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Effect of different soil working techniques on runoff, soil and nutrient losses under Silvipastoral system in degraded hills of Himachal Pradesh

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Abstract
The study was conducted during 2012-2013 to evaluate the effect of different soil working techniques, i.e., continuous contour (T_1), small ridge-ditch (T_2) and pit planting (T_3) on runoff, soil and nutrient losses under Silvipastoral system in degraded lands of Himachal Pradesh. The investigations revealed that among all the soil working techniques continuous contour (T_1) proved to be the most effective soil working technique to reduce runoff, soil and nutrient losses in degraded hilly slopes.

Keywords: Degraded lands, soil working techniques, nutrient losses, soil runoff

Introduction

India has about 18 per cent of the human and 15 per cent of the livestock population of the world that needs to be supported from only 2 per cent of the earth's land area. The per capita land availability has declined from 0.89 ha in 1951 to 0.37 ha in 1991 and is likely to be 0.20 ha by 2035 (Singh, 2005) [9]. Nearly 32.67 per cent of India's geographical area is affected by various forms of soil erosion and land degradation. Increasing human population, livestock and improper land use has been attributed to be a major causative factor of serious land degradation in India.

In Himachal Pradesh 17.6 per cent of the geographical area is under pasture or grazing lands. The livestock population of the state is three times the carrying capacity of grazing lands. Overgrazing of the pasture lands causes soil erosion and great damage to the natural plantation (Anonymous, 2010). Besides, Nomadic graziers (Khadwals, Gaddis, Gujjars, Khas) use sub-alpine and alpine pastures for rearing their livestock. Due to ever-increasing demand of animal products, the livestock population has increased manifold, thereby increasing the grazing pressure on these pastures. This has resulted in the deterioration of the grass cover as well as valuable forest species. As a result of this, significant area of natural grassland has been covered by noxious plant species like *Aconitum, Anemone, Adonis, Aquilegia, Cincifuga, Clematis, Lepidium, Artimisia, Ranunclus, Stipa, Sorbinia* and *Sambucus Parthenium, Trifolium* and *Lantana camara*, (Misri, 1988) [7]. All these factors have led to the decrease in carrying capacity of the pastures. Sub-temperate region of Himachal Pradesh is characterized by undulating topography and steep slopes.

The biomass based economy of our rural population calls for restoration of tree vegetation on degraded and poor areas in order to fulfill the fodder, fuelwood, small wood, minor forest produce needs of rural masses, besides providing benefits of protective/regulative functions and amelioration of the environment. The main constraints in the establishment of plant seedlings on degraded stress sites are poor soil depth, lack of moisture availability and rapid runoff rate. High intensity of soil working coupled with moisture conservation devices likely provide an answer to overcome these constraints towards successful establishment and subsequent performance of trees aimed at greening sites with useful broad leaved tree species.

Regeneration of vegetation can be progressed if usual soil working technique on sloppy land areas is adopted. The basic aim of soil working techniques is to reduce runoff rates thereby preventing damage and erosion due to excessive runoff.

Techniques of soil working suitable for particular locality are mainly governed by precipitation pattern, geology, morphology of soil profile and topography. Adoption of appropriate soil working techniques in silvipastoral systems in degraded lands owe enormous potential to reduce the run off, soil and nutrient loses.

