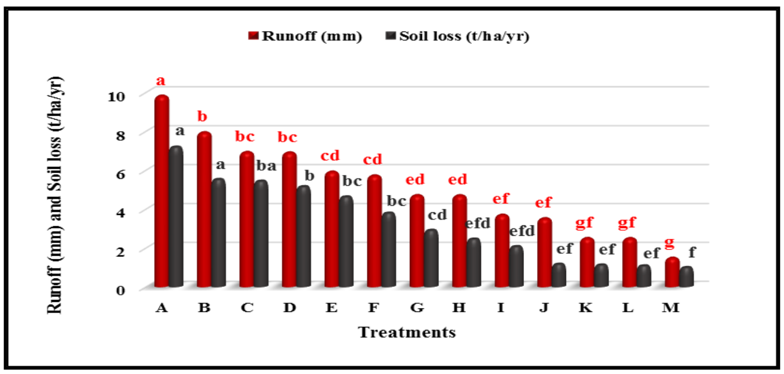

Fig. 7. Effect of treatments (A, B, C D, E, F, G, H, I J, K, L and M) on total annual runoff and soil loss Means of different letters superscripts are significantly different (p<0.05).

additional tools to decreasing the depth of runoff and soil loss rate. The causes of this reduction may be due the contour tillage is increasing the soil surface roughness which led to decrease runoff and reduce of the velocity of any flowing water, providing increase infiltration, improve soil moisture retention and consequently reduce soil loss or runoff sediments rates. Similar results were obtained by [15],[21], [22],[24]. Also, the contour tillage method was more applicable as compared to the other tillage methods. In addition, the plant cover and plant residue associated with increasing the efficiency of contour tillage [24]. On the other hand, Table 2 shows the effect of the catchment area treatments in all tillage types and methods. The results of ratio of 2:1 was better for reducing the runoff depth and soil loss rate than 1:1 ratio in all tillage treatments. This

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result may be due to increasing the space of water harvesting area and consequently increasing soil water retention consequently, reducing soil loss and runoff water [2].

Soil properties:

Soil samples were collected after crop harvesting and some properties were detrimental as follows.

Soil moisture and bulk density:

The results in fig. 8 illustrate that increased of the soil moisture in contour tillage types of system compared with perpendicular on the slope system of all tillage types; this is agreement with [12]. These results can be explained by contour tillage improve the efficiency of moisture management [20]. Accordingly, the treatments M, I and E had increase soil moisture percentage and better than L, H and D treatments. These results due to the quantity of water stored in soil with the 2:1 ratio was higher, and the depth of soil to which this water is stored is higher with contour cultivation than perpendicular on slope [18], [21], [23].

Bulk density is a soil physical parameter used extensively to quantify soil compactness and its significance differences between different tillage types [39]. The value of BD associated with NT was 1.61gm/cm^3 and highest than that of the other treatments, (fig.9). Otherwise, the lowest value was associated with CT treatment and reached about 1.51 gm/cm^3. This result can be attributed to the disturbance of soil up to 20 cm as a result of using moldboard plough.

Similar results were also reported by [12], [16], [39]. The higher BD values were under contour tillage system than perpendicular on slope tillage system. These values can be arranged as follows, (L, M) > (H, I) > (D, E) in each tillage types. These results related to minimum soil disturbance with contour system in conjunction with other conservation tillage using A-frame tool which led to surface compactness. Similar results were also reported by [16].

