INDIAN NATIONAL COMMITTEE ON SURFACE WATER (INCSW-CWC)

UID	**HP-2009-100**
Type (State whether final or draft report)	**Final**
Name of R&D Scheme	**Augmentation of water resources through water harvesting in hilly areas**
Name of PI & Co-PI	**Er. Ghanshyam Agrawal, Assistant Professor (Agricultural Engg.)**
Institute Address	**Dr Y S Parmar University of Horticulture & Forestry, Nauni – Solan (Himachal Pradesh)**
Circulation (State whether Open for public or not)	**Open**
Month & Year of Report Submission	**January, 2020**

Central Water Commission

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1. Name and address of the Institute: Dr. Y.S Parmar University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh)

2. Name and address of the PI and other investigators:

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3. Project title: Augmentation of water resources through water harvesting in hilly areas

4. Financial details: Sanctioned Cost: Rs. 42,51,020 and **Revised Cost:** Rs. 35,78,658

(i) Amount released: Rs. 29,22,778 (Grant Rs. 28,45,000 + Interest 77,778)

(ii) Expenditure: Rs. 29,22,088

(iii) Unspent balance (if any): Rs. 690

(iv) Return of unspent balance: Yes

5. Original objectives and methodology as in the sanctioned proposal

Objectives:

1. To refine and demonstrate technology of roof rain water harvesting at farmers field.
2. To harvest stream flow for increasing irrigation potential and increasing spring recharge.

The project will be executed at farmer fields at Village Pandah nearby the Dr. Y.S Parmar University of Horticulture and Forestry. For roof top rain water harvesting the buildings of Pandah village has been selected and for surface runoff harvesting as well as to recharge ground water the University farm area and farmers of field village has been selected for this purpose. The objective wise methodology is given below:

Objective 1: To refine and demonstrate the technology of roof rain water harvesting at farmers field

The annual average rainfall of the proposed project area is 1100 mm. Seventy (70) per-cent of which occurs during monsoon period, 18 per cent during winter season and the rest is scattered during other months of the year. As such during the months of April and May and first fortnight of June, October and November every year the drought like conditions prevail in the area especially during summer months when discharge of springs is also drastically reduced and virtually no water is available for irrigation and sometimes even for domestic use and the

harvested water will be used for providing life saving irrigations to the high value crops otherwise the crops are likely to be damaged completely due to prevailing water stress problem. Hence, it will be worthwhile and economical to go for roof top water harvesting. The representative study area lies in mid hill zone having undulating topography where as such no ground water table is available. The underground water is available in sandwitched form among the fragmented rocks and a part of which is available in the form of natural springs, which often dries in April-June months and October-December and this period is critical for sowing of crops, flowering and seed/fruit setting and resulting into reduction in productivity.

The area has sufficient volume of rain water especially during monsoon which can be directly used for irrigation and ground water recharging by roof water harvesting with minimum losses. It is proposed to have rain water harvesting from roof top of 18 buildings of Pandah village nearby to the University having roof top area about 1304.0 m^2. The harvested water from each building will be carried through PVC pipes to collection chamber and finally will be stored in the four different tanks having capacity 2.0, 1.2, and 0.4 lakh liters. As it is a new scientific approach and will be demonstrated to orchardists and farmers of the state for adoption and implication. The Pandah village will be developed as a model village for the roof top water harvesting.

The availability of rain water through roof harvesting can be derived using formula

$Y = f \times A \times R / 1000$

Where,

Y -= Yield

f = co-efficient of run-off depending upon the surface of roof top (0.8)

A = area of roof top (m^2)

R = rainfall (mm)

Total roof top area = 1304.0 sq. m

Potential of rainwater to be store water during monsoon =573 cu.m.

Two different type (RCC and poly lined tank) water storage structure will be constructed to compare the cost benefit ratio and their feasibility in hilly areas.

Objective 2: To harvest stream flow for increasing irrigation potential

This objective will be achieved by having nala bundhan, plantation, constructing percolation tanks and trenches. The surface runoff harvested by constructing percolating type farm pond, LDPE lined farm ponds, check dam, loose stone check dam, constructing trenching

and plantation. The nala bundhan structures will depend on slope and site characteristics. It is also proposed to increase infiltration of rain water through vegetative barriers erected through the plantation of shrubs and trees. The study area is having soil with majority of silty loam (88 %) followed by gravelly loam (8%) and sandy loam (4%). The area has step slope 10-50 percent and land are moderately to severe eroded with shallow depth. The area is under scattered vegetation of grasses and forest. The vegetable and fruit crops are commonly found in cultivated land.

This objective will be achieved by executing following treatment in the catchment of two Nalas on both sides of Pandaha village. The area to be treated under stream-1 will be 20 ha and under stream-2 will be 16 ha.

Name of the treatment	Stream/catchment- 1	Stream/catchment- 2
Trenches (m)	250	250
Gabion structure (no.)	2	2
Loose boulder check dam	8	8
Plantation (Trees and shrubs) ha	1	1
LDPE farm pond	2	1
Percolation tank (no.)	5	5

The nala bundhan structures will depend on slope and site characteristics. It is also proposed to increase infiltration of rain water through vegetative barriers erected through the plantation of shrubs and trees. The study area is having soil with majority of silty loam (88%) followed by gravelly loam (8%) and sandy loam (4%). The area has steep slope (10-50%) and land are moderately to severe eroded with shallow depth. The area is under scattered vegetation of grasses and forest. The vegetable and fruit crops are commonly found in cultivated land.