Materials and Methods

The experiment was laid out during the year 2012-2013, in the field near University's Farmer Hostel, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan at an elevation of 1200 m above mean sea level. Experimental site was facing South – West direction having approximately 70 per cent steep slope. The study area lies between 30˚51'' N latitude and 76˚11'' E longitude. The climate of the site is sub-temperate to sub-tropical. Winter frost is almost a daily feature during December and January. The average annual rainfall ranges from 1000-1100 mm, most of which is received during monsoon (July and August). Winter showers although common but usually mild. Experimental plots had a total area of (30 × 33) m which was prepared by working out trenches for establishing continuous contour (T_1) and small ridge-ditch treatments (T_2), while Pit planting (T_3) was done directly without preparing the land. The plot was prepared to accommodate all the treatments for developing the silvipastoral system. The system was developed by planting two multipurpose tree species (*Grewia optiva* Drummond and *Morus alba* Linn) and two grass species (*Setaria sphacelata* var. *Kazangula* and *Panicum maximum*). The three soil working techniques were applied as treatments for developing silvipastoral system. One year old uniform and healthy seedlings of *Grewia optiva* and *Morus alba* were transplanted in the experimental field. Similarly, grass tufts were shifted from the grass nursery in month of July and transplanted in the field between two rows of Multipurpose Tree Species MPT's. The experiment was worked out by using randomized block design for MPT's and RBD factorial for grasses. Runoff studies were carried out by placing the pre-calibrated drums below the experimental plot under each soil working technique in the month of May 2013. The rainfall data from June 1 to September 30, 2013, (Figure 1) was procured from the Department of Environmental Science; Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.). The runoff volume in (ha-m), soil loss (tones ha^{-1}) and nutrient losses (Kg ha^{-1}) were recorded after each rainfall event.

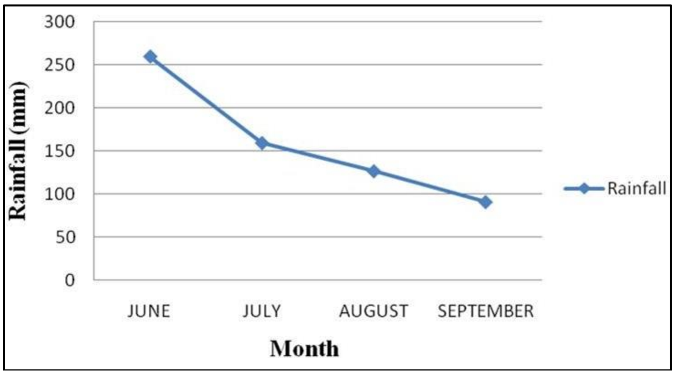

Fig 1: Total rainfall received during study period (June-September 2013).

Runoff and soil loss was determined by collecting the runoff water in pre-calibrated drums, marked in terms of depths in centimeters. The depth of runoff was recorded after each rainfall event and converted into the volume of runoff by the volume height relationship, $\pi r^2 h$, where, r is the radius of the container in cm and h is the depth of water in cm. The runoff collected in the drums was calculated and converted into millimeter (mm) and then finally expressed in ha-m by using the following formula:

$$\text{Runoff (ha-m)} = \frac{Volume\ of\ runoff\ (m^3) \times ha}{Catchment\ area\ (m^2)}$$

Laboratory Studies: Available nitrogen (Kg/ha) was estimated with the help of alkaline potassium permanganate method given by Subbiah and Asija (1956) [10] and available phosphorus (Kg/ha) was determined with the help of Colorimetric method given by Olsen *et al.* (1954). While, available Potassium (Kg/ha) was determined with the help Flame photometric method proposed by Merwin and Peech (1951) [6]. After every rainfall event, the runoff collected in the drum was thoroughly stirred and representative samples were collected immediately in 1000ml capacity bottles. The sediment was allowed to settle, decant off the liquid carefully and collect the sediment samples from the bottom of the container. The samples collected in bottles were thoroughly shaken, 100ml of which was transferred to a beaker and kept for drying at a temperature of 105 °C. The dried soil samples were then weighed in an electronic top pan balance. Finally the total soil sediments were expressed in tonnes per hectare. The volume of runoff and amount of sediments in runoff water were computed and analyzed for losses of nutrients (N, P, K) after each rainfall event.

Statistical Analysis: Data generated from present investigations were statistically analyzed as per the methods outlined by Gomez and Gomez (1984) [4] with Critical difference (CD) at 5% level of significance.