Soil organic matter (SOM) and water erosion hazards:

Negative significantly relationship was obtained between soil organic matter with each of runoff depth and soil loss rate as shown in fig. 10. Moreover, the treatments under consideration had remarkable effects on this relationship, fig. 11 shows the effect of tillage types on SOM, tillage types (NT, MT, and CT respectively) had highest amount of SOM as compared to control by parallel tillage with slope. The results of contour tillage system conjunction with conservation tillage types were higher influence on amount of SOM than vertical cultivation on slope. These results were in harmony with [3],[10], [17], [18], [40], [41], [42]. To explain these results by inducing residue decomposition rate and turnover to SOC and one of contour tillage advantages is reduced runoff and soil loss rate [2]. In addition, we can explain these results according to the previous mention of negative relationship between SOM and soil water erosion so the treatments of conservation tillage with contour tillage system had influence on the increase amount

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SOM than conventional tillage (L, M, H, I, D and E respectively). On the other hand, all treatments with catchment area ratio of 2:1 had highest values of SOM. This result may be due to increase of space of water catchment area and reduce of disturbance of soil, reduce runoff flow by increase soil moisture stored and reduce of evaporation so reduces the decomposition of SOM. The effect of the treatments on amount SOM can be arranged as follows (M>L>I>H>E>D)> (K>J>G>F>C>B).

Table 2. The effect of the treatments, rainfall depth and water harvesting methods on runoff depth(mm), soil loss (t/h/year) under different effective rainfall storm events.

Treatments			Effective storm event (2019-2020)	Rainfall (mm)	Runoff (mm)	Soil loss (t/ha/yr)
Tillage system	**Tillage type**	**The ratio of catchment area to cultivated area**				
Contour	Conventional	1:1	Nov.	26	1.39	1.02
			Dec.	21	1.36	1
			Jan.	37	1.39	1.04
			Feb.	29	1.39	1.02
			Mar.	43	1.4	1.07
			Total annual	**156**	**6.93**	**5.15**
		2:1	Nov.	26	1.18	0.95
			Dec.	21	1.18	0.88
			Jan.	37	1.19	0.93
			Feb.	29	1.19	0.89
			Mar.	43	1.19	0.97
			Total annual	**156**	**5.94**	**4.63**
	Minimum	1:1	Nov.	26	0.94	0.44
			Dec.	21	0.94	0.44
			Jan.	37	0.95	0.51
			Feb.	29	0.95	0.51
			Mar.	43	0.95	0.54
			Total annual	**156**	**4.72**	**2.46**
		2:1	Nov.	26	0.74	0.41
			Dec.	21	0.74	0.4
			Jan.	37	0.75	0.41
			Feb.	29	0.74	0.41
			Mar.	43	0.75	0.44
			Total annual	**156**	**3.72**	**2.07**
	No Tillage	1:1	Nov.	26	0.5	0.21
			Dec.	21	0.5	0.21
			Jan.	37	0.51	0.22
			Feb.	29	0.5	0.22
			Mar.	43	0.51	0.22
			Total annual	**156**	**2.52**	**1.08**
		2:1	Nov.	26	0.3	0.19
			Dec.	21	0.29	0.19
			Jan.	37	0.31	0.2
			Feb.	29	0.3	0.2
			Mar.	43	0.31	0.21
			Total annual	**156**	**1.51**	**1**
Control	Parallel with slope	without	Nov.	26	1.91	1.43
			Dec.	21	1.91	1.43
			Jan.	37	1.92	1.44
			Feb.	29	1.92	1.44
			Mar.	43	2.18	1.44
			Total annual	**156**	**9.84**	**7.19**

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Con.Table 2. The effect of the treatments, rainfall depth and water harvesting methods on runoff depth(mm), soil loss (t/h/year) under different effective rainfall storm events.