Of the total rainfall, 50 per cent goes downward as surface runoff (500 mm), 70 per cent of which occur in rainy season, out of 350 mm can be stored during monsoon and 150 mm during winter months. The location, design and capacity of water harvesting structure and their number has been decided on peak runoff rate during month of August. The peak runoff rate calculated using rational formula and design of structure has been decided on the basis of peak runoff rate.

i) Utilization of stored water to increase irrigation potential:

The available stored water achieving from both objective will be used by farmers and some department of the University for high value crops commonly grown in the area like off season capsicum, cauliflower, tomato, broccoli and fruits like plum, peach, apricot etc. and nursery.

ii) Observation /data to be recorded: Objective wise observation to be recorded

Objective -1

Total rainfall, quantum of water harvested from each building, total water harvested, chemical and biological analysis of harvested water, area expansion, shift in cropping pattern.

Objective -2

Runoff rate and its total volume from the catchment, peak stream flow/runoff, sedimentation under different treatment, plantation – survival rate and coverage, ground water recharge- infiltration and monitoring of discharge of some selected natural springs. Feasibility on diversion and storage of stream flow in LDPE lined pond, expansion of area and shift in crop and their yield and monitoring of natural springs by measuring its discharge regularly.

6. Any changes in the objectives during the operation of the scheme

Objective – 1 (To refine and demonstrate the technology of roof rain water harvesting at farmers field) was omitted due to duplication of activity as per discussed during the 10th R&D session of INCID on the construction of roof top water harvesting structures under ongoing R&D Scheme entitled "Augmentation of water resources through water harvesting in hilly areas" and vide letter no. INCID/SC-II/2006/640 dated 15.11.2012 (Copy of letter is attached in Appendix – I). Hence, construction of roof rain water harvesting structures were not undertaken.

7. All data collected and used in the analysis with sources of data:

All required primary and secondary data were collected and analyzed during the course of study for completing approved objectives of the project. The methodology actually followed for taking observations, analysis of data, preparation and inferences of results. Field activities including plantation, construction of trenches, percolation ponds, loose boulder check dams, gabion structures, LDPE farm ponds etc. and the observations were taken. Results were prepared from the analysis of data, which is observed or measurement in the field.

8. Results and Discussion

8.1 Soil analysis:

Soil samples from 0-15 and 15-30 cm soil depths were collected from different land use systems in the project area and analyzed for various chemical properties by using standard procedures / methods as given in **Table 1** and results obtained from the analysis are shown in **Table 2**.

Table 1 Standard Methods used for determination of chemical properties of soil

Sr. No.	Parameters	Method	Reference
1	Power of Hydrogen (pH)	1:2 soil water suspension and measured with the help of digital pH	Jackson (1973)
2	Electrical Conductivity (EC)	1:2 soil water suspension and measured with the help of digital EC meter	Jackson (1973)
3	Organic Carbon (OC)	Walkley and Black wet digestion method	Walkley and Black (1934)
4	Nitrogen (N)	Alkaline potassium Permanganate method	Subbiah and Asija (1956)
5	Phosphorus (P)	0.5 M Sodium Bicarbonate extractant method	Olsen et al. (1954)
6	Potassium (K)	Ammonium acetate method	Merwin and Peech (1951)

Table 2 Chemical properties of soil under different land use in the project area

Land use	Soil Depth (cm)	pH	EC (dSm^{-1})	OC (%)	N ($Kg\ ha^{-1}$)	P ($Kg\ ha^{-1}$)	K ($Kg\ ha^{-1}$)
Cultivated Land	0-15	7.1	0.21	0.81	255.1	38.1	218.9
	15-30	6.9	0.18	0.76	230.1	27.4	190.4
Newly Formed Land	0-15	7.0	0.12	0.75	241.6	30.2	200.8
	15-30	7.0	0.12	0.70	230.1	29.1	198.1
Chir pine Forest	0-15	6.5	0.09	1.00	360.1	36.4	210.1
	15-30	6.3	0.08	0.88	300.0	28.3	170.1
Scrub Forest	0-15	6.7	0.08	0.98	300.0	32.2	206.5
	15-30	6.5	0.06	0.80	270.5	26.1	161.8
Fruit Orchard	0-15	7.2	0.19	0.30	340.5	41.1	220.6
	15-30	7.1	0.16	0.98	280.1	38.5	198.6
Steep Slope	0-15	5.7	0.01	0.25	45.8	8.1	110.6
Fallow land	0-15	6.8	0.06	1.01	340.8	26.2	199.5
	15-30	6.6	0.05	0.81	299.9	22.1	168.6
Bhajo-Pond	0-15	6.8	0.08	0.72	268.4	30.3	198.4
	15-30	6.8	0.05	0.71	260.1	28.4	190.6

Except from steep slopes, soils were, in general, neutral in pH, low in electrical conductivity, medium to high in organic matter, medium in available N & K and high in available P content.

8.2 Water analysis:

Analysis of water samples from bouries and tanks in the project area have been carried out for different bio-chemical properties by using standard methods as given in **Table 3** and results are shown in **Table 4**. The values of pH and EC ranged from 6.95-7.68 and 0.40-0.68 dSm^{-1}, respectively. Pertinent value for chemical oxygen demand (COD) varied from 20.0 - 70.0 mg $litre^{-1}$. Samples were well within the limits suitable for drinking and irrigation purpose i.e. <150 mg $litre^{-1}$.

8.3 Plantation:

A total of 1700 plants of different species have been planted at different locations in the study area. Out of which, 440 trees of *Grewia optiva* (Bihul) have been planted on bare land, *Cedrus deodara* (Deodar) and *Quercus* spp. (Oak) have also done on higher ridges (600+100=700 plants, respectively). *Salix spp.* (Biyunsh) has been planted to stabilize the stream bank (100 plants). In addition, 160 no. of morous, 200 no. of *robinia* spp. and 100 no. of bamboo plants were also planted **(Plate 1 and Plate 2)**. Deodar, oak and bamboo plantations were failed to establish due to fire incidence in the project area, however, Bihul and Salix plantations were established with the survival per cent of 40 and 30 per cent, respectively.