Results and Discussion

Effect of different soil working techniques on runoff (ha m), soil and nutrient losses (tonnes ha^{-1}) under silvipastoral system

It is evident from the data presented in Table 1 that June month received higher rainfall (259.6 mm) followed by July (159.1 mm), August (126.4 mm) and September (90.6 mm). The magnitude of runoff volume and soil losses varied markedly under different soil working techniques. The total amount of rainfall received during study period was 634.90 mm. Among the different soil working techniques, the highest amount of runoff from all events of rainfall was recorded in pit planting soil working technique (45 ha m) followed by small ridge ditch (41 ha m) whereas, lowest amount of runoff was recorded in continuous contour soil working technique (33 ha m). The runoff losses irrespective of soil working techniques were comparatively higher during the onset of pre-monsoon showers whereas, lowest soil loss (46 tonnes ha^{-1}) was recorded under T_1continuous contour (T_1). Total soil loss through runoff was found to be highest under pit planting (58 tonnes per hactare) and lowest soil loss was recorded in continuous contour, i.e., 46 tonnes per hactare. A perusal of the data presented in Table 1 reveals that high runoff volume coupled with higher soil loss occurred in pit planting (45 ha m) and least runoff was recorded under continuous contour (33 ha m). This may be attributed to the removal of top soil cover from the pit planting techniques through runoff, after each rainfall event in the absence of invert slope, when compared to continuous contour. The said opinions are in consistence with the observations made by Tian *et al*. (2003) [11] and Zheng *et al*. (2012) [12]. Rana *et al*. (1995) also reported annual soil loss of 55.3 tonnes per hectare in the sub-mountain zone of Himachal Pradesh.

Table 2: Rainfall, runoff and soil loss under different soil working techniques

Date	Rainfall (mm)	Runoff (ha-m)			Soil Loss (tonnes ha^{-1})		
		T1	T2	T3	T1	T2	T3
4-6-13	13.4	0	0	0	0	0	0
7-6-13	2.8	0	0	0	0	0	0
8-6-13	1.0	0	0	0	0	0	0
13-6-13	29.4	3	4	4	5	4	4
14-6-13	52	5	6	7	9	10	10
15-6-13	11.2	0	0	0	0	0	0
16-6-13	39.8	4	5	5	7	8	9
17-6-13	30.2	3	4	4	6	8	8
18-6-13	1.4	0	0	0	0	0	0
24-6-13	3.4	0	0	0	0	0	0
26-6-13	19.4	0	0	0	0	0	0
27-6-13	7.4	0	0	0	0	0	0
28-6-13	43.2	4	5	5	7	8	9
29-6-13	3.2	0	0	0	0	0	0
30-6-13	1.8	0	0	0	0	0	0
3-7-13	27.6	2	3	4	2	3	3
5-7-13	0.5	0	0	0	0	0	0
7-7-13	24.4	2	3	3	1	2	2
8-7-13	30.4	3	4	4	2	3	3
9-7-13	6.6	0	0	0	0	0	0
16-7-13	12.6	0	0	0	0	0	0
17-7-13	4.0	0	0	0	0	0	0
18-7-13	5.2	0	0	0	0	0	0
20-7-13	16.2	0	0	0	0	0	0
22-7-13	14.0	0	0	0	0	0	0
24-7-13	6.8	0	0	0	0	0	0
25-7-13	5.2	0	0	0	0	0	0
27-7-13	5.6	0	0	0	0	0	0
1-8-13	3.4	0	0	0	0	0	0
2-8-13	5.8	0	0	0	0	0	0
3-8-13	8.2	0	0	0	0	0	0
4-8-13	6.4	0	0	0	0	0	0
6-8-13	6.5	0	0	0	0	0	0
7-8-13	7.2	0	0	0	0	0	0
8-8-13	7.2	0	0	0	0	0	0
9-8-13	19.6	0	0	0	0	0	0
10-8-13	3.4	0	0	0	0	0	0
11-8-13	9.6	0	0	0	0	0	0
12-8-13	11.6	0	0	0	0	0	0
13-8-13	1.0	0	0	0	0	0	0
16-8-13	7.0	0	0	0	0	0	0
17-8-13	0.5	0	0	0	0	0	0
19-8-13	1.0	0	0	0	0	0	0
21-8-13	24.2	2	3	1	2	2	2
24-8-13	1.8	0	0	0	0	0	0
30-8-13	1.0	0	0	0	0	0	0
31-8-13	1.0	0	0	0	0	0	0
1-9-13	1.0	0	0	0	0	0	0
8-9-13	25.4	1	3	2	3	3	3
9-9-13	3.0	0	0	0	0	0	0
12-9-13	1.8	0	0	0	0	0	0
13-9-13	28	3	3	2	2	2	3
16-9-13	3.0	0	0	0	0	0	0
21-9-13	5.4	0	0	0	0	0	0
22-9-13	22.0	2	3	3	1	2	2
28-9-13	2.0	0	0	0	0	0	0
Total	634.90	33	41	45	46	51	58