Treatments			Effective storm event (2019-2020)	Rainfall (mm)	Runoff (mm)	Soil loss (t/ha/yr)
Tillage system	Tillage type	The ratio of catchment area to cultivated area				
Perpendicular on slope	Conventional	1:1	Nov.	26	1.59	1.19
			Dec.	21	1.59	1.11
			Jan.	37	1.6	1.01
			Feb.	29	1.59	1.19
			Mar.	43	1.6	1.02
			Total annual	**156**	**7.96**	**5.52**
		2:1	Nov.	26	1.39	1.18
			Dec.	21	1.38	1.07
			Jan.	37	1.39	1
			Feb.	29	1.39	1.16
			Mar.	43	1.4	1.02
			Total annual	**156**	**6.95**	**5.44**
	Minimum	1:1	Nov.	26	1.15	0.72
			Dec.	21	1.14	0.62
			Jan.	37	1.15	0.82
			Feb.	29	1.15	0.75
			Mar.	43	1.15	0.88
			Total annual	**156**	**5.74**	**3.79**
		2:1	Nov.	26	0.94	0.57
			Dec.	21	0.94	0.57
			Jan.	37	0.95	0.58
			Feb.	29	0.95	0.58
			Mar.	43	0.95	0.62
			Total annual	**156**	**4.73**	**2.91**
	No Tillage	1:1	Nov.	26	0.7	0.23
			Dec.	21	0.7	0.23
			Jan.	37	0.72	0.23
			Feb.	29	0.71	0.23
			Mar.	43	0.71	0.24
			Total annual	**156**	**3.54**	**1.16**
		2:1	Nov.	26	0.5	0.22
			Dec.	21	0.5	0.22
			Jan.	37	0.51	0.23
			Feb.	29	0.5	0.22
			Mar.	43	0.51	0.23
			Total annual	**156**	**2.52**	**1.12**
Control	Parallel with slope	without	Nov.	26	1.91	1.43
			Dec.	21	1.91	1.43
			Jan.	37	1.92	1.44
			Feb.	29	1.92	1.44
			Mar.	43	2.18	1.44
			Total annual	**156**	**9.84**	**7.19**

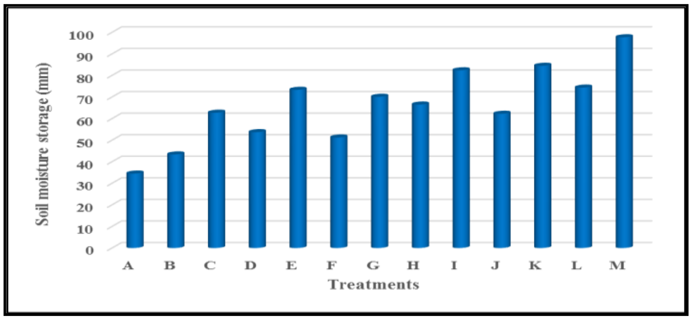

Fig. 8. Effect of treatments (A, B, C, D, E, F, G, H, I, J, K, L and M) on soil moisture storage (mm).

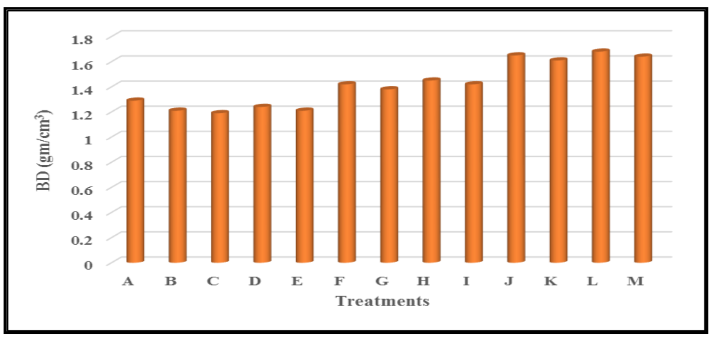

Fig. 9. Effect of treatments (A, B, C, D, E, F, G, H, I, J, K, L and M) on bulk density (gm/cm^3)

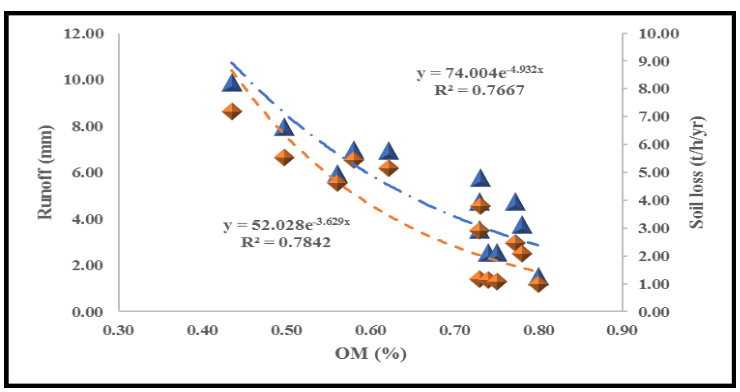

Fig. 10. Relationship between organic matter (%), Runoff (mm) and Soil loss (t/ha/yr)

