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Impact of watershed initiatives on soil properties of selected micro-watersheds in Nalagarh Block of District Solan of Himachal Pradesh

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Abstract
The study entitled "Impact of watershed initiatives on soil properties of selected micro-watersheds in Nalagarh Block of District Solan of Himachal Pradesh" was conducted to evaluate integrated watershed management programme (IWMP-II) covering an area of 6947 ha in Nalagarh Block of Solan District of Himachal Pradesh. Three micro-watersheds namely Badhokhari (1A2A2O2c), Baila (1A2A2O2b) and Matuli (1A2A2O1c) of Kawaj Khad sub-catchment with an area of 2276 ha were randomly selected from six micro-watersheds of IWMP-II to assess the impact of watershed interventions after one year completion of project on fertility status. Soils in the micro-watersheds were slightly acidic to slightly alkaline in reaction, low to medium in OC, low in available N, high in available P and medium in available K. The nutrient index of OC was medium (<1.88) and that of available N, P and K was found to be in low (1), high (3) and medium (2) categories, respectively. The present study is helpful in ecological, biological, socio economic aspects of the area.

Keywords: Soil properties, watershed, catchment etc.

Introduction
A watershed refers to an area of land that comprises a set of streams or rivers that drains into a larger water body like an ocean or a river. The Government of India (GOI) has adopted watershed management as a strategy to address the sustainable agricultural productivity in the rainfed areas. Watershed development by conserving natural resources has the potential to create conditions conducive to higher agricultural productivity (Wani *et al.* 2001) [10]. About 60% of total arable land (142 m ha) in India is rainfed, characterized by low productivity, degraded natural resources, low income, low employment with high incidence of poverty and a bulk of fragile and marginal lands (Joshi *et al.* 2008) [2]. The hill state of Himachal Pradesh has an area of 55,673 km^2 constituting 1.7% of the country's total geographic area. About 90% population of the state is settled in rural areas, which is dependent directly on natural resources. The state has 82% of its area under rainfed conditions and the watershed constitutes the most suitable approach of development for such areas. The evaluation and impact assessment of the watershed development interventions on soil health could be helpful in suggesting appropriate changes or corrective measures required to be incorporated in the implementation of similar watershed development interventions in future and improving their quality so that the gains remain sustainable over a long period of time. Keeping this in view, the present study entitled 'Impact of watershed initiatives on soil properties of selected micro-watersheds in Nalagarh Block of District Solan of Himachal Pradesh.' was carried out.

Material and Methods
The present investigation entitled "Impact of watershed initiatives on soil properties of selected micro-watersheds in Nalagarh Block of District Solan of Himachal Pradesh" was conducted to study soil samples of villages of the three micro-watersheds Four, 3 and 3 villages were randomly selected in Badhokhari, Baila and Matuli micro-watersheds, respectively. From each sampled village of three micro-watersheds, four sites were randomly selected and from each site one soil sample were taken from 15 cm depth and collected samples represented the whole village. A total of 40 soil samples were collected, out of which 16, 12 and 12 were from Badhokhari, Baila and Matuli micro-watersheds, respectively.

The soil samples were processed i.e. dried in shade and then ground in a wooden pestle and mortar, passed through 2 mm sieve and stored in glass bottles for subsequent analysis. Methods followed for the analysis of soil followed are given in the Tables 1

Table 1: Methods followed for the analysis of soil samples.

Parameter	Method and References
pH	1:2 soil water suspension and measured with the help of digital pH meter (Jackson, 1973) [1]
Organic carbon	Walkley and Black rapid titration method (Walkley and Black,1934) [9]
Available N	Alkaline potassium permanganate method (Subbiah and Asija, 1956) [8]
Available P	Extracted by Olsen's Method (Olsen *et al.*, 1954) [5] and determined by $SnCl_2$ reduced molybdate phosphoric acid blue colour method (Jackson 1973) [1]
Available K	Ammonium acetate method (Merwin and Peach, 1951) [3]

Nutrient index

Nutrient index (NI) used for organic carbon and available NPK was calculated by formula developed by Parker *et al.* (1951) [5] and later on modified by Motsara (2002) [4] as given below:

$$\text{Nutrient Index (NI)} = \frac{Nl + 2Nm + 3Nh}{Nl + Nm + Nh}$$

Where,

Nl, Nm and Nh is the number of samples in low, medium and high categories of available nutrients, respectively.

Result and Discussion

The results from the present study reveal that in Table 2, the fertility status of the soils of the micro-watersheds has been shown where all soils in the micro-watersheds were found slightly acidic to slightly alkaline in reaction and pH varied from 6.82 to 7.21, 6.80 to 7.20 and 6.70 to 7.18 Badhokhari, Baila and Matuli micro-watersheds, respectively. The range of soil pH recorded in the micro-watersheds is ideal for growing variety of cereals fruits and vegetable crops and availability of most of the macro and micro-nutrient elements.

