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APPLICATION OF CONTOUR FURROWING AND PITTING ON SOIL EROSION IN ARID AND SEMI-ARID WATERSHED

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ABSTRACT
Erosion is a factor that endangers existence of soil and water which are the supplying source of human food and is an environmental factor that acts in the direction of removing them. Nowadays soil erosion is counted as a danger for human welfare and even his life. It should be seemed that erosion not only removes soil itself and reduces soil fertility but it locks them by making sediment of materials at waterway. Also by filling dam stores it reduces its capacity and therefore decreases their useful age. Using methods of pitting and contour furrow instead of costly methods has many advantages such as the possibility of easy education, construction and cheap methods .Both methods provide context of controlling surface flowing water resulted from rainfall regarding speed and increase of its penetration in soil. This research was implemented in the form of statistical design of full random blocks with 3 treatments (pitting, contour furrow, control) at three repeats at Soltaniyeh watershed in the region of Baft at the hillside with slope of 8% and at the end regarding statistical analysis there was significant difference at the level higher than 1% between two treatments of pitting and contour furrow and furrow treatments and pitting have presented the best result. The highest amount of sediment mean and runoff volume in order of 1.34kg and 60.04kg was related to control group and on the one side there hasn't been observed significant relationship between two treatments of pitting and contour furrow. However contour furrow with 0.02kg of sediment and 0.8liter runoff volume has had the least degree. Regarding the degree of penetration of water and preventing sediment and regarding economic comparisons, furrow operation is suggested in these regions.

KEY WORDS: contour furrow, erosion, pitting, runoff, sediment.

INTRODUCTION

Using new methods of watershed such as spreading flood, reduction of runoff, result in its penetration in bed and increase of underground resources. In this direction improving methods of cultivation and promotion of simpler and low cost methods are more affordable than other techniques and lead to the increase of output of agricultural products. Therefore using these methods (pitting and contour furrow) instead of high cost methods has many advantages such as the possibility of cheap education, reconstruction and cheap methods can be pointed out. In choosing applied methods topographic conditions, climate and soil besides economic factors are effective. Pitting and contour furrow are two primitive methods in this direction. Both methods provide condition of controlling surface flowing water resulted from rainfall regarding speed and increase of its penetration in soil. Increase of plant access to water and humidity of soil caused their quantitative and qualitative growth and especially in rain-fed cultivation it leads to increase of product output.

Amiri (2001) during a research that was done for considering the effect of mechanical methods of conservation of soil and water at hillsides and effect of two methods of pitting and contour furrow on decreasing runoff and preventing water weed in this research among applied methods, contour furrow has more prevented runoff and erosion than pitting. Also considering the humidity situation of soil showed that contour furrow and pitting have had more humidity than control to the degree of 38% and 19.9% and it affected at plant coverage of research area. Eftekhari et al. (2006) in a research entitled as pitting and contour furrow introduced two effective mechanical methods at quantitative and qualitative improvement of plant coverage and control and optimized exploitation of surface runoff at districts Karoon and Zayandehroud, introduce these two methods than other simpler and low cost methods of watershed methods and by using these two methods at area destructed with proper slope and little plant coverage in case of conservation caused

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strengthening plant coverage and considerable reduction at the process of destruction and creating change and qualitative and quantitative improvement at available conditions. Asadi (2000) in a research entitled as pitting and contour furrow achieved two methods of saving rainfall that the degree of humidity of pitting operating plot and contour furrow is more than control plots in most cases. At the north of China due to terrace operation and cultivation on contours don't have high output at preventing erosion(Weng *et al*, 2012) suggested that contour furrow and Grass hedge in should be used in tropics because they have more effect than terrace at conservation of water and soil. In semi-arid region in the south of Africa during two seasons of cultivation, Estiman (2003) concluded that by mechanical operation of watershed(contour furrow, ripping, sub seviller) we can help reestablishments of plant coverage by rain penetration and increase of the degree of soil humidity. Finer et al(2006) by considering creating barriers(watershed operation) at the direction of runoff water from 1994to 2001 at two watershed in central Europe fond that by implementing these operations we can reduce the degree of runoff and sediment to 87% and 93%.

Weng et al., (2008) during a research entitled as the effect of soil management on sediment and runoff output, in two watershed in America that in one watershed cultivation operation was used on contour furrow and in another one traditional cultivation was used from 1995 to 1976 found that furrow method was effective about 36% on runoff, 82-86% on reducing sediment degree and increased growth of corn about 3.8% than control district. According to the research at arid Mediterranean environment of Jordan by (Gamoh, 2011) they found that using deep contour furrow in these regions can increase penetration of rain water and its collecting by furrows. Mackdonald (1999) has considered the effect of contour furrow at eastern and southern lands of Austria that are located in arid and semi-arid regions and found that contour furrow in these regions is proper for decreasing erosion and strengthening reestablishment of plant coverage.

Kayerd(1946) did contour furrow method near Texas and found that in Texas rangeland application of contour furrow is 4 to 7 years during which growth of grassed production increases double. In this research it tried to analyses the effect of two methods of pitting and contour furrow at preventing runoff and soil erosion quantitatively.