8.4 Trenches

The total no. of 193 staggered trenches having dimensions of L × W × H ranged from 6’ × 1.5’ × 1.5’ (0.4 m^3) to 15’ × 1.5’ ×2’ (1.3 m^3) with total water volume of 164.05 m^3 (1,64,050 L in one time) were dug out along the contour lines in the project area to reduce the velocity of runoff, increase the groundwater recharge and reduce soil erosion. The staggered trenches before and after rainfall and its impact on eroded area through regeneration of vegetation are shown in **Plate 3**.

Table 3 Standard Methods used for determination of chemical properties of water

Sr. No.	Parameters	Instrument/Method
1	pH (1:2)	Digital pH meter
2	Electrical Conductivity (EC)	Digital EC meter
3	Chemical Oxygen Demand (COD)	Titrimetric method (United States Environmental Protection Agency)

Table 4: Bio-chemical analysis of water samples collected from bouries and tanks in the project area

Location	No.	Bouri			No.	Tank		
		pH	EC (dSm^{-1})	COD (mg $litre^{-1}$)		pH	EC	COD (mg $litre^{-1}$)
Nando	1	7.68	0.55	40.0	1	6.95	0.65	40.0
	2	7.65	0.68		2	7.10	0.62	35.0
Oachhghat					1	7.15	0.48	20.0
Damrah	1	7.1	0.48	30.0	1	7.15	0.44	20.0
					2	7.00	0.54	30.0
Bhajo	1	7.51	0.60	45.0	1	7.08	0.61	40.0
					2	7.25	0.56	50.0
					3	7.10	0.55	45.0
Kharkog	1	7.26	0.53	60.0	1	7.40	0.48	70.0
					2	7.00	0.55	50.0
Phangari	1	7.35	0.61	65.0	1	7.25	0.51	70.0
					2	6.99	0.55	60.0
Bhag					1	7.25	0.40	50.0
					2	7.15	0.46	55.0
Pandah	1	7.48	0.51	40.0	1	7.20	0.66	30.0
	2	7.65	0.33	20.0	2	7.15	0.51	40.0
	3	7.09	0.53	30.0	3	7.04	0.48	30.0
					4	7.36	0.59	40.0

Plate 1: Plantation pit and Bihul plantation made in the project area

Plate 2: Plantation of Bamboo, Deodar and Oak in project area

Plate 3: Trenches (Staggered) made and its impact in the project area

8.5 Soil moisture conservation

The data on soil moisture content have been recorded at weekly intervals above and below the trenches.

It is evident from **Figure 1** and **Figure 2** that at a distance of 1m, soil moisture content below the trenches remained 0-3.7 per cent and 0.1-2.7 percent higher compared to moisture content above the trenches in year 2011-12 and 2012-13, respectively. The corresponding values ranged from 0-6.0 and 0.1-5.3 percent at 2m distance as shown in **Figure 3** and **Figure 4**.

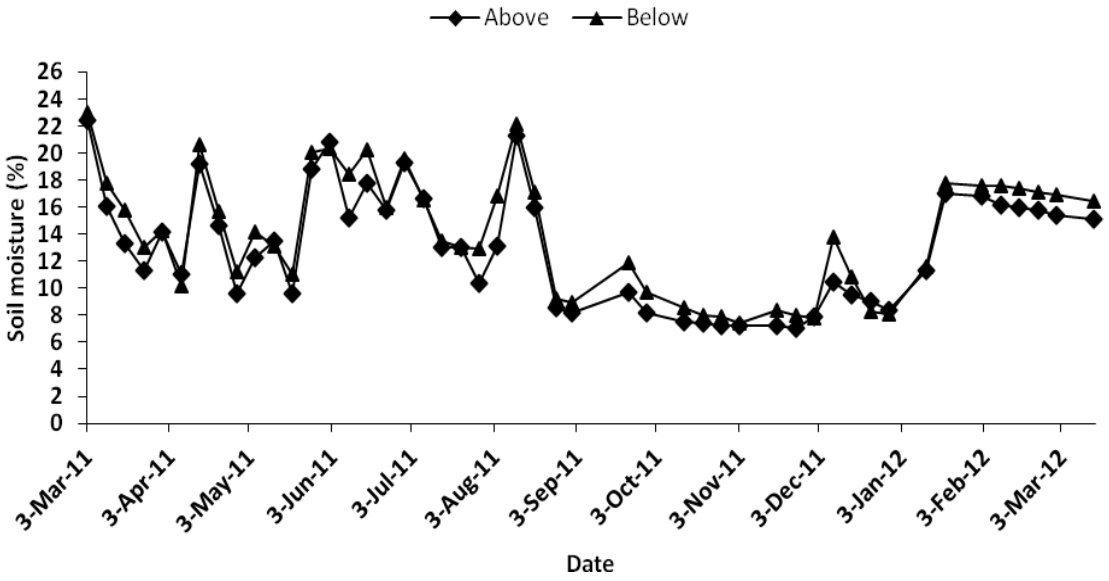

Figure 1: Soil Moisture below and above the trenches at 1m distance in year 2011-12