Effect of soil working techniques on available Nitrogen loss (kg ha^{-1}), Phosphorus loss (kg ha^{-1}) and Potassium loss (kg ha^{-1}) under silvipastoral system

It is evident form the Figure 2, that the lowest available nitrogen loss (1958.04 Kg/ha) was recorded under continuous contour, closely followed by small ridge ditch (1958.58Kg/ha) while, highest available nitrogen loss (2409.13 Kg/ha) was recorded under pit planting. Figure 3, reveals that lowest available phosphorus loss (40.24 Kg/ha) was recorded under continuous contour which is closely followed by small ridge ditch technique (41.32 Kg/ha). Whereas, It was highest (49.33 Kg/ha) under pit planting. Figure 4, indicates that lowest available potassium loss (58.73 Kg/ha) was recorded in small ridge ditch technique closely followed by continuous contour (59.55 Kg/ha). Whereas, it was recorded highest (74.42 Kg/ha) under pit planting technique. Similar results were obtained by Krishna *et al.* (2009) [5] and Garcia *et al.* (1997) [3], they reported that nutrient losses by runoff depends upon different factors such as topography, land use, soil properties, weather conditions, particularly rainfall intensity, duration and in some cases it is also influenced by the intensity of rainfall.

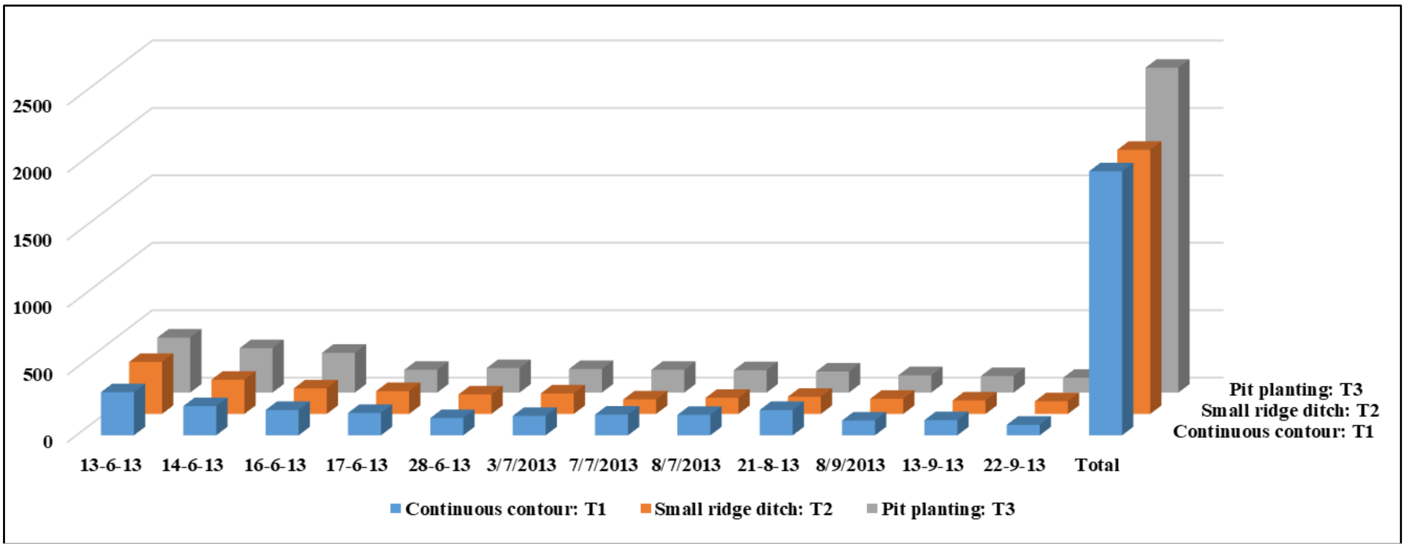

Fig 2: Effect of different soil working techniques on available Nitrogen loss (kg ha^{-1}) in sediment under silvipastoral system