MATERIALS AND METHODS

Characteristics of Soltaniyeh watershed

In studying country's comprehensive water plan, Jazmorian watershed is divided into Hillrood ,Roodshoor, Payabh Hill and Jazmorian that includes 15.9% of lands of country's watershed. Hillrood includes hydrologic units of Soltani, Baft, Dehoj, Raber that Soltaniye watershed in one of them. Soltaniyeh watershed is located in the south of Kerman province and west of Baft city at geographical area of 290413 to 293506 longitudes and 561638 to 563530 altitudes. Area of this watershed is 861.022km^2 that most part of it is covered by mountainous region, Mahour hills and rocky outcrops between plain. The highest point is 3586.65m at the top of northern mountain and the minimum height is 2072.86m at the entrance place of watershed and moderate height from sea is 2508.55m. For facilitation of doing studies, Soltaniyeh watershed regarding topographic situation of the region, waterway network and waterway density is divided into 5 subordinate watersheds that the physiographic characteristics of this watershed in summarized in table 1.

Table 1: some physiographic characteristics of Soltaniyeh watershed

Area(km^2)	Height of STD	Average of Height(m)	Max of Height(m)	Min of Height(m)	Sub region
460/95	140/067	2359/86	2829/58	2072/86	**A**
75/95	270/077	2930/34	3586/65	2538/92	**B**
71/062	99/21	2749/66	3080/23	2526/2	**C**
153/71	214/62	2766/85	3561/63	2416/47	**D**
99/35	106/42	2306/6	2744/29	2157/58	**E**
861/022	**276/083**	**2508/55**	**3586/65**	**2072/86**	**Total**

MATERIALS AND METHODS

This research was implemented in the form of statistical design of random full block with 3 treatments (pitting, contour furrow, control) at 3 repeat at the Soltaniyeh watershed in hillsides with 8% slope. In this design for having sufficient data in usual experiment design, some rainfall is considered and data are recorded. Firstly the regions are visited

through field studying and the situation of implementing plan is recognized and finding exact place is done by SPSS software. Then plots are established to the dimension of 15×15 m and their surrounding a hill with 30cm is made by soil and at the end of slope of each plot a cement impenetrable pool or bucket is made. The nine each pot one's mechanical methods are implemented randomly. Distance of plot from each other are considered about 5 meter so that each treatment doesn't affect another one. For establishing contour furrow firstly on each plot contour lines are distinguished and on these Lines Rivers and hills with depth of 15-20cm are made and distance of furrow from each other is considered 100cm. For implementing pitting holes with depth of 30cm and length of 70cm are made and distance of each hole from each other is 70cm and vertical distance of these holes are 100cm.Soil of each hole is poured at the bottom of each hole to make natural conditions. At the end of a slope of each plot a barrel is placed that runoff resulted from rainfall after filling holes goes to barrels and in this way measure the degree of runoff and sediment. The degree of runoff firstly mixes water inside barrels completely and then after taking sample the degree of sediment in laboratory is measured. Then at the end of a period of 6 watery month the result (obtained data) will be analyzed by variance. In case of being significant Duncan test is used for comparing means.

RESULTS

Descriptive statistics of sediment degree

Some descriptive statistics produced from each treatment has been shown in table 2. Mean of the degree of sediment in contour furrow is 0.023kg, pitting 0.228kg, and control is 1.349kg and it means that the highest degree of sediment exists in control and the lowest amount exist in contour furrow.

Table2-some descriptive statistics of sediment produced in each treatment

Max	Min	Upper	Lower	S.D.	Average	N	Case
2/35	0/58	/81	0/88	1/022	1/35	21	**Witness**
0/36	0/10	0/27	0/18	0/100	0/23	21	**Pitting**
0/04	0/00	0/03	0/02	0/012	0/024	21	**Conterfaro**
3/35	0/00	0/74	0/33	0/83	0/53	63	**Total**

*certainty level of 95% for mean

The result of uniformity of variances for sediment has shown that there isn't uniform sediment between amounts among variances.

Analysis of degree of sediment in treatments

Variance analysis of created sediment has been shown in table 3 and regarding high amount of F and significance level less than1% indicates significant difference between treatments at the degree of sediment that at 99% of certainty level it can be said that methods done on degree of produced sediment were effective.

Table 3: Result of variance analysis test for sediment production

Sis.	F	Mean of Square	Sum of Square	D.F.	Source of Changes
0/00	30/43	10/69	21/38	2	**Intergroup**
		0/351	21/07	60	**Error**
			42/45	62	**Total**

Comparing mean of the degree of sediment in treatments

Because in variance analysis test this conclusion was obtained that there was significant relationship between treatments comparison of means was done through Duncan test for the degree of sediment that has been shown in table 3. Based on this test mechanical method of pitting and contour furrow has had significant difference with control at level higher than 1% nut there hasn't been observed significant statistical difference between two methods of pitting and furrow. The result of Duncan for comparing mean of productive sediment of each treatment has been presented in table 4.