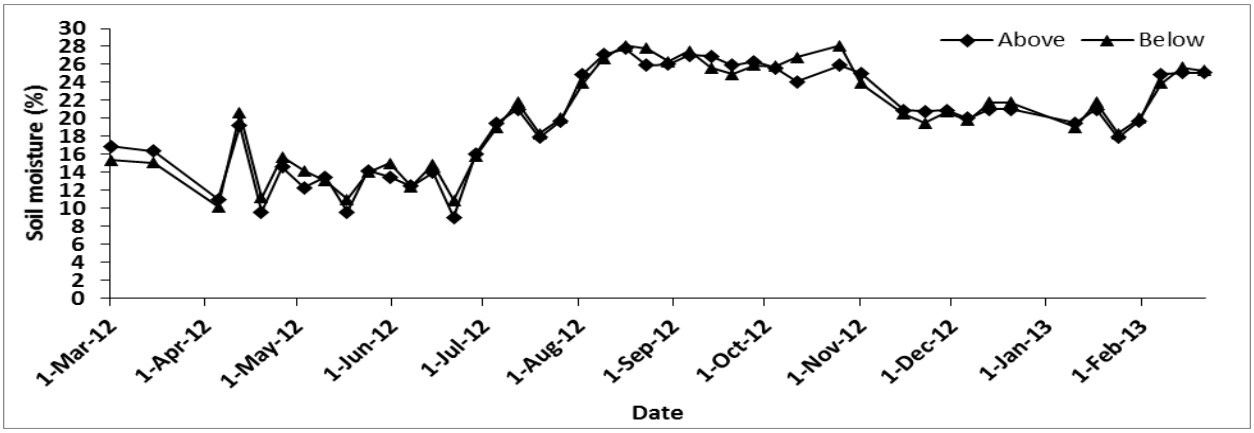

Figure 2: Soil Moisture below and above the trenches at 1m distance in year 2012-13

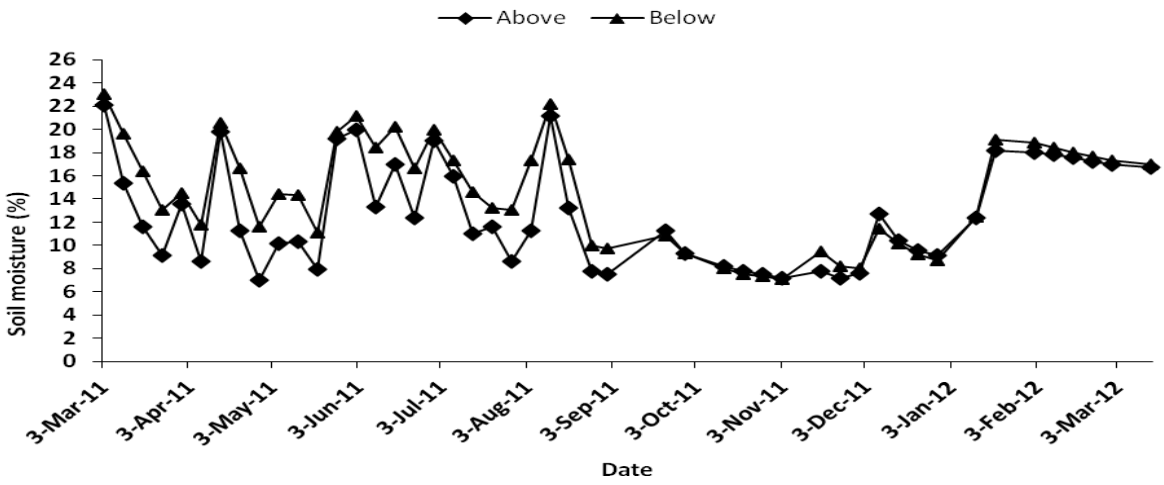

Figure 3: Soil Moisture below and above the trenches at 2m distance in year 2011-12

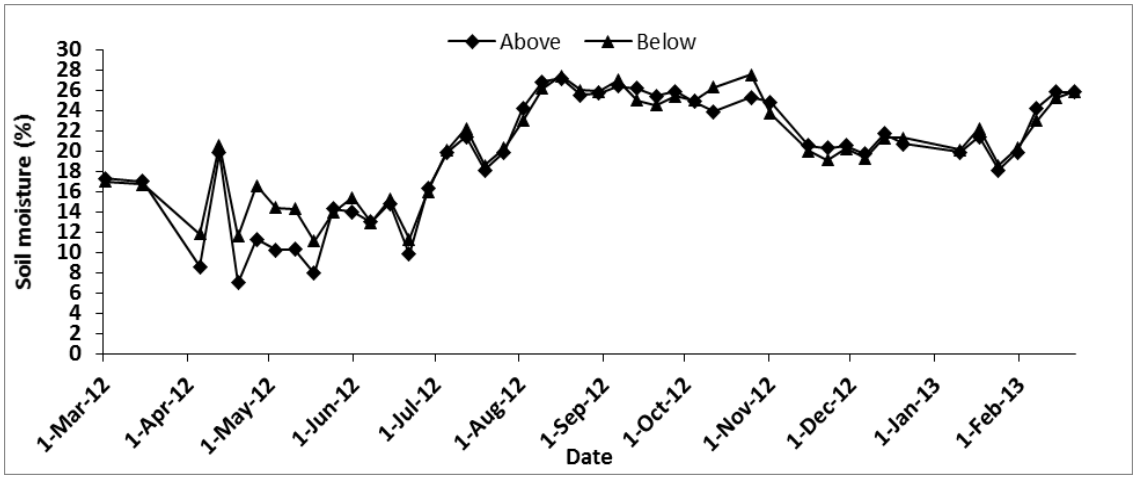

Figure 4: Soil Moisture below and above the trenches at 2m distance in year 2011-12

8.7 Rainfall – runoff analysis

The various meteorological data i.e. rainfall, maximum and minimum temperatures, evaporation are being measured by using standard instruments i.e. non recording rain gauge, maximum and minimum thermometers, pan evaporation respectively at the Meteorological Observatory, Department of Environmental Science, Dr Y S Parmar University of Horticulture & Forestry, Naini – Solan, Himachal Pradesh. **Figure 5** depicts that the highest values of mean maximum temperature (31.2 ^{0}C) and mean minimum temperature (19.8 ^{0}C) were observed in May and July months, respectively while the corresponding lowest values of 17.3 ^{0}C and 1.8 ^{0}C were observed in January month for the years 2011-2017 under the project area. About 70 percent (678 mm) rainfall were received during monsoon season w.e.f May – September months as shown in **Figure 6 & Figure 7**. By using Binnie's Table for runoff estimation, the mean runoff amount of 376 mm (38%) were estimated for years 2011-2017 for the project area as depicted in **Figure 8.**