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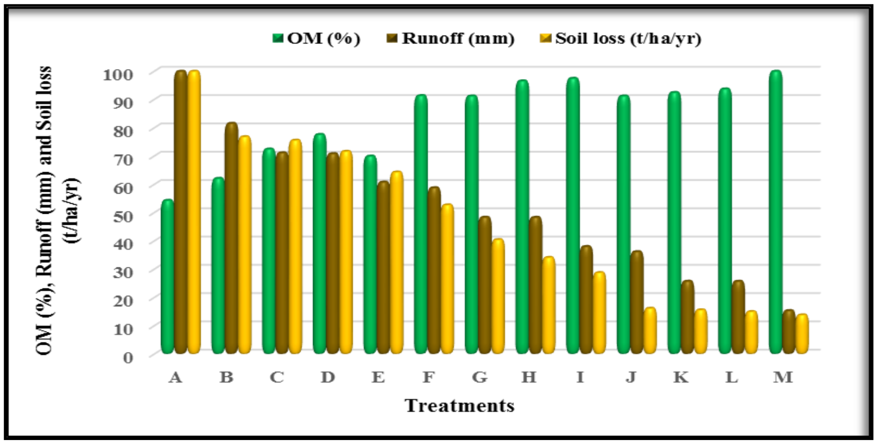

Fig. 11. Effect of treatments (A, B, C, D, E, F, G, H, I, J, K, L and M) on SOM (%), Soil loss (t/ha/yr) and runoff (mm).

Enrichment ratio of macronutrients (N, P, K):

The enrichment ratio (ER) meaning ratio of concentration of nutrients in sediments or eroded materials to that of the initial soil, it is essential estimate of soil degradation by soil erosion. Fig. 12 shows significant effect of lower ER of macro nutrients (TN, Av. P and Av. K) in ER. NT< ER. MT< ER. CT< ER. control with parallel, respectively.

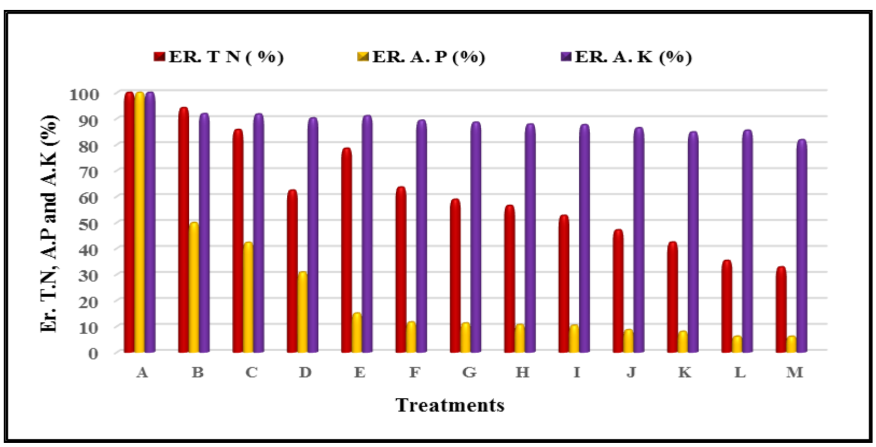

Fig. 12. Effect of treatments (A,B,C,D,E,F,G,H,I,J,K,L and M) on Enrichment ratio of macro nutrients (NPK) between initial soil and eroded material.

