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Analyzing the water harvesting potential and its maximization by the application of clayey dressing in Qargha Reservoir Watershed, Kabul, Afghanistan

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Absract A small area of 2 ha was selected in suitable areas. Based on 16 rainfall events, the volume of surface runoff estimated by the rational method was 509.40 m^3, which was larger than the 478.34 m^3, estimated by the sorptivity method. After clayey dressing application, the estimated volume of surface runoff based on the rational method increased to 1392.36 m^3. Furthermore, the estimated volume of surface runoff after clayey dressing calculated with the sorptivity method increase to 1608.46 m^3 based on 16 rainfall events.

Background Surface runoff harvesting is becoming more popular in regions with an arid-semi-arid climate, such as Afghanistan because of the increasing demand for scarce water resources (Amu-Mensah, 2013). As a semi arid region, crops in the study area need regular irrigation due to low and unequally divided annual rainfall throughout the growing season. Irrigation water shortage during the latter half of the growing season is a serious problem causing crop failure and low productivity in the study area. The result of a survey carried out by Rahmani and Mihara (2017), showed that 83% of the farmers in the Qargha Reservoir Watershed have an irrigation water shortage, and 66% of the farmers severely face it, especially in the latter half of the growing season.

Objectives To analyze the water harvesting potential, and to evaluate the effectiveness of clayey dressing application in maximizing surface runoff compared to control conditions

Methodology A small area of 2 ha was selected in suitable areas. Rational method and sorptivity method were used to estimate the potential surface runoff and clayey dressing (silty clay loam (SCL) and clay loam (CL)) was applied as a conservation strategy. The experiments were conducted in the laboratory and in the field

$S=1/2\times R_i^{-1/2}\times K_{sat}^{-1/2}\times[Sp(\theta)]^2$	$Q=C\times P\times A$
S is the maximum potential retention, Sp() is soil sorptivity, K_{sat} is saturated hydraulic conductivity, R_i is rainfall intensity and is initial moisture content.	Q is direct runoff (m^3), C is the rational runoff coefficient, P is the rainfall amount (m) and A is area (m^2).

Results and Discussion SCL treated soil at 46.4, 52.3 and 56.9 cg g^{-1} increased runoff at 1.16x, 1.28x and 1.3x, While, treated with clay loam at 52.1 60.1 and 64.9 cg g^{-1} increased runoff at 1.27x, 1.41x and 1.42x compared to control.

In the field, Deh Ponba soil treated with clayey dressing at 57.7 and 64.9 cg g^{-1} increased runoff by 1.41x and 1.42x, and Doda Mast soil increased runoff by 1.55x and 1.58x compared to control.

Conclusion The result showed that Qargha Reservoir Watershed has the water harvesting potential. **So, it** was concluded that the application of clayey dressing onto the soil surface was highly effective in surface runoff inducement . Additionally, statistical analysis indicated that there were significant differences between the surface runoff volume from clayey dressed and that from control ($p>0.01$).

Table Surface runoff water under different treatments (Laboratory)

Clayey dressing	Dry density g cm^3	Treatment cg g^{-1}	Water applied (dm^3)	Runoff (dm^3 m^{-2})	Infil. (dm^3 m^{-2})	Runoff (C)	Increase from control (x)
SiCL	1.3	Control	12.96	9.70 a**	3.20	0.75	
		46.4	12.96	11.24 b**	1.68	0.87	1.16
		52.3	12.96	12.45 b**	0.50	0.96	1.28
		56.9	12.96	12.62 b**	0.00	0.97	1.30
CL	1.5	Control	12.96	8.68 a**	3.82	0.67	
		52.1	12.96	11.04 c**	1.55	0.85	1.27
		60.1	12.96	12.20 b**	0.00	0.94	1.41
		64.9	12.96	12.38 b**	0.00	0.95	1.42

CL = Clay loam dressing, SiCL = Silty clay loam dressing, C= Coefficient
**denotes significance difference level at P<0.01

Table Surface runoff field experiments

Site	Treatment cg g^{-1}	Water applied (dm^3)	Runoff (dm^3 m^{-2})	Runoff (C)	Increase from control (x)
Deh Ponba	Control	45.0	27.7 a**	0.62	
	SiCL 57.7	45.0	39.2 b**	0.87	1.41
	SiCL 64.9	45.0	39.5 b**	0.88	1.42
Doda Mast	Control	45.0	25.3 a**	0.56	
	SiCL 57.7	45.0	39.2 b**	0.87	1.55
	SiCL 64.9	45.0	39.5 b**	0.88	1.58

SiCL = Silty clay loam dressing
**denotes significance difference level at P<0.01