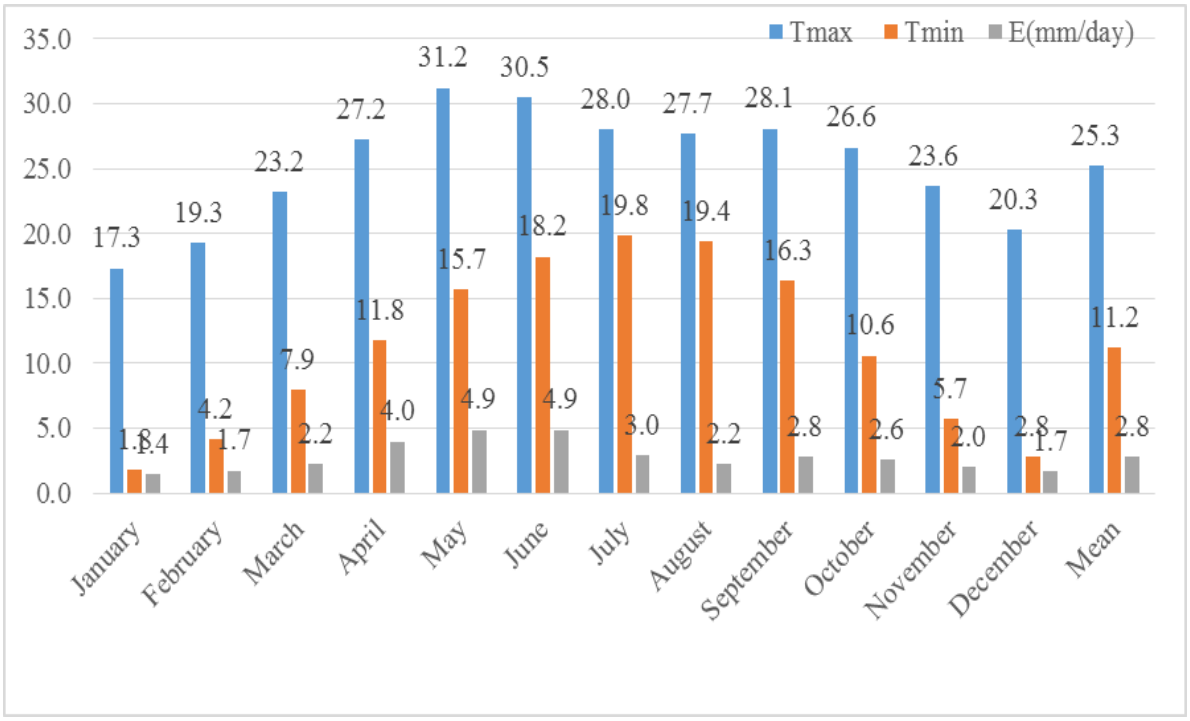

Figure 5: Monthly Trend of Maximum, Minimum Temperature and Evaporation rate during Year 2011-2017 for the project area