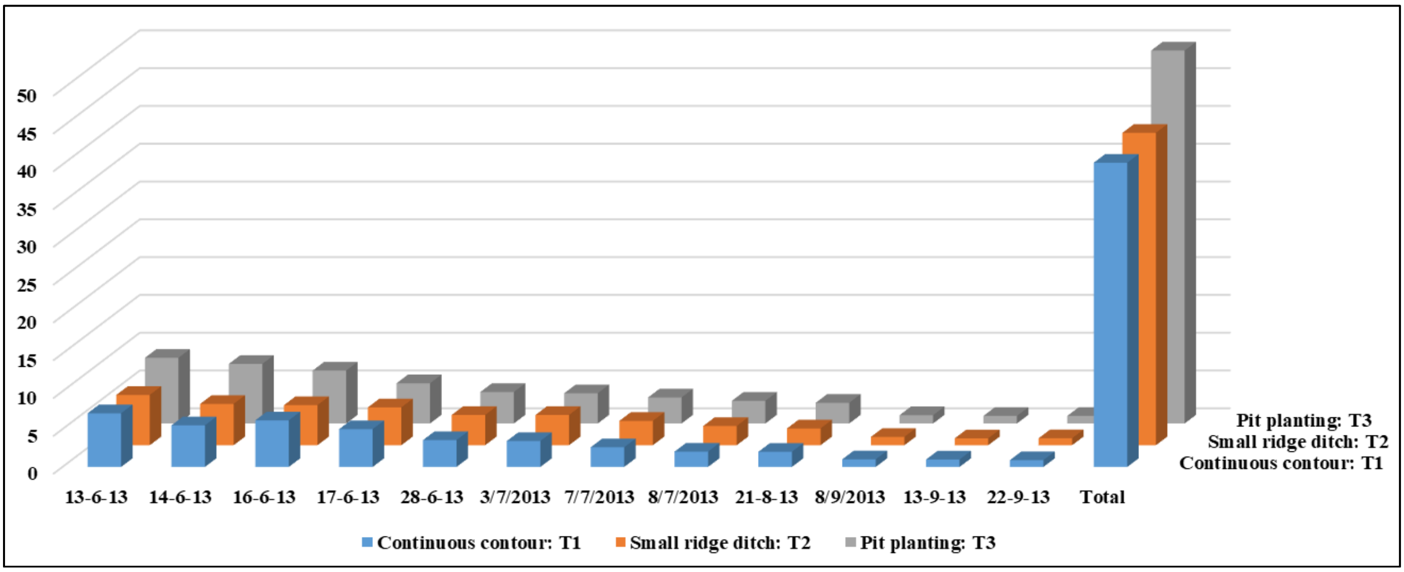

Fig 3: Effect of different soil working techniques on available Phosphorous loss (kg ha^{-1}) in sediment under silvipastoral system