Table 2: Fertility status of soils in different micro-watersheds

Parameters	Micro-watersheds	No. of samples	Range	Mean (SD +)	C.V. (%)	Percent of samples by category (%)			Nutrient index
						Low	Medium	High	
Organic carbon (%)	Badhokhari	16	0.45- 0.90	0.72(0.07)	9.72	12.5	87.5	-	1.88
	Baila	12	0.43 -0.86	0.68(0.11)	16.18	16.67	83.33	-	1.83
	Matuli	12	0.42-0.89	0.66(0.07)	10.61	16.67	83.33	-	1.83
Available N (kg ha^{-1})	Badhokhari	16	194.5- 229.6	210.1(4.63)	2.21	100	-	-	1
	Baila	12	185.4- 223.7	203.6(10.44)	5.13	100	-	-	1
	Matuli	12	185.3- 218.3	201.3(9.65)	4.80	100	-	-	1
Available P (kg ha^{-1})	Badhokhari	16	29.7 -37.2	32.2(1.15)	3.56	-	-	100	3
	Baila	12	26.9- 35.9	32.1(0.86)	2.73	-	-	100	3
	Matuli	12	26.4- 34.7	31.9(0.85)	2.65	-	-	100	3
Available K (kg ha^{-1})	Badhokhari	16	282.9- 324.2	306.1(4.35)	1.42	-	100	-	2
	Baila	12	272.7- 318.8	301.3(8.04)	2.67	-	100	-	2
	Matuli	12	275.1 -310.7	296.8(2.84)	0.96	-	100	-	2
pH	Badhokhari	16	6.82-7.21						
	Baila	12	6.80-7.20						
	Matuli	12	6.81-7.26						

Organic carbon (OC) content varied from 0.45 to 0.90, 0.43 to 0.86 and 0.42 to 0.89% in Badhokhari, Baila and Matuli micro-watersheds, respectively. Highest OC was found in Badhokhari micro-watershed (0.90%) and lowest in Matuli micro-watershed (0.42%). The soils were found to be low and medium in OC having 12.5, 16.67 and 16.67% soils in low category; 87.5, 83.33 and 83.33% in medium category in Badhokhari, Baila and Matuli micro-watersheds, respectively. Soils were low to medium in OC having 12.5, 16.67 and 16.67% samples in low category and 87.5, 83.33 and 83.33% in medium category in Badhokhari, Baila and Matuli micro-watersheds, respectively (Table 2). Majority of the watershed soils (>80%) have moderate OC contents and need to be supplemented with recommended dose of farm yard manures to improve their OC contents as well as Physico-chemicals properties.

Available N contents varied from 194.52 to 229.6, 185.4 to 223.7 and 185.4 to 218.3 kg ha^{-1} in Badhokhari, Baila and Matuli micro-watersheds, respectively. Highest available N was found in Badhokhari micro-watershed (229.6 kg ha^{-1}) and lowest (185.3 kg ha^{-1}) in Matuli micro-watershed. As per the critical limit, all soils were classified as low in available N contents in all micro-watersheds. Available N supply was low in all the micro-watersheds and this could be due to intensive cultivation and higher leaching losses in coarse texture soils of micro-watersheds. So, to maintain optimum supply of N, the recommended dose of N fertilizers for a crop needs to be increased by 25%.

Available P contents varied from 29.7 to 37.2, 26.9 to 35.9 and 26.4 to 34.7 kg ha^{-1} in Badhokhari, Baila and Matuli micro-watersheds, respectively. Highest available P was found in Badhokhari micro-watershed (37.2 kg ha^{-1}) and lowest (26.4 kg ha^{-1}) in Matuli micro-watershed. All soils were classified as high in available P contents in all micro-watersheds. Available P status was high in all the micro-watersheds which might be due to accumulation of fertilizer P

in the surface soils because of its low mobility. So, recommended dose of P fertilizers for crops could be reduced by 25%.

Available K contents varied from 282.9 to 324.2, 272.7 to 318.8 and 275.1 to 310.7 kg ha^{-1} in Badhokhari, Baila and Matuli micro-watersheds, respectively. Highest available K was found in Badhokhari micro-watershed (324.2 kg ha^{-1}) and lowest (272.7 kg ha^{-1}) in Baila micro-watershed. All soils were classified as medium in available K contents in all micro-watersheds. Available K status was medium in all the soils. So, the potassic fertilizers should be added as per recommendations for the crops to be grown in the micro-watersheds.

Nutrient index (NI) was found medium for OC, available N and K while it was high for available P in all micro-watersheds. Nearly 12.5 and 87.5% soils in Badhokhari micro-watershed, 16.67 and 83.33% in Baila and Matuli micro-watersheds, were classified as low and medium in OC contents with NI of 1.88, 1.83 and 1.83 in Badhokhari, Baila and Matuli micro-watersheds, respectively. Nutrient index was found to be low, high and medium for available N, P and K with index values of 1, 3 and 2 in Badhokhari, Baila and Matuli micro-watersheds respectively The nutrient index (NI) of OC was medium (<1.88) and that of available N, P and K was found to be in low (1), high (3) and medium (2) categories, respectively (Table 2). Sharma and Chaudhary (2007) [7] also found similar results in their studies in Mandhala watershed in District Solan of Himachal Pradesh.

Conclusion

Impact assessment of soil fertility status in three micro-watersheds indicated that soils were slightly acidic to slightly alkaline in reaction (nearly neutral), low to medium in OC in Badhokhari, Baila and Matuli micro-watersheds, respectively. All soils of these micro-watersheds were low in available N, high in available P and medium in available K. The nutrient index (NI) of OC was medium (<1.88) and that of available N, P and K was found to fall in low (1), high (3) and medium (2) categories, respectively. The present study can be utilized to work in other watersheds so that the soil fertility status of the soil can be founded and utilized to increase the socio economic status of farmers.

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