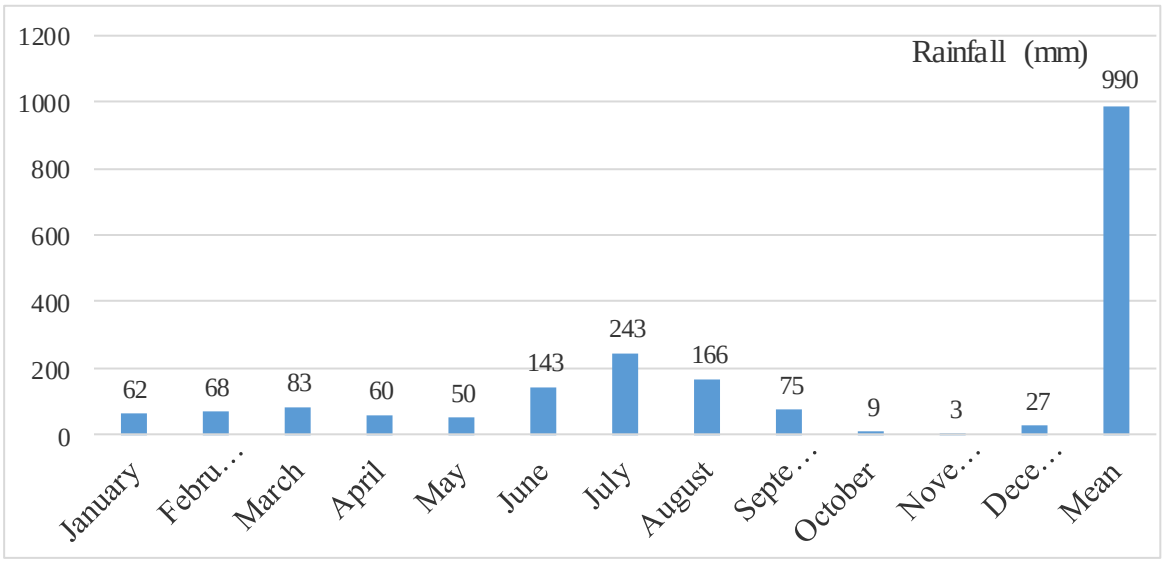

Figure 6: Monthly Trend of rainfall during Year 2011-2017 for the project area

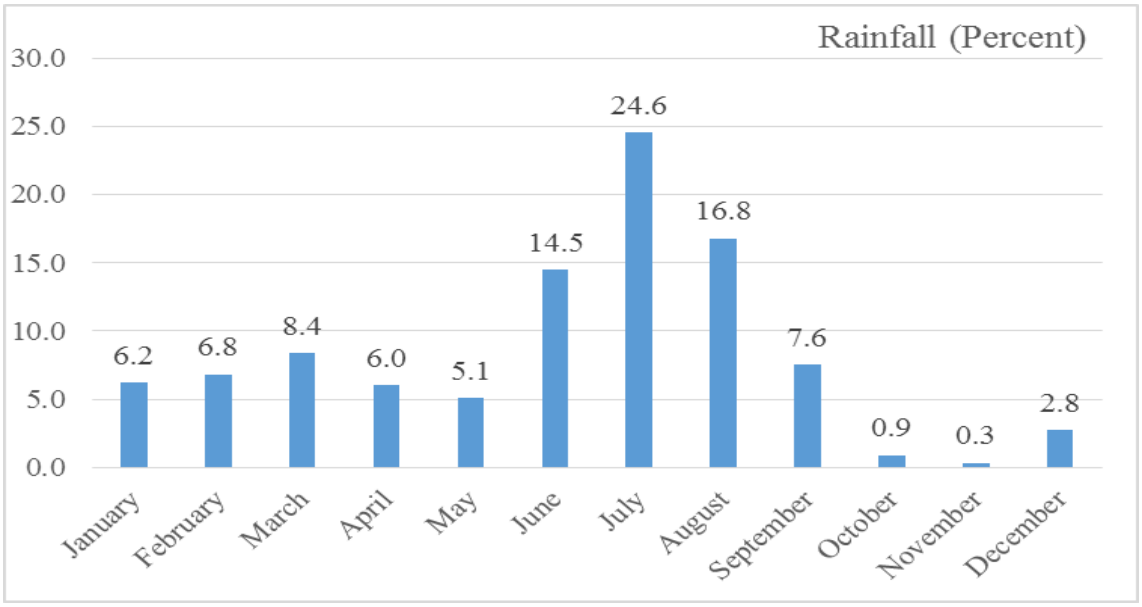

Figure 7: Percent distribution of rainfall over months during Year 2011-2017 for the project area

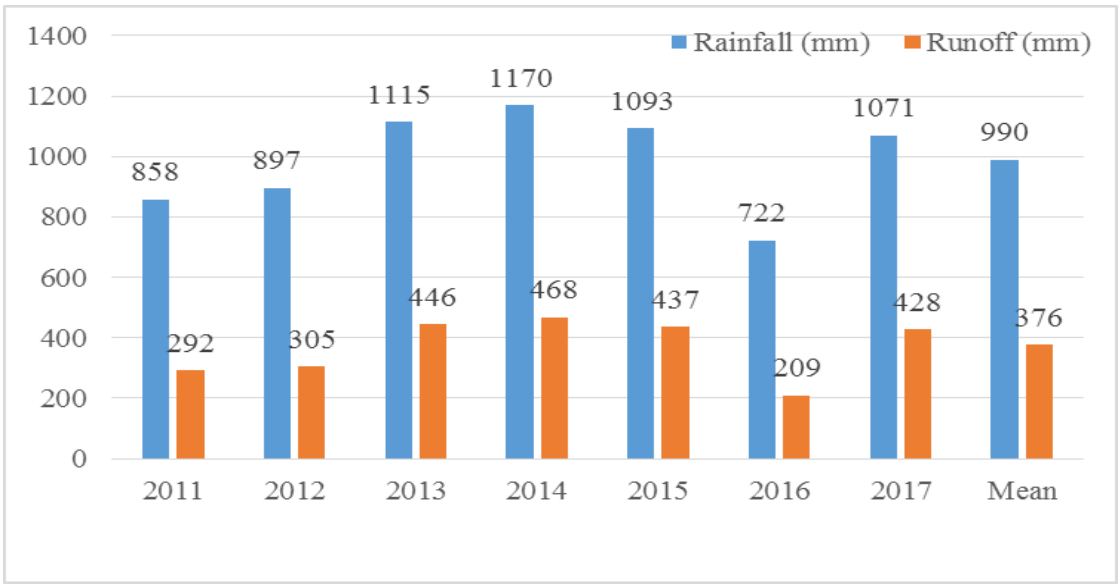

Figure 8: Annual trend of rainfall and runoff during Year 2011-2017 for the project area

The fluctuation of water level in different bouries located in the project area are shown in **Figure 9**. The figure indicates that the higher water level (0.7-0.8m) were found in the month of September and October after monsoon, while minimum water level (0.3-0.5m) in month of December to April months before monsoon, which indicates the ground water recharge occurs in local water bodies during monsoon season. This also helps for reducing runoff as well as soil erosion.