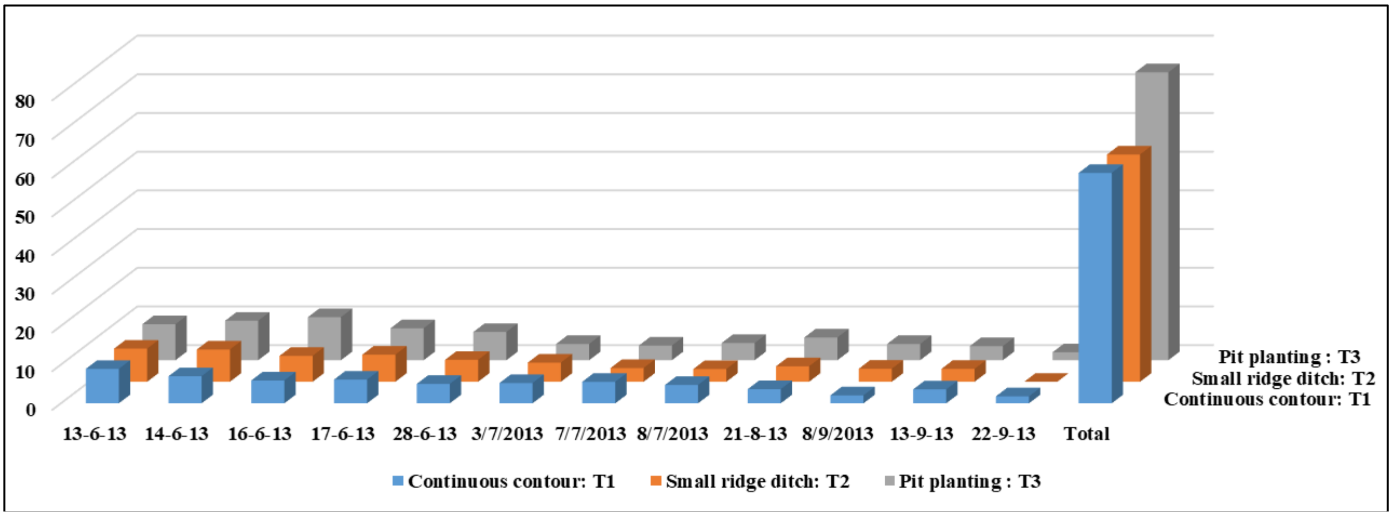

Fig 4: Effect of different soil working techniques on available Potassium loss (kg ha^{-1}) in sediment under silvipastoral system

Conclusion

Continuous contour depicted least runoff rates as compared to small ridge-ditch and pit planting. Similarly soil and nutrient losses were recorded lowest in continuous contour as compared to small ridge-ditch and pit planting. However potassium loss was slightly decreased in small ridge-ditch, whereas all other values against nutrient losses were favoured in continuous contour. Therefore continuous contour (T1 soil working technique) is recommended for stabilization of degraded hilly slopes.

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References

1. Anonymous. State forest report released by Govt. of India 1989, 3.
2. Anonymous. Agricultural Statistics at a glance. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi 2000.
3. Garcia Rodeja, I Gil, Sotres F. Prediction of parameters describing phosphorus-desorption kinetics in soils of Galicia (northwest Spain). Journal of Environmental Quality 1997;26:1363-1369.
4. Gomez KA, Gomez AA. Statistical procedures for agricultural research. (2nd Ed), John Wiley and sons. New York 1983, 680 p.
5. Krishna R, Tiwari Bishal K, Situala Roshan, Bajacharya M, Borresen T. Effects soil and crop management practices on yields, income and nutrient losses from upland farming systems in the Middle Mountains region of Nepal.Nurt cycl Agroecosyst 2009. Doi 10. 1007/s10705-009-9289-0.
6. Merwin HW, Peech PM. Exchangeability of soil potassium in the sand by nature of complementary exchangeable cation. Proceedings of Soil Science Society of America 1951;15:125-128.
7. Misri B. Forage production in alpine and subalpine regions of north-west Himalayas. In. Punjab S (ed). Pasture and forage crop research: A state of knowledge report R. M. S. I Jhansi 1988, 43-55.
8. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus by extraction with sodium bicarbonate, United States Department of Agriculture. Citric 1954, 939.
9. Singh KA. Studies on forage production, soil binding capacity of grasses and changes in soil properties on the terrace risers. Range Management and Agroforestry 2005;26(2):113-115.
10. Subbiah BW, Asija GL. Rapid procedure for estimation of available nitrogen in soils. Current Science 1956;25:259-260.
11. Tian G, Wang F, Chen Y. Effect of different vegetation system on soil erosion and soil nutrient in red soil region of south eastern China. Pedosphere 2003;13(2):121-128.
12. Zheng H, Fang S, Yang J, Zhang H, Wang B, Mo M, *et al*. Reduction effects of three garden types on runoff, sediment and nutrient loss in the red soil hilly region China. Journal of Food and Environment 2012;10(3-4):1301-1307.