The results demonstrated tillage types with different tillage system on macronutrients in both of initial soil and eroded materials. On the other hand, the results of tillage types of conjunction with contour tillage system were less enrichment ratio than the perpendicular tillage system. So, the results were as follow (Er. (L+M) <Er.(H+I) < Er.(D+E) < (Er.(J+K)<Er. (F+G)<Er. (B+C)) respectively. These results agreement with

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[2], [3], [10], [15], [16], [18], [20], [43]. The effect of contour tillage system was more substantial retained of macro nutrient by less the losses of it in eroded materials. These because of contour tillage was reduce runoff and soil disturbed as mentioned before [15]. In addition, contour tillage system with conjunction with catchment area 1:2 gave much more positive results in enrichment ratio although differences were not significant, that means the losses in N, P, K were more less with catchment area 1:1 compared with catchment area 2:1. These results due to moisture content of consistently higher in M > I> E than L>H>D [18].

For summarizing the abovementioned, the results of contour tillage system achieved its benefits in preserving soil from nutrient depletion, improve of some soil properties such as soil moisture and bulk density [20] and removing some of the obstacles facing conservation tillage by perpendicular tillage method. In addition, the treatment of water harvesting of catchment area 2:1; led to an increase in the efficiency of contour tillage in managing moisture and increasing its percentage in the soil, thus improving the efficiency of conservation tillage. Generally, the No tillage type conjunction with contour tillage system treatment was the best treatments on soil properties agree with [17].

Yield and economic return:

Figs. 13&14 shows the contour tillage system caused improvement non-significant of grain and straw for wheat yield. Otherwise, there was an improvement significant of biological yield ($P \leq 0.05$). The biological wheat yield was increased with contour cultivation method by 13%, 12%, 14% in (D, E), (H,I) (L,M) respectively compared with perpendicular on slope tillage system (B, C), (F, G) (J, K) . These data are in harmony with [17],[21], [23], [24], [39]. These results may be due to the effect of contour tillage of improvement water supply. In addition, its effect in conjunction with water harvesting of catchment area. On the other hand, the effect of contour tillage system on reduces enrichment ratio of nutrients, [21], [23], [39]. These treatments influence more positive efficiency of contour tillage system and consequently on increase biological yields. Moreover, the increment of water storage in soils through contour tillage method had a huge effect on grain, straw, and biological yield [23]. From the statistical point of view, fig. 15 Shows the negative significant relationship between runoff depth, soil loss rate and biological wheat yield. This is clarified that the efficiently of contour tillage to reduce water erosion hazards by decrease of runoff depth and soil loss rate and thus increase biological wheat yield. These results agree with [23].

Concerning the total cost for cultivation wheat crop, the total cost for different treatments showed in table 3. The total cost was decreased about 13%, 17% and 23% when compared between contour tillage system (L, M), (H, I), (D, E), respectively, and perpendicular on slope cultivation method (J, K), (F, G), (B, C), respectively. On the other hand, when comparing between conservation tillage types (NT and MT) the total cost decrease about 13% and 18 % respectively. Comparing with CT type. Total cost

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reduction can be explained because of reducing labor and machinery costs in contour tillage system in conjunction conservation tillage. Likewise, machinery and fuel costs are the most important cost item for larger producers and so the impact of CT on these expenditure items is critical. In addition, the conservation agriculture costs as economic considerations are less in terms of money but also time. No tillage wheat significantly reduced the costs of production mostly due to using less diesel fuel, less labor, and less pumping of water. Moreover, NT with contour tillage system by A-frame tool is easy to use, easy to make and inexpensive.