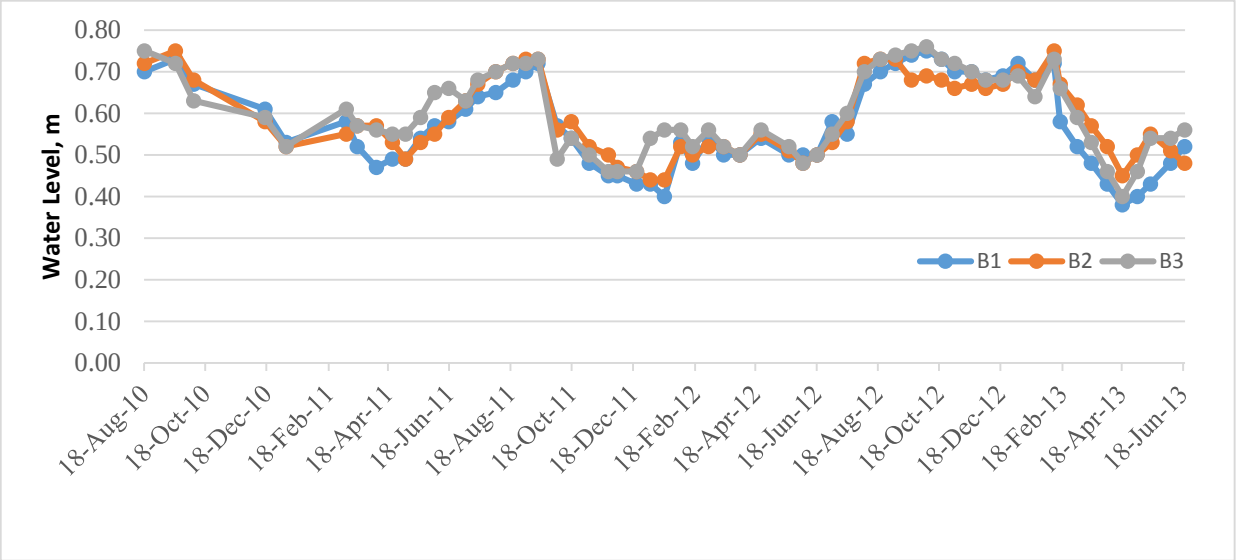

Figure 9: Water level variation in different bouries in the project area

Figure 10 shows spring flow variation in the project area. The maximum flow rate varied from 4.76 – 6.17 litres/second in different springs which is occurred during monsoon season while corresponding minimum values varied from 2.66 -3.85 litres/second, which is occurred during off monsoon season. Hence, the higher spring flow during rainy season. Figure 10 also depicts the lesser spring discharge in pre-monsoon months of January to May in comparison to spring discharge in post-monsoon season.

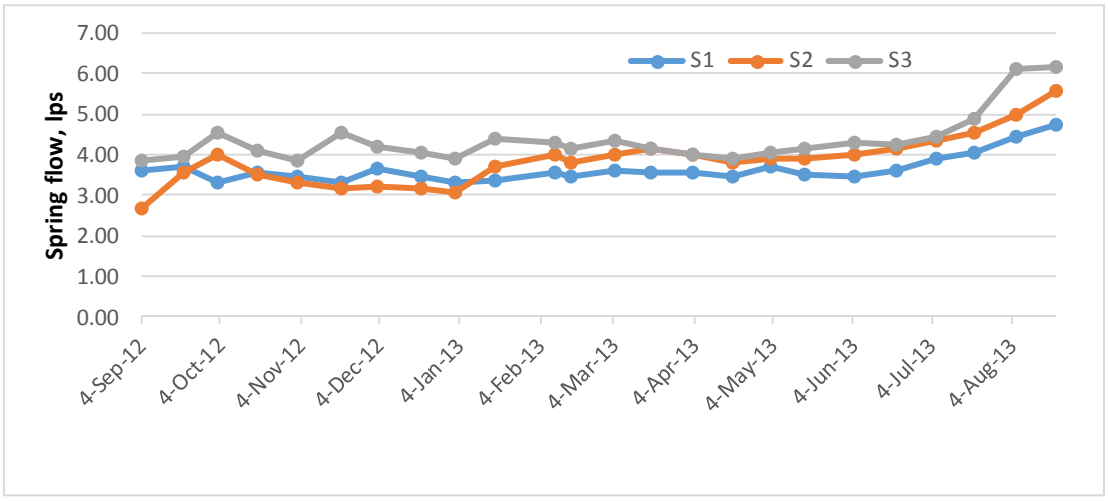

Figure 10: Spring flow variation in different springs in the project area

8.8 Construction of Percolation ponds

To reduce the surface runoff and enhance the groundwater recharge, percolation ponds were constructed in the project area as shown in **Plate 4**. A total of 33 such ponds (17 at Phagari and 16 at Bhajo) were constructed. The size of such ponds ranged from 0.4 m^3 to 1.3 m^3 having total volume of 78 m^3 (78000 L in one time). In addition, a natural depression on the way to Pandah was deepened and widened to increase its water storage capacity. Old dimensions were 6'-8' × 5'-6' × 1.5' compared to new dimensions of 22' × 12' × 5'.

8.9 Construction of Loose boulder check dams

To check the runoff velocity and retard the soil erosion, the cost effective measure is to construct the loose boulder check dams. In addition, these are also serve the purpose of in-situ moisture conservation and helpful in stabilizing stream banks as shown in **Plate 5**. In totality, 50 no. of loose boulder check dams (25 No. at Bhajo and 25 No. at Phagari) were constructed.

8.10 Construction of Gabion structures

The gabion structures are constructed to improve the in-situ moisture conservation status and ultimately check the soil erosion and stabilize the steep slope areas. Overall 4 no. of gabion structures (02 Nos. at Bhajo and 2 Nos. at Phangari) were constructed to stabilize small stream banks as shown in **Plate 6** & **Plate 7**. The total amount of 243.35 tonnes of sedimentation were deposited behind these gabion structures with the minimum value of 28.30 tonnes to maximum value of 122.76 tonnes per structure as depicted in **Table 5**

Table 5: Sedimentation behind the gabion structures constructed in the project area

Gabion Structure No.	Length (m)		Width (m)		Depth (m)	Sediment deposited behind the structure (tonnes)
	Bottom	Top	Bottom	Top		
G1	8.75	8.75	3.75	1.25	3.75	122.76
G2	6.25	6.25	2.50	1.25	2.50	60.05
G3	7.00	7.00	2.50	1.25	2.50	32.34
G4	7.00	7.00	2.50	1.25	2.50	28.30
					Total	**243.35**

8.11 Construction of LDPE farm ponds

Overall, 3 No. of LDPE farm ponds having the capacity of 3,20,000 litres for rain water harvesting and efficient utilization of harvested water were constructed in the project area as shown in **Plate 8 & 9 and Table 6**. Moreover, one no. of earthen pond of 90,000 litres capacity (15m × 8m × 0.75m) were also renovated in the project area.

The benefit cost ratio (B:C) for LDPE farm pond was estimated as 0.05 Rs. per litre under the ptoject while it was estimated as 0.27 Rs. per litre for RCC tank under another study by considering life span of 20 years for both LDPE and RCC water storage structures. Hence, it was concluded that the LDPE water storage ponds are useful, durable and cost effective for water harvesting. RCC water harvesting tanks are about six times costlier and less earthquake resistant than the LDPE farm ponds for rain water harvesting. This harvested water can be utilized for providing life saving irrigations to plants and fulfill the requirement of irrigations through conventional method as well as by installing micro/drip irrigation system. Since, hi-tech irrigation systems like micro/drip system requires assured availability of water for irrigation. Hence, the water can be stored during monsoon season and utilized for growing off season crops for fetching higher economic returns to the farmer.