Table 4: result of Duncan test for comparing treatments sediment mean

α= 0.01		N	Case
2	1		
	0.2362	21	**Contorfaro**
1.34905	0.2288	21	**Pitting**
		21	**Witness**
1.00	0.266		**Sig.**

Effect of treatment on runoff volume

Deccrptive statistics of runoff volume

Table 5 shows some descriptive statistics of runoff produced in each treatment. Based on this statistics, control region with 60.047 liter has created the highest degree of runoff and contour furrow has created the least degree of runoff. The degree of mean of runoff produced in plots of pitting is 7.85 liters.

Table 5: some descriptive statistics of runoff produced in treatments

Max	Min	Upper	Lower	S.D.	Average	N	Case
120/0	32/00	72/68	47/42	27/75	60/047	21	**Witness**
13/50	3/50	9/09	6/61	2/73	7/852	21	**Pitting**
1/80	0/16	1/02	0/59	0/48	0/802	21	**Conterfaro**
120/0	0/16	30/71	15/09	30/99	22/901	63	**Total**

Also the result of doing variance uniformity test for runoff volume denotes in uniformity of variance of the degree of runoff volume.

Analysis of the degree of runoff volume in treatments

Table 6 shows variance analysis of the degree of produced runoff in plots. As it is observed in table there has been observed significant difference at 1% between treatments regarding the significant level and amount of F at the degree of produced runoff. That this amount shows significant difference between produced runoff in each treatment.

Table 6: result of variance analysis test for the degree of runoff

Sig.	F	Mean of Squares	Sum of Squares	D.F.	Source of Changes
0/00	84/835	21994/153	43988/305	2	**Intergroup**
		259/257	15555/426	60	**Error**
			59543/732	62	**Total**

Comparing mean of runoff volume in treatments

Comparison of mean of runoff volume has been shown in table 7 based on Duncan test and this table shows that with the existence of significant statistical difference higher than 1% between two methods of contour furrow and pitting with control, there isn't statistical difference between pitting with contour furrow at the degree of produced runoff volume.

Table 7: Result of Duncen test for comparing treatments sediment mean

α= 0.01		N	Case
2	1		
	0/2362	21	**Contorfaro**
1/34905	0/2288	21	**Pitting**
		21	**Witness**
1/000	0/266		**Sig**

There is relatively strong direct relationship between degree of carried sediment and degree of created runoff volume that for calculating the degree of this relationship Pearson correlation coefficient has been used. Table 8 shows the result of this test. By using Pearson correlation coefficient, in table 8 the amount of r is 0.929 and at a level higher than 1% it is significant that we achieve this reality that there is strong correlation and relationship between degree of sediment and runoff volume. That is with the increase of degree of runoff we should expect increase of degree of sediment and erosion.

sediment	runoff		Case
[a]0/929	1	R	runoff
0/000		Sig.	
63	63	N	
1	[a]0/929	R	sediment
	0/000	Sig.	
63	63	N	

DISCUSSION AND CONCLUSION

Getting statistics during implementation of this research denotes that contour furrow and pitting has more effect than control at preventing water weed and reducing sediment. The degree of producing water weed was a lot in control and by spending time and increase of time of rainfall it increases that saturation of soil level and decreasing penetration is counted its main factor. At implementation region of this research the degree of soil penetration is little, the degree of rainfall is low and conformation of runoff is considerable especially at severe rainfall. Therefore in such regions the necessity of seeming necessary solutions for soil conservations and optimized use of rainfall is an important action at creating coverage and producing grass. The solution is using different operations of watershed such as establishment of contour furrow, pitting at places with 8% and as it is mentioned in current research in soils with semi-heavy texture and with semi-arid climate situations these methods are useful. This action in runoff statistics and sediment is completely obvious. Studies and considerations shows that the degree of sediment and runoff in most cases has direct relationship that is if more runoff is produced it will carry more sediment with itself and in general the degree of carried sediment depends on the degree of runoff, plant coverage, topography, penetration, soil conservative operations and so on. In this design the highest degree of runoff and sediment was obtained from control treatment. Based on the result of current research the least degree of runoff sediment has been identified in treatments having pitting operation and furrow. In this direction (Branson, 1996), (Gabrigsyaber, 2009), (Panometerinchagl, 2005) denotes this subject.

The result of this research denotes that statistically there isn't significant difference between two treatments of contour furrow and pitting but at statistics the degree of sediment and runoff in contour furrow is lower than pitting. The reason is that contour furrow acts as small plots and causes saving water at the back of created furrow that during water penetration in soil it has increased and runoff will not get speed. Also this research was a confirm of studying affairs (Amiri, 2001, Eftekhari, 2006) that by doing these methods it had positive effect on both plant coverage and degree of water penetration. The degree of effectiveness of method of contour furrow is more than pitting at preventing runoff and sediment based on this research that in this direction (Gamoh, 2011, Khana, 2003, Jing an, 2008, Abriskoita, 2007, Baniasadi, 2003) have done studies in this directions and all confirm the accuracy of these results. In relationship with increase of water penetration in soil and decrease of water weed by (Mack hog, 2007, Malleli, 2004, Lee, 2008, stamen, 2003, Asadi, 2000 and Babahanlou, 2003) has done studies that their result confirms the accuracy of findings of this research.

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