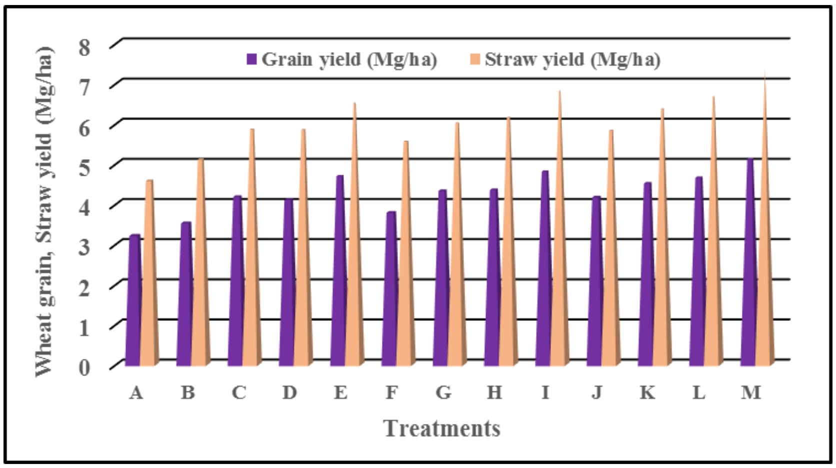

Fig. 13. Effect of treatments (A, B,C,D,E,F,G,H,I,J,K,L and M) on grain and straw yield (Mg/ha).

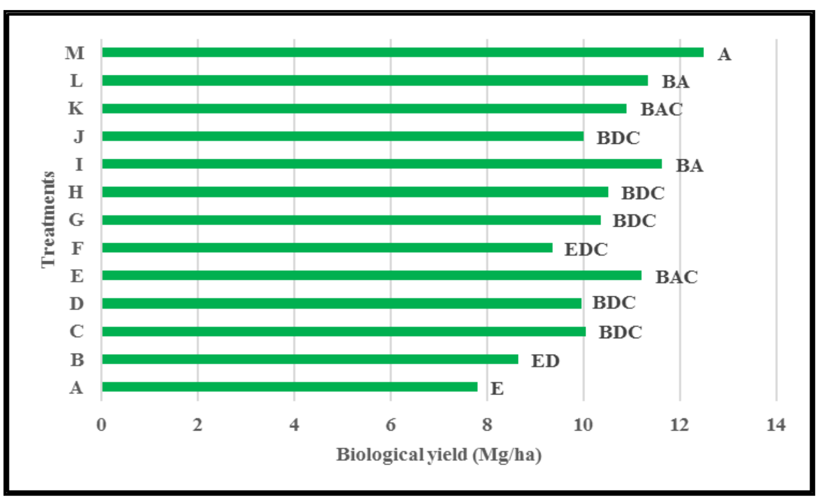

Fig.14. Effect of treatments (A,B,C,D,E,F,G,H,I,J,K,L and M) on Biological yield (Mg/ha) Means of different letters superscripts are significantly different (p<0.05).

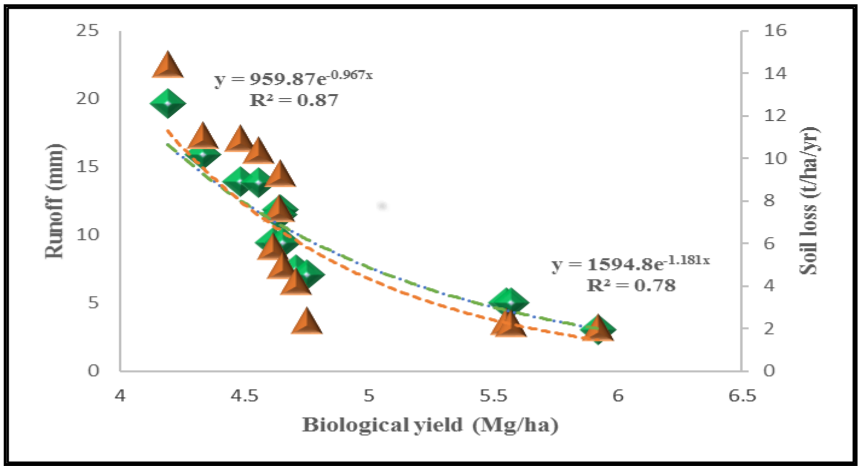

Fig. 15. Relationship between Biological yield (Mg/ha), Runoff (mm) and Soil loss (t/ha/yr)

On the other hand, table 3 clarifies the total net profit of CT reduced about 30% as compared to conservation tillage types. In addition, the net profit was on the contrary of the total cost. It was increased in contour tillage system (L, M), (H, I), (D, E), respectively and about 12 %, 14% and 29% when compared to perpendicular on slope tillage system (J, K), (F, G), (B, C), respectively.