Table 6: Water storage capacity of LDPE ponds constructed in the project area

LDPE pond No.	Length (m)		Width (m)		Depth (m)	Side Slope	Capacity (Litres)
	Bottom	Top	Bottom	Top			
LDPE1	5.5	10.0	1.5	6.0	1.5	1.5:1	50,000
LDPE2	6.0	12.0	3.0	9.0	2.0	1.5:1	1,20,000
LDPE3	6.0	12.0	3.0	9.0	2.5	1.25:1	1,50,000
						Total	3,20,000
Renovation of earthen pond (90,000 litres)							90,000
						Grand Total	4,10,000

The dimensions i.e. length, width and effective depth may be suitably adjusted as per field conditions for constructing a LDPE farm pond of desired capacity. The capacity and no. of the LDPE farm ponds can be decided on the basis of total water requirement of the crops grown in the field by employing a thumb rule that one 20 cum capacity pond is adequate to provide two irrigations through conventional irrigation methods to one canal (400 m^2) cropped area, or, four irrigations through micro/drip irrigation method to one canal (400 m^2) cropped area. Hence, the developed rain water harvesting capacity of 410 m^3 is sufficient for about 1 ha cultivated land area in the project area. The harvested water is being utilized for the purpose of nursery raising and cultivation of land under various off season vegetable crops i.e. capsicum, cauliflower, tomato, broccoli and fruits like plum, peach, apricot etc. by different departments of the university and local residents of the project area for increasing their land productivity. Overall, an additional irrigation potential of 4 ha is also created through augmentation of water resources achieved through this project.

Plate 4: Percolation pond made and its impact in project area

Plate 5: Loose boulder check dam and its impact in project area

Plate 6: Gabion structure No. 1 and 2 and its impact in project area



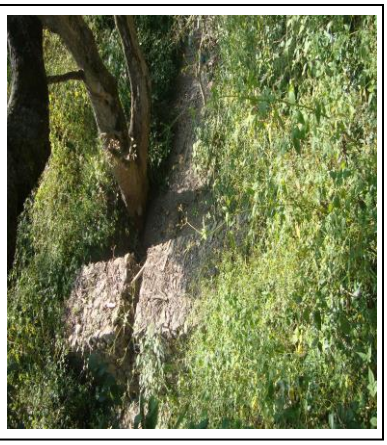

Plate 7: Construction of Gabion structure No. 3 and 4 and its impact in the project


Plate 8: Renovation of earthen dam & Construction of LDPE farm pond – 50, 000 litres


Plate 9: Construction of LDPE farm ponds (1,20,000 & 1,50,000 litres capacity)

8.12 Physical achievements/activities

The physical achievements/activities carried out during the study period under the project are enumerated in Table 7.

Table 7: Overall physical achievements/activities

S.No.	Name of the treatment	Activities (Nos.)
L	Trenches	193
2.	Gabion structures	04
3.	Loose boulder check dams	50
4.	Plantation	1700
	Grewia optiva	440
	Cedrus deodara	600
	Quercus spp.	100
	Salix spp.	100
	Bamboo	100
	Morous	160
	Robinia spp.	200
	Grasses - Setaria (Rooted slips)	2500
	Grasses - Napier (Rooted slips)	2500
	Grasses - Panicum (Rooted slips)	2500
5.	LDPE farm ponds	03
6.	Percolation ponds/tanks	33

9. Conclusions/Recommendations:

The construction of LDPE ponds are recommended for providing life saving irrigations to the plants/crops for efficient utilization of rain water harvesting and maximizing productivity. The construction of gabion structures in series are recommended for minimizing soil loss. In situ moisture conservation/ground water recharging techniques i.e. plantation, construction of trenches, percolation ponds, loose boulder check dams etc. are recommended for reducing the land degradation, soil erosion, stabilizing hill slopes & stream banks and efficient utilization of natural resources particularly in hilly areas.

10. How the conclusions/recommendations compare with current thinking:

The conclusions /recommendations have proved the superiority of LDPE farm ponds over RCC tanks under hilly conditions to minimizing the cost of construction of harvesting structures to enable life saving irrigations to the plants.

11. Field tests conducted: Yes

12. Software generated: No

13. Possibilities of any patents/copyrights: No

14. Suggestions for further work:

Further studies may be conducted on the impact assessment of soil conservation measures on soil properties, crop yield, water use efficiency and benefit cost ratio.

Signature
Head of the Department
Deptt. of SSWM
Name: Dr J C Sharma
Date : 13.2.2020

Professor & Head, SSWM
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Dr. Y.S.P. University of Horticulture & Forestry
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Signature
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Name: Er. Ghanshyam Agrawal
Date : 10.2.2020

Signature
Director of Research
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Name: Dr J N Sharma
Date : 18.2.2020

Director of Research
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References:

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APPENDIX - I

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GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION
INCSW SECRETARIAT

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No. INCID/SC-II/2006/ 640

Dated: /5/11/2012.

To,

Dr. Sudhir Verma
Assistant Professor,
Dept. of Soil Science and Water Management
Dr. Y. S. Parmar University of Horticulture and Foresty.
Nauni, Solan (H.P.).

Sub: Construction of roof top Water Harvesting Structures under ongoing R&D Scheme - reg.

Ref: Your Letter No. UHF/SSWM/E-63/1478-79, dated 03.10.2012.

Sir,

This is with reference to your letter referred to above. As you may recall, during the discussions in the 10th R&D session of INCID on the cited subject, it was emphasized that no duplication should occur while constructing Roof-Top Water harvesting structures, wherever Govt agencies have already undertaken this type of work.

Yours sincerely,

(Yogesh Paithankar)
Director Rem. Sens. / R&R