Overall, our results support those of other authors who have found that there a relationship between tillage types and total costs and total profits. Also, it is clarified that the conventional tillage aggravates of soil erosion and have less tillage type profit and vise versa of total profit [18], [44]. Otherwise, our results focused of merging the conservation tillage by contour tillage system and its effects of wheat yield and economic return. The L and M were the lowest cost and highest profit when comparing with other tillage type treatments. On other hand, these results confirmed by other research findings about the conservation tillage decrease loses of soil nutrients by decreasing soil erosion and in turn increased crop yield by preservation of soil fertility, [17],[18].

Finally, the results reported that the conservation tillage (NT and MT) by conjunction contour tillage system and water harvesting of catchment area had improve crop yield without affecting soil quality as compared with conventional tillage.

Table 3. Economic return for productivity of wheat yield under different tillage type, method, and catchment area.

Treatments			Cost			Wheat grain yield (Mg/ha)	Wheat straw yield (Mg/ha)	Profit			Net profit (LE/ha)
Tillage system	Tillage type	The ratio of catchment area to cultivated area	Machine cost (LE/ha)	*Seeds cost (LE/ha)	Total cost (LE/ha)			*Wheat grain profit (LE/ha)	*Wheat straw profit (LE/ha)	Total profit (LE/ha)	
Contour	Conventional	1:1	1921	1400	3321	4.113	5.853	19619	10360	29979	26658
		2:1	1711		3111	4.699	6.511	22414	11524	33939	30828
	Minimum	1:1	523		1923	4.361	6.158	20802	10900	31702	29779
		2:1	471		1871	4.815	6.816	22968	12064	35032	33161
	No Tillage	1:1	292		1692	4.665	6.672	22252	11809	34061	32369
		2:1	252		1652	5.127	7.366	24456	13038	37494	35842
Perpendicular on slope	Conventional	1:1	1814		3214	3.533	5.115	16852	9054	25906	22692
		2:1	1647		3047	4.189	5.863	19982	10378	30359	27312
	Minimum	1:1	490		1890	3.795	5.559	18102	9839	27942	26052
		2:1	440		1840	4.337	6.017	20687	10650	31338	29498
	No Tillage	1:1	247		1647	4.178	5.831	19929	10321	30250	28603
		2:1	212		1612	4.525	6.371	21584	11277	32861	31249
Control	Parallel with slope	without	2121		3521	3.221	4.583	15364	8111	23476	19955

Seed Cost= 120kg/ha seeds ×11.66 LE/kg= 1400 LE/ha

Wheat of weight grain = 4770 LE/Mg

Wheat of weight straw = 1770 LE/Mg

CONCLUSION

This experiment support valuable information's for rain-fed agriculture under sloping area and there was very little information about contour tillage particularly with using water harvesting technique to combat the climate change and water scarcity in Egypt. To improve tillage and guiding towards sustainable agricultural development.

Based on our finding, we conclude that erosion on sandy soil under rainfed condition can be reduced by using conservation tillage with conjunction contour tillage system. Also, our work shows that A-frame tool can be used to drawing contour lines for overcome disadvantages of implementation contour tillage. Which, it will be prevent soil, nutrients, and water losses by water erosion. Moreover, it encouraged yield increase, water conservation and soil conservation by reducing water erosion and more available water and nutrients in soil.

Interestingly, in this work, the highest positive results were NT type by conjunction contour tillage system. It was more efficient treatments for preservation soil properties. Also, when merging NT with catchment area of harvesting water was improved soil moisture retention and decrease water erosion. Thus, it can be recommended that in the future searches to investigate different types of contour tillage system and spread it by awareness of farmers in Egypt under rainfed condition. Because of it has the lowest total cost and the highest of net profit of yield.

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